(No Model.)

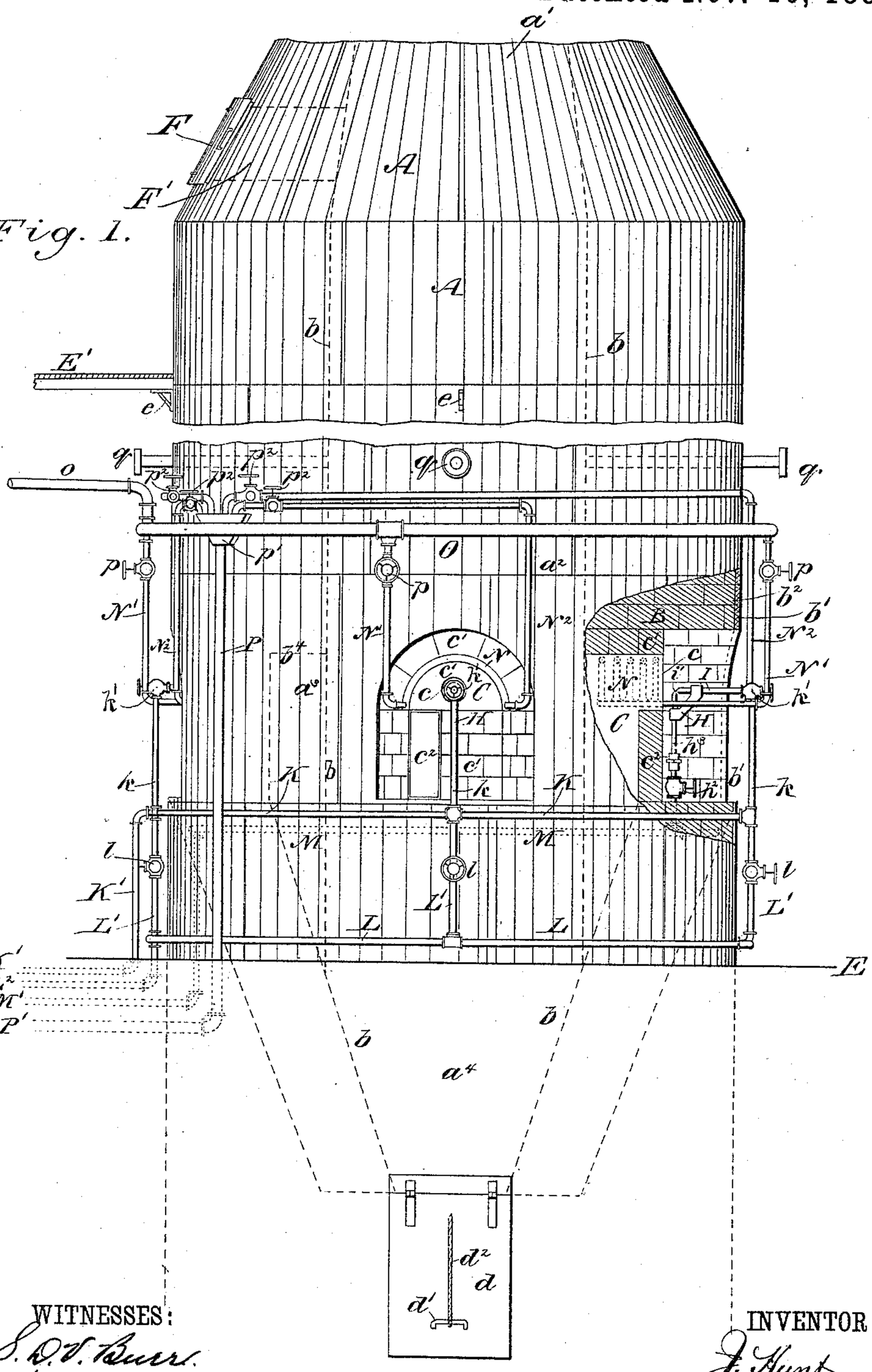
2 Sheets—Sheet 1.

J. HUNT.

LIMEKILN.

No. 330,121. Patented Nov. 10, 1885.

Fig. 1.



WITNESSES:

S. D. V. Burr.

C. Sedgwick

INVENTOR:

J. Hunt

BY Munn & Co

ATTORNEYS.

(No Model.)

2 Sheets—Sheet 2.

J. HUNT.

LIMEKILN.

