B. E. ELDRED.
PROCESS OF BURNING CEMENT.
APPLICATION FILED APR. 9, 1905.
To all whom it may concern:  

Be it known that I, Byron E. Eldred, a citizen of the United States, residing at Bronxville, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Processes of Burning Cement, of which the following specification and accompanying drawings illustrate the invention in a form which I now regard as the best out of the various forms in which it may be embodied.

This invention relates to the making of Portland cement, which in the best modern practice is burned in rotary inclined or "barrel" kilns by means of a blast-flame of powdered coal projected from one end of the barrel in heating relation to a continuous stream of the material fed along the floor of the barrel. These instrumentalities I am able to utilize in a new manner and with improved results in respect to the consumption of fuel, the quality of the product, and the durability of the apparatus.

The powdered-fuel blast has hitherto been used with certain objectionable limitations due principally to the extremely high temperatures attained and the difficulty of regulating the combustion. Thus, although this method has the advantage of affording a strong flame at a long distance from the root of combustion, it is also attended with the disadvantages, among others, of overheating, rapid deterioration of linings, inflexibility, and waste of fuel. In burning cement in rotary kilns with the powdered-coal blast it has become customary to employ a non-impinging axial flame, which is preserved from excessive contact with the material and lining by a stratum or envelop of air, an expedient which has the effect of protecting the lining and material to some extent from the intense heat of the flame, but which results in quite a waste of heat, which I am able to reduce.

My invention, among other things, aims to secure the benefits of the long blast-flame in cement-burning without incurring the aforementioned disadvantages, and this I do by employing a predetermined volume of diluent, such as products of combustion in the blast-current, which modifies the flame and reduces its temperature, rendering it longer, more slow-burning and voluminous. Such a flame is found to be hot enough to calcine the lime in the cement-forming material and cool enough to be allowed to impinge directly on the lining and the material without undue injurious effect upon either.

I prefer to separate the calcining and sintering operations and to make the former precede the latter in point of space—that is, I may so regulate and graduate the temperature as to perform practically all of the calcining in one portion of a traveling stream of material and practically all of the sintering in another portion. By so doing a better product is obtained and much fuel saved, since the calcination or driving off of carbon dioxide is not interfered with by simultaneous fusion of the material. The calcination requires a considerable time for its accomplishment and can be done with a comparatively low temperature—that is, lower than the ordinary powdered-fuel blast-flame—while the sintering requires a high temperature, but may be done in a comparatively short time and restricted space. The separation of the calcining and sintering operations and their performance as distinct successive steps I believe to be new with me by whatever specific heating agents performed. I also believe the use of the specific agents described for burning cement to be broadly new. Heretofore the flame which has done the sintering has been used for calcining; but as the sintering requires a higher temperature than the calcining and the single temperature heretofore used has had to be high enough to make fusion clinkers it follows that the temperature has been unnecessarily high for calcining and fuel waste has occurred. The nature of the flame heretofore used has not been suited to the most economical work in this line.

There may of course in the practice of my invention occur conditions under which a small amount of sintering will take place in the calcining region, as where the mixture or native material is particularly fusible; but that would not alter the characteristic nature of the proceeding herein described. In employing blast combustion I may therefore produce an inflated blast-flame, use the relatively cool diffuse portion thereof for calcining or decarbonizing the lime in the cement material, and locally intensify a portion of the flame or a portion of the blast-current in order to produce a higher sintering temperature. A gaseous jet or jets, which may be a gas containing free oxygen, preferably at a high pres-
sure and directed at an angle to the blast-axis near the root of the flame, so as to agitate and deflect a portion of the blast, may be utilized for the local sintering temperatures. The employment for this purpose of a plurality of temperatures independently controlled is an important feature of the invention. The auxiliary jet being preferably directed upon a part of the kiln covered by cement material, the lining underneath is preserved from rapid burning out.

I believe it to be new to calcine the cement material with a flame produced as described. Having more or less separated the calcining step from the sintering step, I may of course omit the function of the intensifying-jet and reserve sintering or at least the final production of a hard clinker for a subsequent operation, though I prefer to use the high and low temperatures in cooperation for the completion of the burning of cement clinkers in one continuous series of steps.

