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Townley

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[54] **KILNS AND FURNACES**

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Related U.S. Application Data

[63] Continuation of Ser. No. 222,071, Jan. 31, 1972, abandoned.

[30] **Foreign Application Priority Data**

Feb. 8, 1971 United Kingdom 4122/71

[52] **U.S. Cl.** **432/14;** 431/60; 431/76; 432/17; 432/25; 432/51; 432/99; 239/76

[51] **Int. Cl.** **F23n 1/02;** F27b 1/10

[58] **Field of Search** 423/14, 17, 19, 25, 37, 423/51, 54, 97, 99, 159, 196, 225, 79, 26, 31; 106/102, 103; 431/18, 24, 60, 76, 89; 239/76, 101

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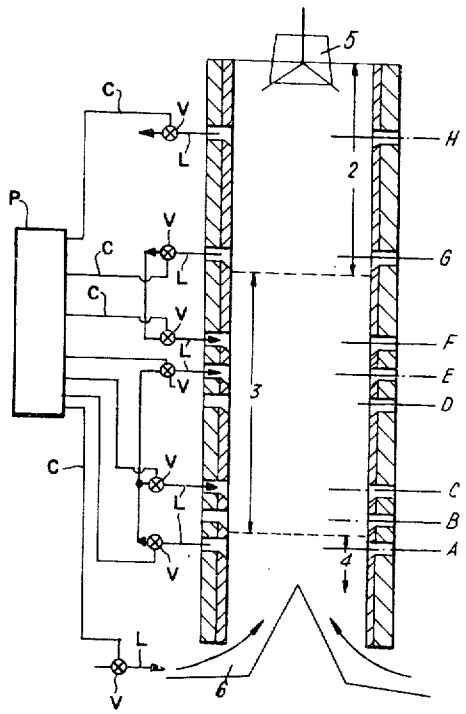
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[57] **ABSTRACT**

This invention relates to kilns and furnaces in which granular material is heat treated and to a method of operating such kilns and furnaces.

26 Claims, 6 Drawing Figures



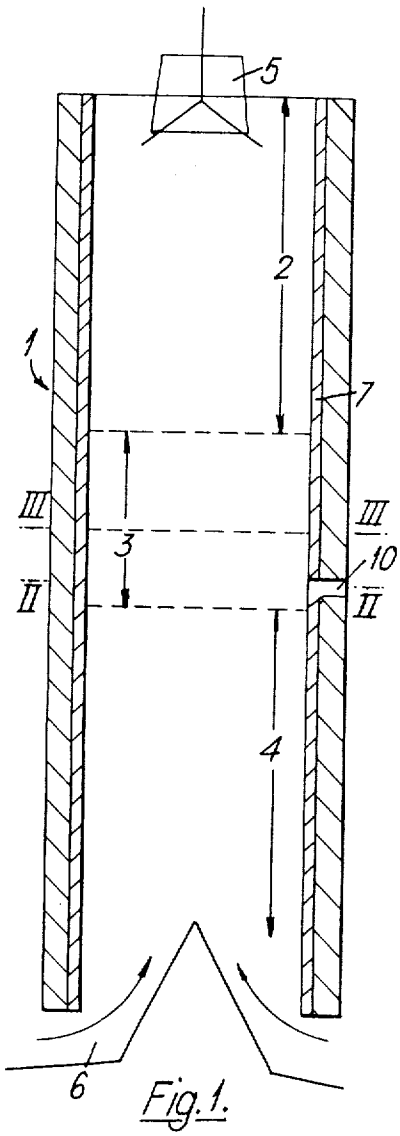


Fig. 1.

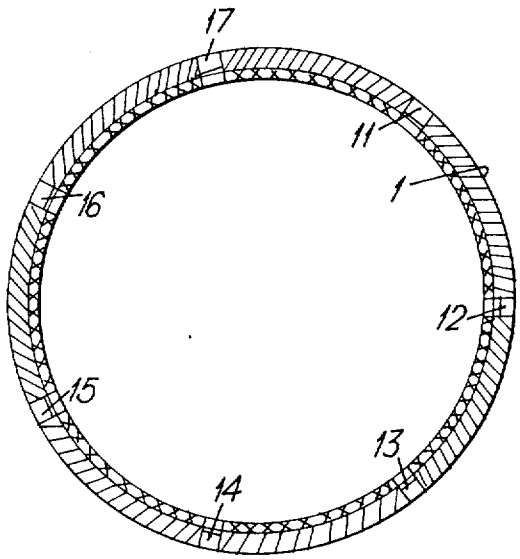


Fig. 2.