No. 330,121. Patented Nov. 10, 1885.

Fig. 3.

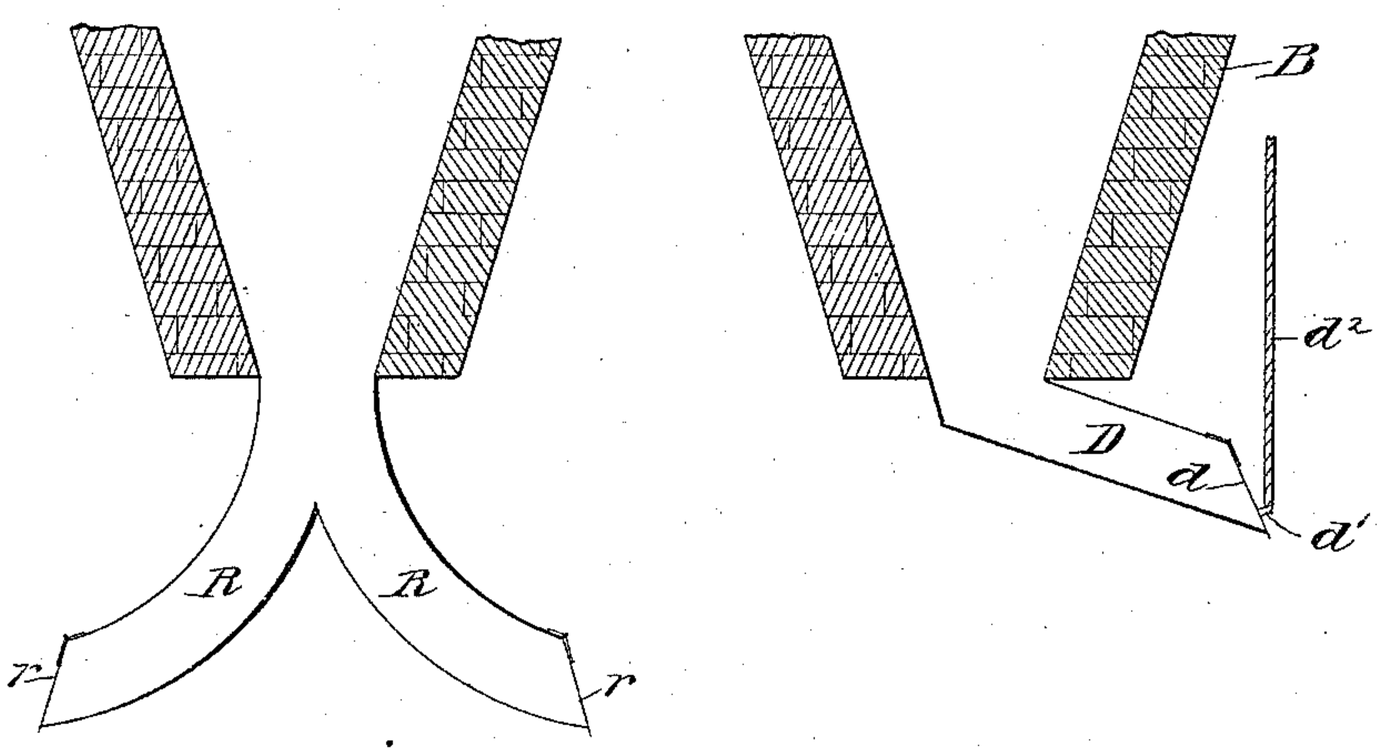


Fig. 2.

Fig. 4.