The described method, per se, of producing and industrially applying a novel heating agent is not broadly claimed herein, being made the subject of a separate application.

For the performance of the process here set forth and claimed I have devised a certain novel combination of apparatus whereby the forces and materials concerned in the process are caused to cooperate in the relation necessary to its exercise, which apparatus is also claimed herein.

In the accompanying drawings, Figure 1 represents a side elevation of a cement-burning furnace equipped to carry out this invention. Fig. 2 represents an enlarged sectional view of one end of the furnace. Fig. 3 represents a view, partly in section and partly in elevation, of the blast-nozzle and connections. Fig. 4 represents an end view of said nozzle.

The same references characters represent the same parts in all the figures.

In the drawings, 1 is the inclined rotary barrel of a so-called "horizontal" cement-kiln similar to the ordinary, although permissibly longer than usual. The barrel has a refractory lining 2, Fig. 2, and at its higher end is the stack 3. At this end also is a screw conveyer or feeder 4 for introducing the material. At the lower end is a removable head 5, supporting the blast-nozzle 6 and combined with a stationary outlet 7 for the burned clinkers. A suitable concentrated or high-powered fuel, such as powdered coal, is fed to the nozzle 6, in this case by means of a screw conveyer 8, from a bin or other receptacle and is blown into the kiln with a jet of gaseous fluid delivered through a pipe 9, entering the rear end of the nozzle-pipe or combining-tube. The nozzle 6 is flattened at the end, as shown at Fig. 4, to spread the flame laterally.

The pipe 9 leads from the chimney 3 and contains a fan-blower 10, which serves to draw back a small portion or modicum of the inert gases or products of substantially complete combustion and force them into the kiln in company with the powdered fuel in predetermined proportion and in company with a predetermined volume of air drawn into the pipe 9 on the suction side of the fan at the point 11, whereas is an adjustable valve or damper for regulating the proportion of air. There is also a damper 12 in the trunk of the pipe for regulating the proportion of stack gases. This proportion should be accurately adjusted and may be varied to produce a longer or shorter flame. The kiln-gases contain a percentage of carbon dioxide from calcination of the lime as well as from combustion. This gas is an efficient diluent and endothermic carbonate, and these constituents also act as a diluent. The proportion of the total kiln-gases returned depends somewhat upon their composition, the quality, temperature, or length of flame desired, &c.; but I have secured good results with ten per cent. or twelve per cent. approximately of the total gases.

On the upper side of the nozzle 6 is fixed an air-pipe 13, shown with a water-jacket 14, terminating in an auxiliary nozzle 14 just forward of the outlet of nozzle 6 and directed slantingly forward and downward toward the floor of the barrel. There may be more than one of these jets. The nozzle is preferably adjustable, as shown, to vary the direction of the jet. An air-compressor 16, connected with this pipe, furnishes a jet of compressed air through the nozzle, which serves to divert a portion of the mixed current of powdered fuel, stack-gases, and air issuing from the main nozzle and direct this current upon the floor of the barrel near its lower end, thereby obtaining by agitation and addition of air a localized high temperature for sintering the cement mixture. This auxiliary air may, if desired, be preheated by any suitable expedit for, as may also the main air-supply, and the intensity of the local temperature may be reduced by modifying the jet, as by products of combustion. The main portion of the flame which is unaffected by this secondary jet develops within the main body of the barrel and is of a voluminous slow-burning character, very long, cooler than the usual powdered-fuel flame, and well suited to the preliminary calcination or decarbonization of the lignite and carbaminate in the material. It is preferably caused to hug the bottom of the kiln to a large extent. Favorable conditions for the maintenance of ignition and complete combustion are furnished by the refractory reverberative lining of the barrel and the heat-retentive or incandescent character of the material. Owing to the slow-burning character of the flame and the increased volume of the blast, the flame may be projected to the necessary extent with a weaker blast-current than has heretofore
been used. I do not restrict myself as to the particular method of driving the blast.

By means of the auxiliary jet a temperature may easily be attained amounting to 600° Fahrenheit or more in excess of that afforded by the main flame and ample to effect the proper fusion of the clinkers.

