(No Model.)

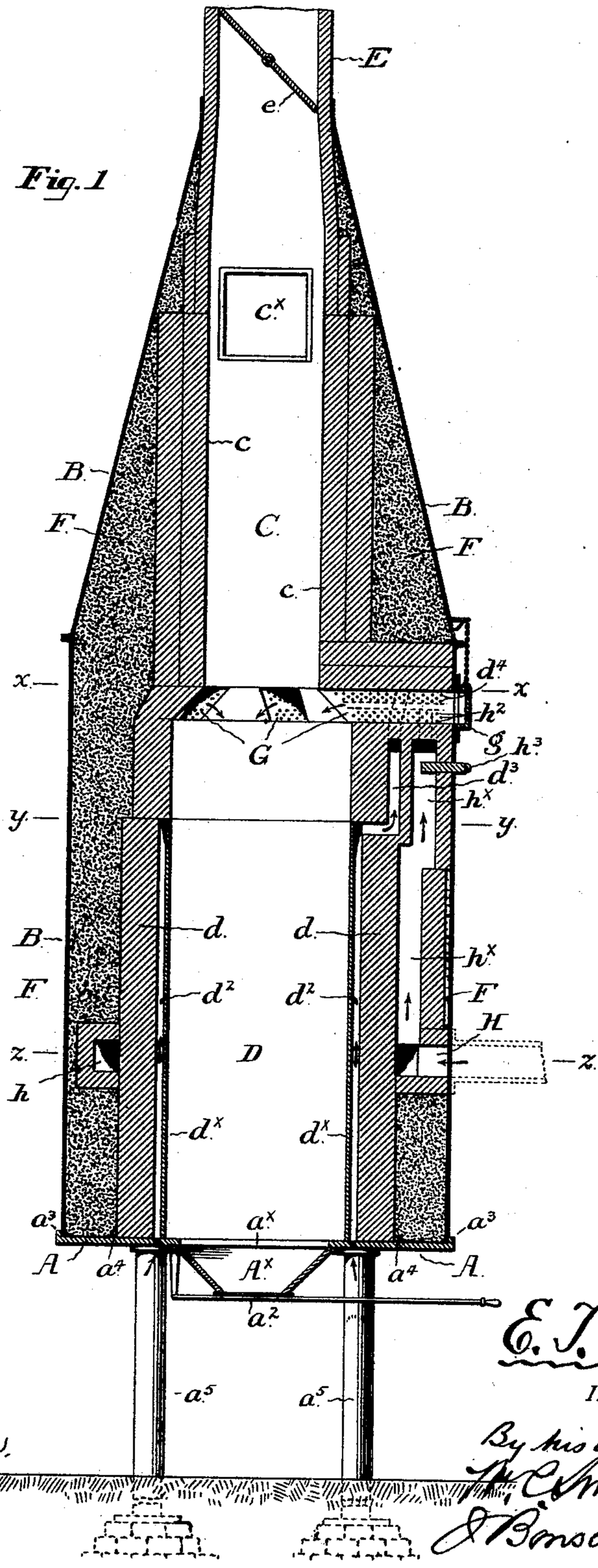
2 Sheets—Sheet 1.

E. T. WARNER.

LIMEKILN.

No. 414,350. Patented Nov. 5, 1889.

Fig. 1



WITNESSES:

F. Norman Dixon,
Louis Altmaier.

E. T. Warner,
INVENTOR
By his attorneys,
H. C. Hazelwood Jr.
& Bonsall Taylor

(No Model.) 2 Sheets—Sheet 2.

E. T. WARNER.

LIMEKILN.

No. 414,350. Patented Nov. 5, 1889.

Fig. 2.