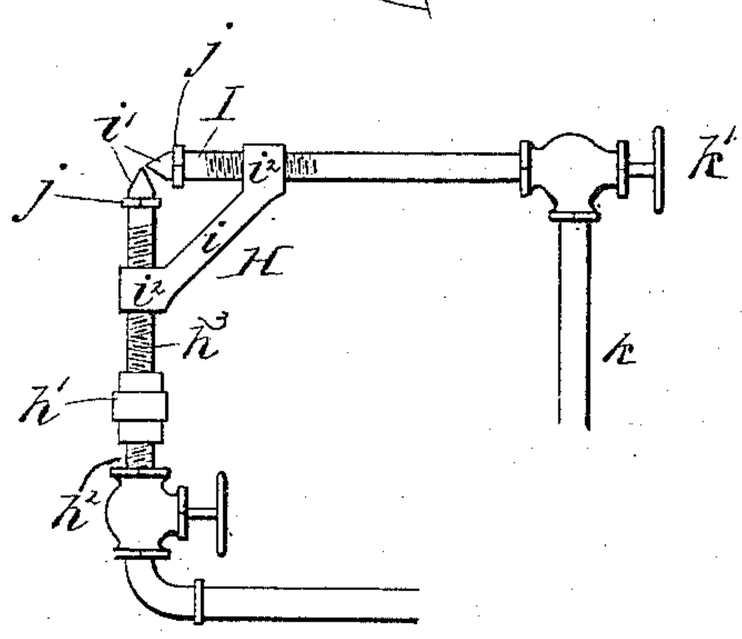


Fig. 5.

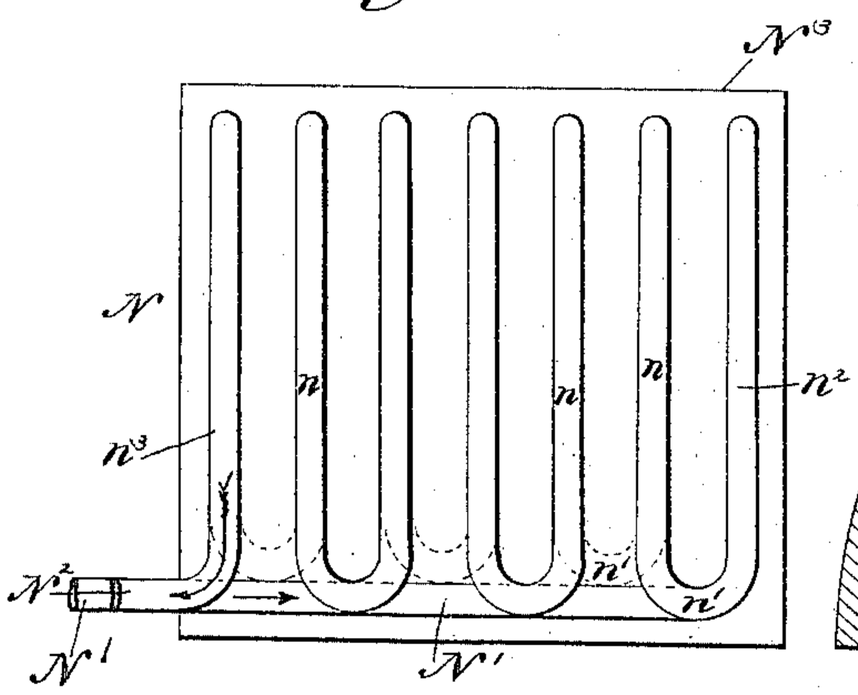
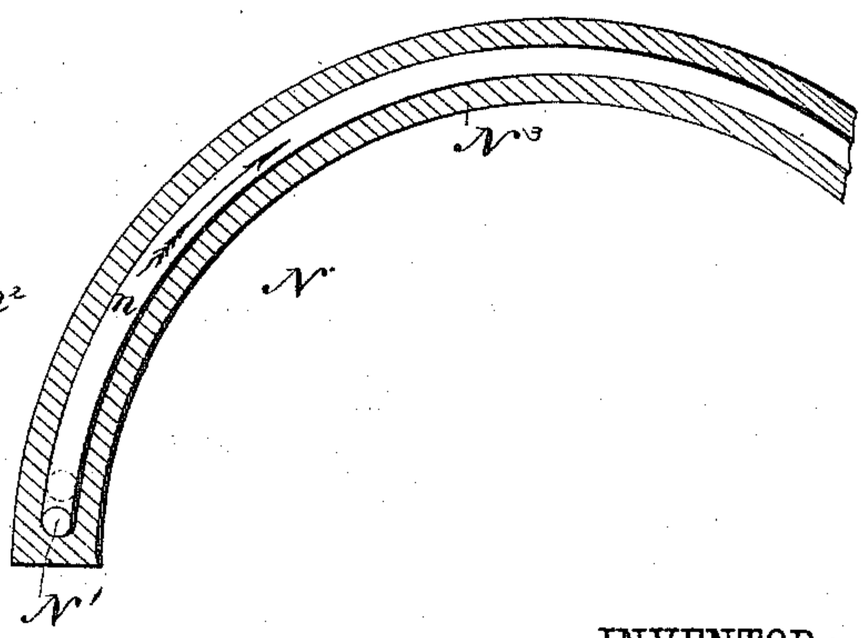


Fig. 6.