I prefer to furnish in the blast all or the main part of the oxygen necessary to a complete combustion, and in such case the chimney-damper may be so regulated as to reduce the chimney-draft and minimize the leakage of other air into the kiln. Any air which may tend to leak in through the openings is prevented by the auxiliary jet from forming a stratum or envelop for the main blast.

There results a blast of large volume and low velocity, producing a voluminous slow-burning flame which fills the cross-section of the kiln and develops much of its heat in substantial contact with the material and the revolving lining, where it is of maximum effect. Since the temperature of the flame is reduced, it has but little destructive effect on the lining.

At 17 in the base of the stack I have shown a damper by the adjustment of which the region of effective combustion may easily be shifted longitudinally of the kiln. By opening this damper the flame is held back toward the clinker-discharge end of the barrel and by closing it the flame is lengthened toward the stack.

What I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described process of burning cement which consists in producing in operative relation to the cement-forming material a region of relatively low-temperature combustion suited to the calcination of the material, and a distinct region of relatively high-temperature combustion suited to the sintering thereof.

2. The herein-described process of burning cement which consists in producing in operative relation to the cement-forming material in successive portions of a stream of the material, a region of relatively low-temperature combustion suited to the calcination of the material, and a distinct region of relatively high-temperature combustion suited to the sintering thereof.

3. Process of burning Portland cement which consists in calcining the lime in the material with a slow-burning voluminous flame so regulated as not to sinter the material.

4. Process of burning cement by successive steps which consists in first calcining the material with a slow-burning flame artificially inflated with products of combustion added to the supply-current of the fire, and later sintering the material with a higher temperature.

5. The described method of preparing cement material for clinkering which consists in driving off the gasifiable portions from material containing lime and fusible ingredients in proportions to make Portland cement, without substantially fusing said fusible ingredients.

6. The herein-described process of burning cement which consists in performing substantially the whole of the calcining of the material at one time and substantially the whole of the sintering of the calcined material at a different time.

7. The herein-described process of burning cement which consists in performing substantially the whole of the calcining and substantially the whole of the sintering of a stream of cement material as distinct steps in successive sections of said stream.

8. The herein-described process of burning cement which consists in producing a slow-burning voluminous flame in operative relation to the cement-forming material, and locally intensifying the activity of said flame in a desired region.

9. The herein-described process of burning cement which consists in producing a slow-burning voluminous flame in operative relation to the cement-forming material to calcine the lime in said material, and locally intensifying the activity of said flame by a transverse jet of air directed toward the material to effect the final sintering.

10. The herein-described process of burning cement which consists in calcining the lime in the material with a slow-burning voluminous flame applied in a substantially unobstructed space, and sintering the material by the action of a flame-intensifying pressure-jet.

11. The herein-described process of burning cement which consists in causing the cement-forming material to travel through the furnace, causing a slow-burning voluminous flame to travel in operative relation to and in the opposite direction to the material, and producing a local intensified combustion in the vicinity of the root of the flame.

12. Process of treating cement material which consists in decarbonizing the lime therein with a long, slow-burning flame produced by means of a blast of previously-unignited fuel in suspension together with air and a gaseous diluent.

13. Process of making cement in a kiln or furnace which consists in calcining the material with an artificially-inflated flame of retarded combustion produced by means of a blast of previously-unignited fuel together with air and a volume of gaseous diluent equivalent to a modicum of the total waste kiln-gases.

14. Process of making cement which consists in calcining the material with a blast-flame containing powdered coal in suspension together with air and products of combustion.

15. Process of burning cement material which consists in calcining the lime with an artificially inflated or retarded impinging blast-flame.
16. Process of burning cement material which consists in calcining the same in a reverberative chamber with an impinging slow-burning flame produced with a blast containing powdered coal in suspension together with air and gaseous products of combustion.

17. The process of applying a powdered-fuel blast-flame to the calcination of cement material in a rotating refractory-lined chamber, which consists in inflating the flame with products of combustion introduced with the blast, and causing said flame to substantially fill the cross-section of the working chamber.

18. Process of burning cement which consists in applying thereto a blast-flame of previously-unignited fuel sufficiently hot to calcine the lime in the cement material but not hot enough to complete the sintering.