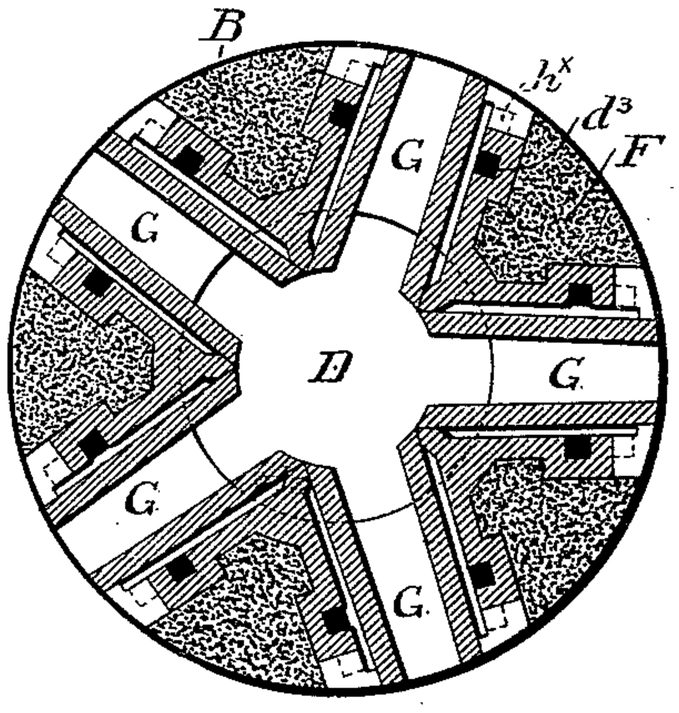


Fig. 3.

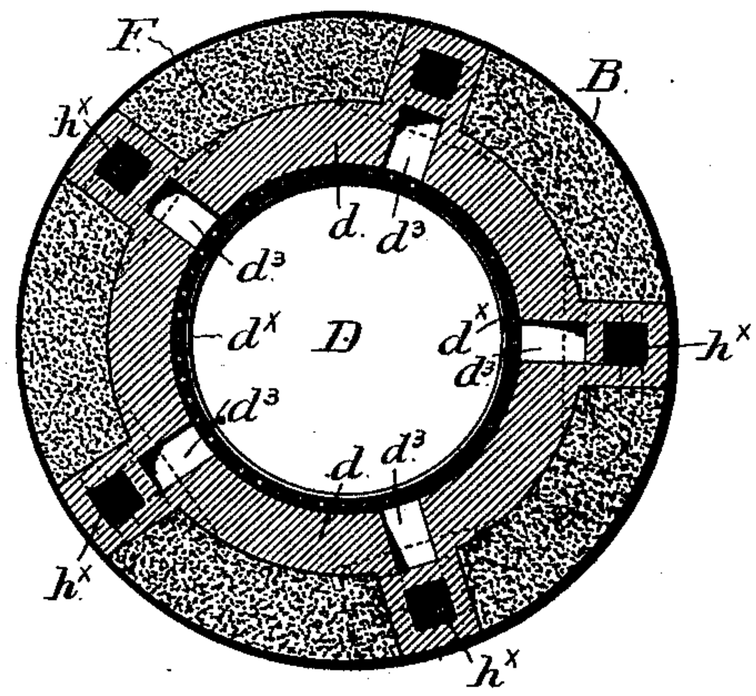


Fig. 4.