WITNESSES:

S. D. V. Burr.

C. Sedgwick

INVENTOR:

J. Hunt

BY Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

JOSHUA HUNT, OF CATASAUQUA, ASSIGNOR TO THE BAKER LIME COMPANY, (LIMITED,) OF AVONDALE, PENNSYLVANIA.

LIMEKILN.

SPECIFICATION forming part of Letters Patent No. 330,121, dated November 10, 1885.

Application filed April 23, 1885. Serial No. 166,127. (No model.)

To all whom it may concern:

Be it known that I, JOSHUA HUNT, of Catasauqua, in the county of Lehigh and State of Pennsylvania, have invented a new and Improved Limekiln, of which the following is a full, clear, and exact description.

The object of my invention is to provide a kiln for the burning of limestone, wherein the limestone in its passage vertically through the kiln from the feeding-door at the top to the delivering-chute at the bottom will be subjected to the action of the intense heat produced by a hydrocarbon-burner, which heat is driven by the operation of the burner into the interior space of the kiln. I thus form a kiln which may be operated continuously, and which will deliver the lime in a condition absolutely free from physical impurities, such as cinders, and also free from chemical impurities, particularly sulphur, and which will lessen the labor required to handle both the limestone and the lime.

My invention consists in a limekiln constructed with an exterior iron shell and an interior fire-clay or brick lining, between which and the iron shell is a recess filled with cinders or some similar yielding material.

My invention further consists in a limekiln constructed with an opening in its upper portion for the passage of limestone, and with openings just below its central portion for receiving the hydrocarbon-burners, and with an opening in its base leading to a chute from which the lime is delivered.

My invention further consists in a limekiln constructed with burner-openings, in the rear upper portions of which are water-backs, through which water circulates in order to keep the adjacent fire-brick lining from being burned out.

My invention further consists in a limekiln constructed with a water-circle fed from a tank or reservoir, and from which a pipe leads to the inner end of each water-back, the outer end of each water-back being connected to a pipe which delivers the water into the funnel-shaped mouth of a pipe which carries the water away, and with an oil-circle connected by a pipe with an auxiliary tank, which in turn is connected with a storage-tank, and also to one of the two tubes forming the burner, and with a steam-circle supplied from a boiler through suitable connections and connected with the second of the two tubes forming each burner, and also connected with a circle of pipe placed below it, so as to carry away the water of condensation. These circles and pipes are provided with valves, by means of which the flow of the vapor or liquids passing through them can be regulated.

My invention further consists in particular constructions and combinations of parts of the limekiln, all as hereinafter fully described and claimed.

Reference is to be had to the accompanying drawings, forming part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a side elevation of my improved limekiln, parts being broken away to show the burner-opening in horizontal sectional elevation. Fig. 2 is a sectional elevation of the delivery-chute in a plane perpendicular to Fig. 1. Fig. 3 is a modification of the delivery-chute in the same sectional elevation as Fig. 2. Fig. 4 is a side elevation of the burner. Fig. 5 is a side view of the water-back, the outline of the iron casing of which is shown; and Fig. 6 is a section through the water-back at right angles to Fig. 5.

The limekiln proper is, as shown, formed of an iron shell, A, the lower portion of which is cylindrical in shape, while the upper portion forms the frustum of a cone, the upper end of the conical portion terminating in a smoke-stack. (Not shown.) Within the shell A is a fire-brick lining B, extending from the lower end of the kiln to a point a little above the feed-door F. The interior shape of this lining is indicated by the dotted lines *b b*, its upper part, a', being conical, its central part, a^2, being cylindrical, with recesses a^3 at the burner-openings C, as indicated by the dotted lines b^4, and its lower part, a^2, being in the form of the frustum of an inverted cone. Between the shell A and the lining B is a space, b', which is filled with cinders b^2, or some similar yielding substance, which will adapt itself to the expansion and contraction of the iron shell A, thereby relieving the lining B of all undue pressure and the shell A of all undue strain.