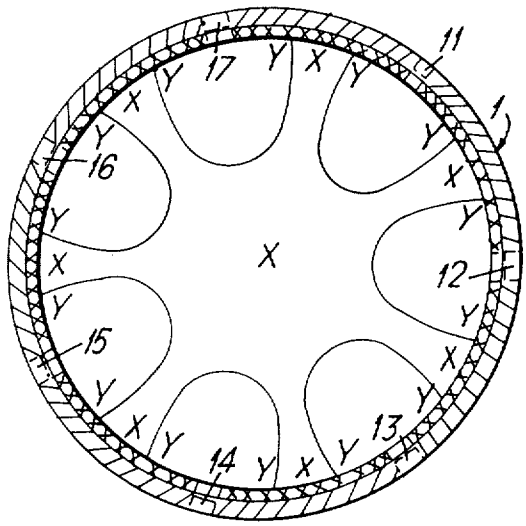
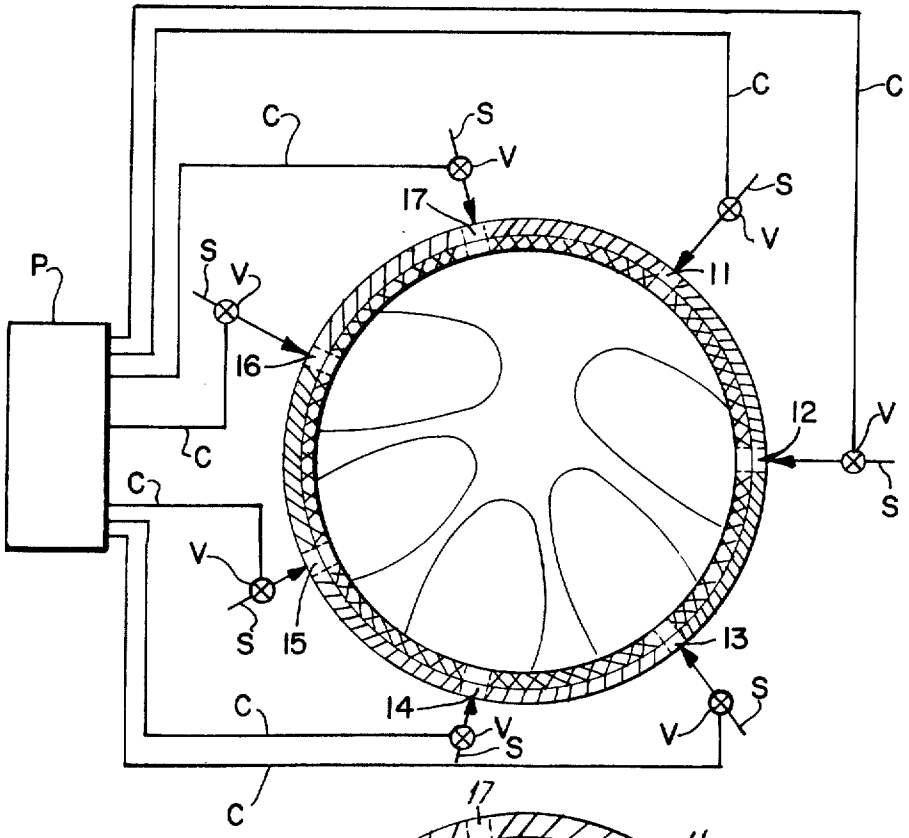


Fig. 3.