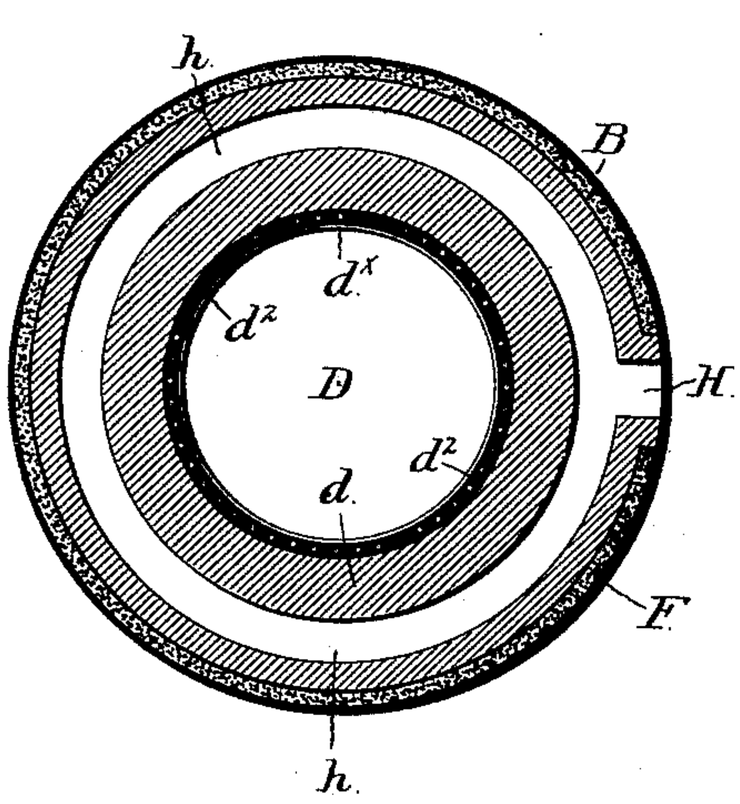
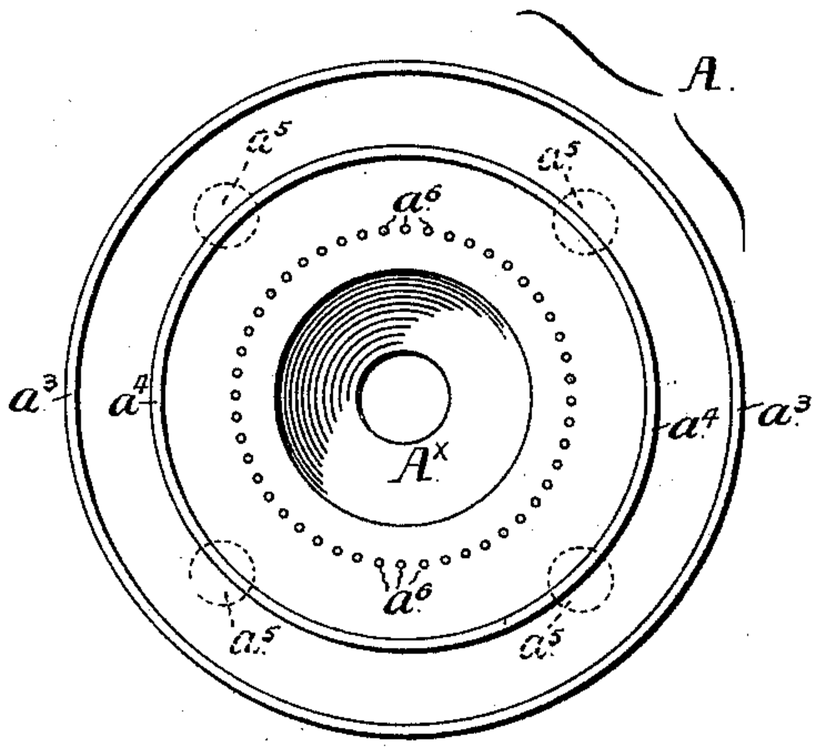


Fig. 5



WITNESSES:

F. Norman Dyson
Lewis Altmaier.

E. T. Warner,
INVENTOR

By his attorneys,
Wm. C. Strawbridge & Bonsall Taylor

UNITED STATES PATENT OFFICE.

EDWARD TATNALL WARNER, OF WILMINGTON, DELAWARE.

LIMEKILN.

SPECIFICATION forming part of Letters Patent No. 414,350, dated November 5, 1889.

Application filed May 7, 1889. Serial No. 309,909. (No model.)

To all whom it may concern:

Be it known that I, EDWARD TATNALL WARNER, a citizen of the United States, residing at Wilmington, in the State of Delaware, have invented certain Improvements in Limekilns, of which the following is a specification.

My invention relates to a class of devices for burning limestone, cement rock, and other material, rudimentally so well known as not to require special description, and its object is the construction of a kiln in which the calcining of the carbonate of lime, or other material, can, by the combustion of commingled heated air and gas, be rapidly, effectually, and economically, conducted.