The lower extremity of the interior cham-

ber of the kiln terminates in an inclined iron box or chute, D, of square or circular cross-section, the end of which is provided with a hinged door, *d*, formed with a handle, *d'*, to which the end of a rope or chain, d^2, is secured. This rope d^2 leads over pulleys suitably located, and carries a weight at its outer end, by means of which the door may be raised.

The building in which the kiln is placed is divided into three stories. The lower floor (not shown) is at such a distance below the end of the chute D as to permit a barrow or small wagon being run under the door *d*. The second floor, E, is at the bottom of the iron shell A. The third floor, E', is nearly at the top of the cylindrical part of the shell A. The beams of that section of the upper floor surrounding the kiln are supported by brackets *e*, attached to the shell A. The shell A and lining B need not extend below the floor E, and may be supported upon any foundation of suitable construction. The feed-door F is hinged to the conical part of the shell A, and opens into a horizontal passage, F', leading through the lining B to the interior chamber.

At or near the base of the main or combustion chamber of the kiln are four (more or less) openings, C, extending from outside to inside, and placed in the same horizontal plane and at equal distances apart around the kiln. I prefer to make the lower portion of the outward half of these openings rectangular in a section at right angles to their axes, and with sides converging toward the interior of the kiln. The upper portions of the openings are semi-cylindrical. Extending across each opening, about at the center, is a wall, *c'*, of fire-brick, in an aperture in which the brick c^2 is loosely inserted, in order that it may be removed when necessary. From the inside of the cross-wall *c'* the opening is sloped away to the inner line of the kiln-lining, forming recesses a^3. At a point a little below the arched roof of the openings C is an aperture, *c*, through the cross-wall *c'*. The flame from the burners H enters the interior of the kiln through these apertures.

The burner H is known as the "hydrocarbon-burner." It is similar in construction and acts upon the same principle as the ordinary atomizer. It consists, mainly, of two tubes, I h^3, held at right angles to each other by the bracket *i*, the ends of which, i^2 i^2, are formed with screw-threaded holes, into which screw the threaded ends of the tubes h^3 I. The opposite ends, *i'*, of these tubes are sharply tapered, and the points so formed are brought close together. The tubes are formed near their tapered ends with squared portions *j j*, to which a wrench may be applied to turn the tubes to bring their points *i'* into proper relationship with each other. The tubes I h^3 have a small aperture extending entirely through them longitudinally.

The end of the pipe *k* is threaded to fit in the outer part of the upper end of bracket *i*. This pipe leads to the steam-circle K, which surrounds the exterior of the kiln in a plane a little below the bottom of the burner-openings C, and is supplied with steam from a boiler suitably located (not shown in the drawings) through the pipe K'. The pipe *k* is furnished with a valve, *k'*, by means of which the quantity of steam passing through the burner H may be regulated. Surrounding the kiln in a plane below that of the steam-circle K is the pipe L, which is connected by the pipes L' with the steam-circle K. The pipes L' are located vertically below the pipes *k*, and are designed to lead the water of condensation to the pipe L, from which it is led away through the pipe L^2. Each connecting-pipe L' is provided with a drip-cock, *l*, to allow the water of condensation to pass off.

The pipe h^3 is formed with a right and left screw-thread, and its upper end screws into the lower end, i^2, of the bracket *i*. The upper end of the pipe h^2, which leads to the oil-circle M, is screw-threaded, and in this pipe, below the pipe h^3, a valve may be provided for regulating the flow of oil. The pipes h^2 and h^3 are united by means of the right-and-left coupling *h'*. The oil is led from the auxiliary tank (not shown in the drawings) to the oil-circle M through the pipe M'. The oil-circle M is shown as located just within the iron shell A, and about at the level of the floors of the burner-openings C; but in practice it may be preferable to place the oil-circle on the exterior of the kiln. I do not limit myself in this respect. The auxiliary oil-tank is placed at such an elevation that when full the level of the oil will be about three inches below the points *i'* of the burners, and as the tank is preferably made about thirteen inches deep inside, the level of the oil, when the tank is nearly empty, will be about fifteen inches below the points of the burners. This auxiliary tank is supplied from an oil-reservoir of large capacity.