Fig. 4



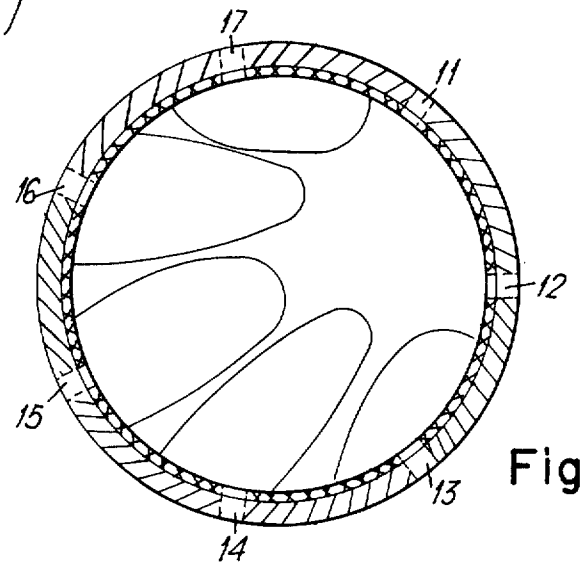


Fig. 5

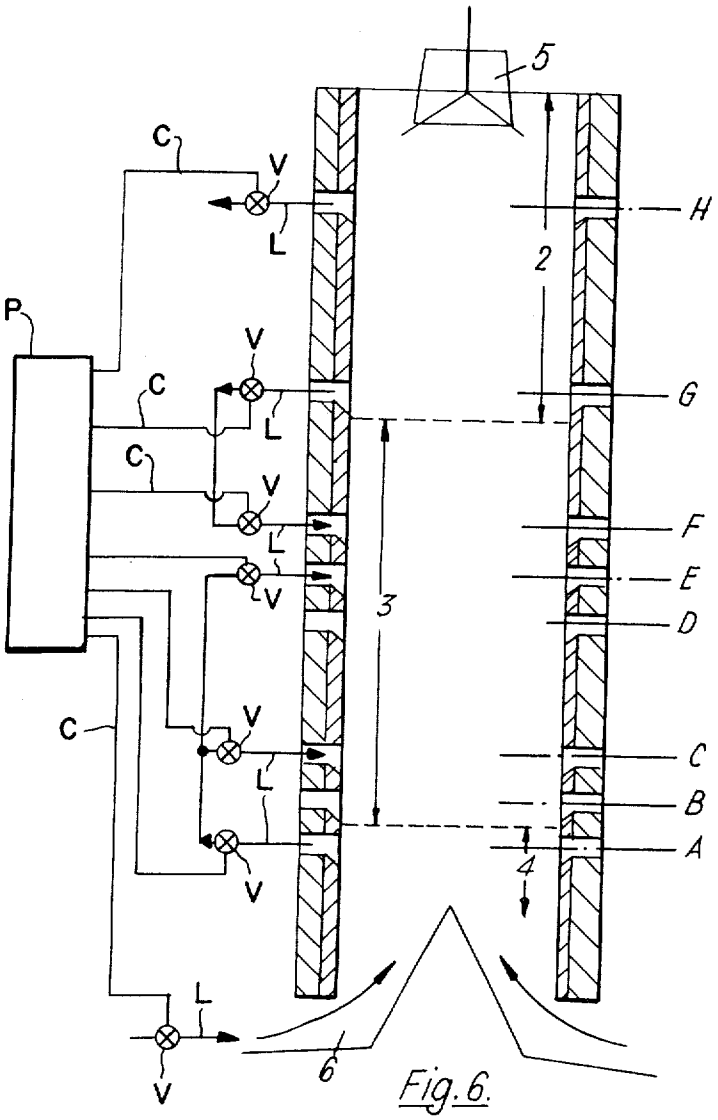


Fig. 6.

KILNS AND FURNACES

This is a continuation of application Ser. No. 222,071 filed Jan. 31, 1972, now abandoned.

In the operation of vertical shaft kilns and furnaces fired by gaseous or liquid fuel, it is difficult to achieve the desired distribution of heat and temperature or uniform flow of material in the shaft. Consequently, material flowing through the shaft does not all receive the desired heat treatment. For example, in the case of a vertical shaft lime kiln fired by a gaseous or liquid fuel, some pieces of limestone are fully calcined, or even over-calcined, whilst other pieces of limestone are not fully calcined. The difficulties of achieving the desired heat treatment are particularly acute in large diameter kilns and furnaces, and in shaft kilns and furnaces in which small pieces of material are treated. The situation may be aggravated when, as is often the case, the material fed to the kiln or furnace has a wide distribution of sizes.

Hitherto, uniformity of heat treatment has been sought by attempting to provide a heating effect which is uniform across any given level in the kiln or furnace shaft. We have now found, surprisingly, that improved results can be secured by deliberately operating the kiln or furnace in such a manner that, at any instant, the heating effect across any given level in the kiln or furnace shaft is non-uniform but fluctuates in a predetermined sequence.

According to the present invention there is provided a method of operating a vertical shaft kiln or furnace fired by hot gases or liquid or gaseous fuel wherein the heat distribution in the shaft is controlled by varying the pattern of flow of gases in the shaft in accordance with a predetermined sequence whilst the general direction of flow of the gases remains unchanged.

The variation in the pattern of gas flow is carried out whilst the general direction of flow (i.e. co-current or counter-current with respect to the granular burden) in the shaft remains substantially constant, although if desired there may be changes in the general direction of flow and the varied pattern of flow may be imposed on a general flow in either (or both) directions.

It should be understood that in kilns and furnaces operated in accordance with the invention, the flow pattern of gases and the temperature distribution in the shaft may at any instant by asymmetrical in both horizontal and vertical planes. The patterns of flow and sequence of variation (including the times for which any pattern is maintained) are determined with a view to achieving either substantially the same overall heat treatment for all the material during the period of the passage through the shaft, or different treatments when these are desirable; for example when limestone of varying size having a known size distribution across the shaft is treated, it may be desirable for the smaller sizes of limestone to receive, overall, less heat treatment than the larger sizes.

The pattern of flow may be varied in a cyclic or non-cyclic manner. For example, when the operation is controlled by a computer, the variation will probably be non-cyclic if it is dependent on the measured values of process variables.