With these ends in view, my invention comprehends apparatus, a good form of a convenient embodiment of which is represented in the accompanying drawings and hereinafter described, the particular subject matter which I claim as novel being hereinafter definitely specified.

In the accompanying drawings, Figure 1 is a central, vertical, sectional, elevation, of a limekiln embodying my improvements; Fig. 2 is a horizontal sectional plan taken through said kiln in the plane of the dotted line $x\ x$ of Fig. 1; Fig. 3 is a similar plan taken through said kiln in the plane of the dotted line $y\ y$ of said Fig. 1; and Fig. 4 is a similar plan taken through said kiln in the plane of the dotted line $z\ z$ of said Fig. 1. Fig. 5 is a top plan view of the basal mantel which supports the kiln proper.

Similar letters of reference indicate corresponding parts.

The kiln represented in the drawings and hereinafter described is internally of cylindric form, and externally its lower portion is likewise cylindric while its upper portion is conical. It is to be understood, however, that this form is resorted to from preference merely, and that I do not confine myself to it, as the kiln as an entirety may be both externally and internally of other than cylindric form, its section, for instance, being, at will, square, polygonal, elliptical, or irregular.

In the drawings, A represents the basal mantel or base plate upon which as a bed the structure of the kiln proper is erected. This mantel is of annular form, preferably composed of metal, and of sufficient strength to support the superimposed structure. The central circular discharge opening $a^{\times}$ of the mantel is conveniently closed by a discharging funnel $A^{\times}$, the discharging throat of which is in turn closed by a gate a^2 of any preferred character. Upon the upper face of the mantel R are, for convenience of construction, formed two concentric ribs or flanges, of which the rib a^3 is formed at the outer edge or circumference, and the rib a^4 about midway between said outer edge and the inner edge or that of the discharge opening. The mantel itself is conveniently supported upon columns a^5 erected from the ground to a height sufficient to permit of suitable access to the throat and gate of the discharging funnel.

Upon the mantel is erected and supported the external inclosing shell B of the kiln, conveniently made of sheet iron. This shell, in the form shown, is cylindric as to its lower portion and conical as to its upper. Upon the mantel within the shell is also erected and supported the fire brick, soapstone, silica rock, or other fire proof structure which forms the body of the kiln proper, and which is essentially constructed to form two chambers, of which the upper or burning chamber C, the fire brick walls of which are designated c, is preferably of less diameter than the lower or cooling chamber D, the fire brick walls proper of which are designated d. Above the burning chamber extends the stack E, within which, preferably, is a stack damper e of any preferred character. At the upper portion of the burning chamber is a charging aperture $c^{\times}$, likewise of any preferred character.

The annular interspaces between the external surfaces of the fire brick walls of the kiln proper and the internal surfaces of the inclosing shell, are filled with packing material F of any preferred character, ashes or earth being suitable for the purpose.

G are a series of combustion chambers, which are five in the structure shown, and which radiate from the base of the burning chamber to and through the inclosing shell B of the kiln. These combustion chambers are best shown in Fig. 2. They are formed

of fire brick, and into them lead the hot air and the gas flues, whereof hereinafter. Externally the apertures of these combustion chambers are conveniently closed by doors *g* of any suitable character, by the opening of which access can be had to the chambers.

Within and surrounding the cooling chamber is erected a lining or charge-retaining wall $d^{\times}$, which, in the form of construction shown, is conveniently a cylinder of cast iron of a thickness, for instance, of three-quarters of an inch, the external diameter of which is sufficiently less than the internal diameter of the fire brick walls proper *d* of said cooling chamber to afford between said walls proper and itself, the said lining wall, an annular cylindriform space or air chamber d^2 into which atmospheric air is fed or flows conveniently through a circular series of air inlet orifices a^6 formed through the basal mantel in such position as to open only within said air chamber.