Owing to the intense heat of the flame near the burners, it is necessary to protect the part of the lining B with which the flame would come in direct contact. This is accomplished by artificially cooling that portion of the lining immediately adjacent to the upper rear section of the burner-openings by means of a current of water circulating through the water-backs N. The water-back may be formed of a semi-cylindrical box fitting within the upper portion of the burner-opening, through which water is allowed to flow; but I prefer to construct it with a pipe, *n*, bent so as to return upon itself, as shown in Figs. 5 and 6, thereby forming a series of zigzags, in which the pipe-sections between the bends *n' n'* are parallel to each other. The pipe-sections between the bends *n' n'* are curved to form a semicircle, which will fit snugly within and be concentric with the cylindrical portion of the burner-opening C. The inner one, n^2, of these pipe-sections is connected with a pipe, N', leading to the water-circle O, and the outer one, n^3, of these pipe-sections is connected with a pipe, N^2, leading

to the waste-water collector P. By this means the water from the water-circle O is lead through the pipe N′ to the rear of the water-back N, and after circulating back and forth through the pipe *n* it is conducted through the pipe N^2 to the collector P, from which it flows away through the pipe P′. By this construction the cool water is led directly to the rear portion of the burner-opening C, and during its passage through the water-back it reduces the temperature of the adjoining brick lining B sufficiently to prevent it being burned or disintegrated. Surrounding the curved line of pipe *n* in the water-back N is a casing, N^3, of cast-iron or fire-clay, which is curved in lines parallel with those of the pipe *n*. The casing protects the pipe from the action of the flame, and serves to evenly distribute the cooling effect of the water.

The water-circle O surrounds the exterior of the kiln in a plane higher than the highest point in the water-back N, and is connected by the pipe *o* to the bottom of a reservoir placed at a greater elevation than the water-circle O. The water is thus enabled to flow by gravity through the water-circle O to the water-backs N, and to be discharged into the pipe P. The pipe N′ is provided with a valve, *p*, which may be used, although it is not absolutely necessary to the perfect working of my kiln, to regulate the quantity of water flowing through the water-backs.

Each water-back is provided with a pipe, N^2, each of which terminates directly over the flared or funnel-shaped mouth *p′* of the waste-water collector P, and the end of each pipe N^2 is provided with a valve, p^2, and it is by means of these valves that I prefer to regulate the quantity of water flowing through the water-backs. The valves p^2 are more conveniently located than the valves *p*, since by holding the hand under the delivery end of the pipes N^2 the temperature of the water coming from the water-backs may be judged and the flow regulated accordingly. By providing each water-back N with an independent pipe, N^2, leading to the collector P, I am enabled to regulate the flow of water, and thereby gage the cooling effect of each water-back independently of the others.

In a direct line above each burner H is a peep-hole, *q*, through which the interior of the kiln may be seen, and if the heat in one part of the interior should appear to be more intense than in another the flames may be regulated accordingly.

The hinged door F is placed at a convenient height above the floor E′ for passing the limestone through the passage F′ (indicated by the dotted lines) to the interior of the kiln.

The brick c^2 is loosely inserted in the punching-opening in the cross-wall *c′* of the burner-opening C, in order that it may be removed, and an iron rod inserted if it should become necessary to loosen the mass of limestone descending through the interior of the kiln.

I do not limit myself to the particular form and construction of kiln shown and described, as my appliances and method for burning lime may be applied to kilns differently constructed and arranged; nor do I limit myself to any particular method for producing the heating-flame.

The operation of my improved limekiln is as follows: The interior chamber of the kiln is kept filled with limestone passed through the opening closed by the door F. By turning the valve *k′* steam is allowed to pass from the steam-circle K through the tube I and enter the interior of the kiln. The rapid passage of steam across the opening in the tapered point *i* of the tube *h* creates a partial vacuum which draws up the oil from the oil-circle M through the pipe h^2. The oil is thus finely sprayed or atomized, and when ignited an intense heat is produced, which is driven into the kiln. The flame is conical in form, the apex of the cone being at the burner-points *i′*. The current of steam issuing from the steam-point *i′* is regulated by means of the valve *k′*, and thereby the quantity of oil drawn up to the oil-point *i′* and the intensity of the flame are also governed. The quantity of oil consumed being dependent upon the rapidity of the flow of steam form the tube I, there is but little need of a valve in the oil-pipe h^2 or in the oil-circle M, for since the burner-points *i′* are always at a greater elevation than the oil in the auxiliary tank the oil-pipe at the burner need not in all cases be provided with a valve; but I prefer to place a valve in the pipe h^2, to insure the regulation of the flow of oil. By this method I obtain not only an intense heat, but a very perfect combustion and deliver the lime in a state absolutely free from sulphur, an ingredient which is almost invariably present in all lime burned with either coal, coal and coke, or coal and wood, and which not only injures the bond of mortar made from the lime, but also results in the discoloration of brick-work. In addition to this the great heat of the flame and its purity act to desulphurize the material passing through the combustion-chamber, so that by this method of burning lime I not only prevent the possibility of the introduction of sulphur in the lime, but I remove that deleterious element when it is present in the limestone. The lime is also delivered in a condition wholly free from the mechanical impurities, and as it is taken from the chute D it may be either stored or packed. Further than this, the kiln may be operated continuously, the oil, steam, and water supplies requiring but little attention, and the feeding of the limestone and the removing of the lime requiring but little labor. Water resulting from condensation of the steam in the pipe *k* is led away through the pipe L′, the drip-cock *l* being open. When once adjusted, the valve p^2, regulating the flow of water through the water-backs N, will need but occasional looking after.