19. Process of making cement which consists in feeding the material in a stream, and passing over the same a diffuse slow-burning blast-flame of concentrated fuel in suspension, so regulated as to calcine the lime but not fuse the clinker.

20. Process of burning cement which consists in applying a blast-flame of previously-unignited fuel so regulated as to calcine but not fuse the material, and subsequently fusing to the clinker condition with a high-temperature heating agent.

21. Process of making cement which consists in feeding the material in a stream, passing over the same a diffuse slow-burning blast-flame of concentrated fuel in suspension, so regulated as to calcine the lime but not fuse the clinker, and producing an adjacent higher temperature which fuses the clinker.

22. Process of burning cement which consists in calcining the lime in the cement-forming material with a flame produced by means of a blast of previously-unignited fuel in suspension, together with air and products of combustion, and sintering the hot calcined material with an adjacent flame of higher temperature.

23. Process of burning cement which consists in calcining the lime in the cement-forming material with a flame produced by means of a blast of previously-unignited fuel in suspension, together with air and a diluent, and localizing the combustion of a distinct portion of said blast with a gaseous jet to produce a sintering temperature.

24. Process of making cement which consists in calcining the lime in the cement material with a relatively cool flame produced with a blast of previously-unignited fuel, air and products of combustion, and producing a local sintering temperature with an auxiliary gaseous jet acting on a portion of the blast and directed toward the material.

25. Process of making cement which consists in calcining the lime in the cement material with a relatively cool flame produced with a blast of powdered fuel, air and products of combustion, and sintering the material with a local high temperature produced by acting on a partial section of said blast with a transverse jet of air at a higher pressure than that of the blast.

26. Process of sintering cement which consists in acting thereon with an impinging flame of fusing temperature containing powdered fuel in suspension together with an added volume of gaseous products of combustion, and driven against the material by means of a high-pressure jet.

27. Process of making cement clinkers which consists in acting on calcined cement-forming material with a blast-flame of powdered fuel and gaseous diluent concentrated with a high-pressure jet of air.

28. Process of burning cement which consists in passing a stream of the material through a furnace, calcining the body of said stream with a blast-flame of previously-unigned fuel traveling oppositely to the material and so regulated as not to fuse the same, and producing a local fusing temperature near the exit of said material from the furnace.

29. Process of burning cement which consists in acting on a progressing stream of cement material with a powdered-fuel blast-flame traveling oppositely to the material and rendered slow-burning by dilution, so as to calcine the material, and acting on the calcined portion of the stream near its terminus with a local high temperature caused by intensifying a portion of the blast.

30. A cement-burning furnace comprising a reverberative chamber having provision for advancing the material along its floor or hearth, a seat of combustion or propagation of the flame, connections anterior to said seat for deriving a supply of diluent fixed gas for retarding combustion, an air-supply inlet for supporting combustion, so disposed as to operate under forced draft, and means for artificially propelling the draft-current for the flame.

31. A cement-burning furnace comprising a reverberative chamber having provision for advancing the material along its floor or hearth, a seat of combustion or propagation of the flame, a flue for discharging the products of combustion, a return-conduit for products of combustion branching from said flue and leading to said seat, a draft-accelerator in said conduit, and an inlet located to supply air for supporting combustion under forced draft.

32. A cement-burning furnace comprising a reverberative chamber having provision for advancing the material along its floor or hearth, a seat of combustion or propagation of the flame, a flue for discharging the products of combustion, a return-conduit for products of combustion branching from said flue and leading to said seat, a fan-blower in said conduit, an air-inlet to the conduit on the suction side of the fan, and means for varying
the relative proportions of air and products of combustion in the fan-current.

33. A cement-burning furnace comprising a rotary inclined combustion-chamber having at one end a stack and devices for supplying the chamber with cement material, and at the other end a seat of combustion or propagation of the flame, and connections for supplying underforced draft through said seat air for supporting the combustion of the flame and a diluent gas for retarding said combustion.

34. A cement-burning furnace comprising a rotary inclined combustion-chamber through which the material is caused to travel, a seat of combustion at one end thereof, a conduit leading to said seat and having connection at its receiving end with a source of gaseous diluent, draft-accelerating means for said diluent and the air-supply, whereby a forcible flame-current is projected from said seat into the combustion-chamber, and an air-supply inlet on the suction side of said means.