From out the upper portion of the air chamber, at predetermined circumferential intervals, lead air flues d^3, conveniently correspondent in number with the number of combustion chambers, which respectively, conveniently, branch to both sides of the combustion chambers, are conveniently extended lengthwise of said walls of said combustion chambers, and discharge thereinto through air outlets d^4 formed, conveniently, through the walls of said combustion chambers.

H is a gas inlet conveniently formed through the lower portion of the shell of the kiln, and conveniently leading into a circular supply flue *h* conveniently formed within the packing around the walls proper of the cooling chamber. Leading upward from this supply flue, which is common to them all, are a series of gas flues $h^{\times}$ preferably correspondent in number with the number of combustion chambers employed, which at their upper extremities are respectively, conveniently, branched to the sides of the combustion chambers, longitudinally along which they are preferably externally extended, and into which they open through gas outlets h^2. Each of these gas flues is conveniently controlled by a damper h^3.

Such being a convenient construction of an apparatus embodying my invention, the operation which it is adapted to effectuate is as follows:—Assuming the initial charge of limestone to have been subjected in the burning chamber to the operation of calcining the carbonate, and the calcined charge to have descended into the cooling chamber until the latter has been completely filled by it,—thereafter, as successive fresh charges of stone are introduced to the burning chamber, the radiation through the lining walls of the cooling chamber from the heated and burned charge then contained therein will serve to heat the air flowing into the surrounding air space or chamber, which will therefore in its heated condition rise and through the air flues flow into the combustion chambers and therein commingle with the gas also flowing thereinto, and aid to support the combustion of the gas in said chambers and in the burning chamber. It will be apparent that this operation utilizes and recovers for the heating of the air the latent heat in the charge within the cooling chamber, while said charge is gradually cooling.

It is proper to explain that the gist of the invention resides in the provision of an air space or chamber within the kiln and around the cooling chamber, and in communication with the combustion chambers,—which is best accomplished by the interposition between the outer walls proper of the cooling chamber and the charge within said chamber (which would otherwise be supported against said outer walls) and at a suitable distance from said outer walls, of a heat-transmitting or radiating lining wall or cylinder, be its material what it may, which serves to radiate the heat which it receives from the cooling charge to the air with which the air chamber is constantly supplied, to the end that said air may be heated for the better supporting of the combustion of the gas in the combustion and burning chambers. With these considerations in mind, it is apparent that it is immaterial as to precisely how the lining walls and air chamber are formed, and as to whether the air chamber be a single undivided annular chamber or be composite of a series of divided air spaces not necessarily in communication with each other; and immaterial as to precisely how or in what directions both the heated air and the gas flues lead up to and discharge into the combustion chambers;—and also immaterial as to what form and precise relation to the burning chamber the combustion chamber or chambers assume, or as to what number of combustion chambers are employed.

Of course the mechanical detail of construction of the kiln as an entirety may be greatly varied, provided always that the salient features of the charge-retaining heat-radiating walls of or inner lining to, and of the air chamber or spaces surrounding, the cooling chamber, be retained. It is proper to state also that while I prefer to introduce the air to the air chamber through separate inlet orifices, as, for instance, through those described as formed through the basal mantel, the air can be otherwise admitted to said air chamber.

Having thus described my invention, I claim and desire to secure by Letters Patent:—

A kiln in which are combined the following elements, namely:—a basal cooling chamber the inner lining or charge-retaining walls of which are formed of heat-radiating material and surrounded by an air chamber or air spaces provided with air inlets;—a burning chamber above and discharging into the cooling chamber;—combustion chambers above

the cooling chamber and in communication with the burning chamber;—flues for gas leading to the combustion chambers;—and flues for heated air leading from out the air chamber or spaces surrounding the cooling chamber to said combustion chambers;—substantially as set forth and for the purposes specified.

In testimony that I claim the foregoing as my invention, I have hereunto signed my name this 4th day of May, A. D. 1889.

EDWARD TATNALL WARNER.

In presence of—

J. BONSALL TAYLOR,

F. NORMAN DIXON.