The modification of the lower end of the kiln shown in Fig. 3 consists of delivering-

chutes R, (two or more in number,) which, beginning at a common point beneath the center of the kiln, curve downwardly and outwardly, and are provided with hinged doors *r* at their outer ends. These chutes may have a rectangular or circular cross-section. The lime may be removed from one of these chutes while the other is being filled with lime descending through the kiln. By this means one or more storage-chambers may be formed in which to cool the lime.

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

1. A limekiln constructed with an outer iron shell, an inner fire-brick lining, and an interposed layer of yielding material, as set forth.

2. A limekiln constructed with an outer iron shell and an inner fire-brick lining, and provided with openings for the introduction of the flame of hydrocarbon-burners to the interior space of the kiln, as set forth.

3. The combination, with a limekiln having openings for the introduction of the flame of hydrocarbon-burners, of water-backs at the upper inner portions of said openings, as set forth.

4. The combination, with a limekiln constructed with an outer iron shell, an inner fire-brick lining, and an intervening yielding material, and having burner-openings through said shell, lining, and intervening yielding material, of water-backs arranged at the upper inner portions of said openings adjacent to the fire-brick lining, whereby said lining will be protected from the heat of the flame of hydrocarbon-burners, as set forth.

5. A limekiln constructed with burner-openings having their inner upper portions covered and protected with water-backs, in combination with a water-circle connected with a water-reservoir and with the water-backs.

6. In a limekiln constructed with burner-openings having their inner upper ends protected with water-backs, the combination, with said water-backs, of a water-circle having connections with said water-backs and with a water-reservoir, as set forth.

7. In a limekiln constructed with burner-openings, and said burner-openings being protected with water-backs, the combination, with said water-backs and with a water-circle connected with said water-backs, of overflow-pipes from the said water-backs, provided at their extremities with regulating-valves, substantially as set forth.

8. In a limekiln having burner-openings protected at their inner upper portions with water-backs, the combination, with said water-backs, of a water-circle arranged above the plane of the water-backs, connections from the water-circle to a water-reservoir and to one end of the water-backs, of overflow-pipes from the other end of the water-backs to a suitable water-collector, and of regulating-cocks at the outer extremities of said overflow-pipes, the said outer ends of the overflow-pipes being arranged below the level of the water-reservoir, as set forth, whereby a continuous and regulated current of water can be passed through the said water-backs, as set forth.

9. In a limekiln constructed with burner-openings, the said burner-openings provided with an apertured cross-wall, as set forth.

10. In a limekiln constructed with burner-openings, a cross-wall arranged centrally of said burner-openings, and provided with a flame-opening and with a punching-hole, as set forth.

11. The combination, with a limekiln constructed with burner-openings, of a hydrocarbon-burner, as set forth.

12. The combination, with a limekiln constructed with burner-openings having an apertured cross-wall, of a hydrocarbon-burner, substantially as set forth.

13. The combination, with a limekiln having burner-openings, of hydrocarbon-burners arranged in said openings, as set forth.

14. The combination, with a limekiln having burner-openings provided with an apertured cross-wall, of hydrocarbon-burners and of a steam-circle having connections with said burners, as set forth.

15. The combination, with a limekiln having openings provided with an apertured cross-wall, of a hydrocarbon-burner, and of an oil-circle having connection with the vertical tube of said burner and of an oil-reservoir, and said reservoir being arranged so that the level of the oil will always be below the end of the vertical pipe of the burner, as set forth.