35. Apparatus for burning cement comprising a hearth for supporting the cement material, means to supply the material to said hearth, a seat of combustion arranged for the projection of a flame over said hearth, means to supply powdered fuel anterior to said seat, means to supply and propel a blast-current to drive the fuel, and connections for deriving a volume of neutral products of combustion as a component of said blast-current.

36. A cement-burning furnace comprising a reverberative roofed combustion-chamber having a hearth for supporting the cement material, a blast-nozzle directed therethrough, fuel-feeding and air-supply connections to said nozzle, connections from a furnace for supplying products of combustion to the nozzle as an ingredient of the blast-current, and pressure-blast-producing means.

37. A cement-burning furnace comprising a long reverberative combustion-chamber whose floor constitutes a hearth for the support of the materials, fuel jet devices at one end of said chamber directed longitudinally therethrough, connections for supplying to said jet devices ignited fuel, air to support combustion, and a fixed diluent gas to retard combustion, and propelling means in said connections whereby the air and diluent gas act to drive the fuel.

38. A cement-burning furnace comprising a hearth having provision for advancing the cement material therealong, means to supply a flame-current of entrained fuel over the hearth, and a jet-nozzle directed toward the hearth and commanding a portion only of said current.

39. A cement-burning furnace comprising a combustion-chamber to contain the cement material under treatment, a blast-nozzle directed thereinto, means for feeding powdered fuel to said nozzle, means for supplying a propelling blast-current therethrough, a jet-nozzle commanding said blast-current and directed at an angle to the axis of the blast-nozzle, and means for supplying pressure fluid to said jet-nozzle.

40. Apparatus for burning cement comprising a hearth having provision for feeding the material therealong, a seat of combustion from which a flame is projected over the hearth, means for supplying air and a flame-retarding diluent to said seat, an auxiliary jet-nozzle commanding the dilute-fuel current, and means to supply pressure fluid to said nozzle.

41. A cement-burning furnace comprising a reverberative chamber having provision for advancing the material therethrough, means for projecting a substantially axial flame through said chamber, and a jet-nozzle directed at an angle to the chamber-axis toward the floor of the chamber, near the material-discharging end.

42. A cement-burning furnace comprising an inclined rotary combustion and material-feeding chamber having a stack at the higher end, blast devices at the lower end for forcibly projecting a fuel-carrying flame-current longitudinally of the chamber, and a jet-nozzle at the lower end commanding the flame-current and directed downwardly toward the floor of the chamber.

43. Process of treating incandescent substances which consists in passing thereover a long inflated impinging flame produced with a blast of preexisting concentrated fuel together with a supporter of combustion and diluent products of combustion.

44. Process of treating materials disposed in a layer on the hearth of a reverberative chamber, which consists in subjecting the same to a superincumbent flame produced by a blast containing previously-unignited fuel and a supporter of combustion and modified by diluent gaseous products of combustion.

45. Process of treating incandescent materials in a reverberative chamber which consists in subjecting the same to a long slow-burning flame produced with a blast of powdered coal in suspension together with air and a medium of the gaseous products of combustion.

46. Process of heating incandescent materials disposed on the hearth of a reverberative chamber which consists in subjecting the materials to an impinging, slow-burning, diffuse flame, produced with a blast of powdered coal containing a volume of burned-out gases equivalent to a medium of the total gaseous products of combustion.

47. Process of applying heat to mineral solids or other materials on a hearth which consists in subjecting the same to a superincumbent long, voluminous, slow-burning and relatively cool flame produced with a blast of powdered coal and neutral products of com-
bustion together with air, and intensifying the combustion of a portion of said blast in a restricted region with an auxiliary jet of air directed toward the materials.

48. A process of treating materials which consists in feeding the same in a stream, subjecting one section of said stream to a relatively low temperature flame produced with a blast of previously-unignited fuel, and subjecting another section to a relatively higher temperature produced by a concentrating jet.

In testimony whereof I have hereunto set my hand, in the presence of two subscribing witnesses, the 1st day of April, 1905.

BYRON E. ELDRED.

Witnesses:

JAS. K. CLARK,
R. M. PIERSO.