16. The combination, with a limekiln having a burner-opening provided with an apertured wall, of a hydrocarbon-burner, an oil-circle having connection with the vertical tube of the burner, a steam-circle having connection with the horizontal tube of the burner and of a regulating-valve in the connection between the steam-circle and the burner, as set forth, whereby the current of oil fed to the burner can be regulated and the intensity of the flame controlled.

17. In a limekiln having burner-openings, hydrocarbon-burners in said openings, and an oil and a steam circle for feeding and operating said burners, the combination, with said steam-circle, of a circle having valve-connection with the steam-circle for carrying off the water of condensation, as set forth.

18. The combination, with a limekiln having burner-openings, hydrocarbon-burners in said openings, and devices for supplying oil and steam to said burners, of water-backs in the upper inner portions of said openings, and of means for keeping up a continuous circulation of water through said water-backs, as set forth.

19. A limekiln constructed with central burner-openings centrally divided by an apertured cross-wall, and in the front part of which opening is a hydrocarbon-burner, in

combination with said burner an oil-circle receiving oil from an auxiliary oil-tank and having a pipe leading to the vertical tube of each burner, the said oil-tank being at such an elevation that the level of the oil in it will always be below the points of the burners, substantially as herein described and set forth.

20. A limekiln constructed with central burner-openings centrally divided by an apertured cross-wall and provided with water-backs in their upper rear portions, in combination with a hydrocarbon-burner, one tube of which is connected with an oil-circle fed from an oil-reservoir, and the second tube of which is connected with a steam-circle fed with steam from a boiler, substantially as herein described and set forth.

21. A limekiln constructed with an outer iron shell, a fire-brick lining, and an intervening space filled with a yielding material and having a vertically-ranging inner chamber, in combination with a chute or chutes beginning at the bottom of the vertical inner chamber and extending downwardly and outwardly, having a rectangular or circular cross-section and being provided with an outer end door or doors, substantially as herein described and set forth.

22. In a limekiln constructed with an inner fire-brick lining forming a vertical chamber in said kiln, the said chamber having its upper portion in the form of the frustum of a cone, its central portion formed with straight vertical walls recessed near the base of said straight portion, and having its lower portion formed as an inverted frustum of a cone and provided with a delivery-chute, as set forth.

23. In a limekiln having an inner fire-brick lining forming a vertical chamber, the central vertical walls of which are recessed near the base of the straight portion, the said kiln and its lining having burner-openings opening into the said recessed portions of its interior chamber, as set forth.

24. A limekiln constructed with an outer iron shell, a fire-brick lining, and an intervening space filled with a yielding material, and with a vertically-ranging inner chamber with centrally-located burner-openings having their inner upper portions protected by water-backs and having hydrocarbon-burners located in their front portions, in combination with a water-circle receiving water from a reservoir and suitably connected with the water-backs, a steam-circle receiving steam from a boiler and suitably connected with one of the burner-tubes, and an oil-circle receiving oil from a tank and suitably connected with the second burner-tube, as herein described and set forth.

25. A limekiln constructed with an inner fire-brick lining, openings through the kiln and lining into the interior chamber of said kiln, water-backs at the inner upper portions of said openings, hydrocarbon-burners in said openings, a suitably-valved connection from a water-supply to the said water-backs, suitable connections from the burners to an oil-supply, and suitably-valved connections from the burners to a steam-supply, substantially as set forth.

26. A limekiln constructed with an interior vertically-ranging chamber extending from the upper to the lower end, in the upper end of which chamber is an opening for the admission of limestone, and in the lower end an opening through which the lime may be drawn away, and having central openings through which the flame from hydrocarbon-burners enters the interior chamber of the kiln and subjects the limestone to an intense heat as it passes by gravity through the kiln, substantially as herein described and set forth.

27. The combination, with a kiln, of hydrocarbon-burners arranged to throw their flame into the mass of limestone descending by gravity through the kiln, substantially as herein described and set forth.

28. The combination, with a continuous limekiln provided with burner-openings, of burners arranged in said openings, and of blast devices in connection therewith, substantially as set forth, whereby a powerful heating-flame can be forced into the mass of limestone passing through the said kiln.

JOSHUA HUNT.

Witnesses:
R. H. HEPBURN,
ISAAC CONARD.