The method of the present invention is applicable to kilns and furnaces in which granular solid material, for example limestone or metal ore, is heat treated in a vertical shaft. The solid granular material in the shaft at ny time is referred to herein as the burden. In such

kilns and furnaces the material to be heated may be introduced, in batches or continuously, at the top of the shaft, preferably with a desired size distribution across the shaft. The material passes down the shaft through a series of treatment zones, for example a pre-heating zone, a heating or calcining zone and a cooling one, and is removed either continuously or in batches at the base of the shaft. The liquid or gaseous fuel (or hot gases) is usually introduced into the shaft at a level or levels intermediate between the top and bottom of the shaft and, if desired, some solid fuel may be added to the material charged to the top of the shaft. The hot gases (if used), the products of fuel combustion and any gaseous products of the heat treatment may move up the shaft counter-current to the flow of material heated, or may flow down the shaft co-current with the flow of material heated, or may flow co-current and counter-current at different levels in the shaft. Whilst the method of the invention may be applied to kilns and furnaces with shafts of any diameter, it is especially advantageous for the operation of kilns and furnaces with shafts of large diameter (for example, 5 feet or more) since uniform heat treatment of material is most difficult to achieve in large diameter shafts (especially when treating granular material of small size). The method of the present invention is especially applicable to the operation of vertical shaft lime kilns used for the calcination of limestone, chalk, dolomite and similar materials, since it is important that these materials be evenly burnt.

The method of the present invention may be applied in kilns and furnaces which are fired by hot gases or gaseous or liquid fuel (or a combination thereof) supplied to one or more burners. By the term "burner" used herein we refer to means for introducing the fuel or hot gases into the kiln or furnace shaft. When hot gases are used, these may be produced by the burning of any fuel outside the shaft. If a normally liquid fuel, for example fuel oil, is used, it may be gasified before it is introduced into the shaft or it may be introduced the shaft in liquid form. The heat required to gasify a liquid fuel may conveniently be supplied by spraying the fuel on to a hot surface, or by partially burning the fuel. The gasification may be accomplished outside the kiln or furnace or, if desired, in ports in the kiln or furnace walls or in constructions within the shaft, for example bridges or central columns. Similarly, if a gaseous fuel, for example natural gas, is used, it may be preheated, for example, by heat exchange with used combustion gases or by partial burning, before it is passed into the kiln or furnace shaft. The burners may introduce the fuel or hot gases into the kiln or furnace shaft in any way known in the art, for example through ports in the shaft wall, or through passages in constructions within the shaft, or through tuyeres projecting into the burden in the shaft. The fuel or hot gas may enter the shaft directly into the burden or may pass into a space in the burden; such spaces may be provided by positioning constructions in the shaft which divert the burden locally. Air or oxygen for combustion of the fuel may be fed into the heating zone of the kiln or furnace part way up the shaft, for example at substantially the same level as the burners. The air or oxygen may be introduced in known manner, for example the ways described above for the introduction of the fuel. However, part or even all of the combustion air or oxygen usually enters the furnace or kiln at the base of the

shaft and, as it rises to the heating zone where the burners are located, is heated by contact with the descending burden.

It is generally most convenient to use more than one burner, and in such cases the burners are usually, but not necessarily, disposed substantially symetrically in (and especially around) the kiln or furnace shaft. The burners may be arranged at one or more levels (for example in tiers) within the shaft.

Fuel entering the kiln or furnace shaft through the burners burns in the combustion gas (air or oxygen) available to it. Fuel from each burner burns in an envelope wherein there is the necessary degree of mixing of air or oxygen and fuel under conditions which will permit combustion. The limit of this envelope in which combustion takes place is referred to herein as the flame front. In a preferred aspect of the invention, the configuration of the flame front(s) associated with a burner(s) is varied in a predetermined sequence.

The local pattern of gas flow adjacent a given burner (which commonly involves some measure of cross-flow) will depend upon the amount of fuel or hot gas supplied to the burner, the quantity of combustion air (or oxygen) available to that fuel, and the pressure distribution within the kiln or furnace shaft.

Thus we are able to vary the pattern of gas flow and hence the heat and temperature distribution in the kiln or furnace by any one or more of the following techniques:

1. By varying the fuel or hot gas supply to one or more burners. For example, by reducing the fuel supply to a burner, the flame front associated with that burner may be moved back across the kiln towards the burner. Conversely, if the fuel supply to the burner is increased, the flame front will move away from the burner. By way of further example, if the fuel supply to one of two opposed burners is reduced, the flame front associated with the other burner will move across the shaft towards the former burner.

2. By varying the quantity of combustion gas (air or oxygen) supplied to the kiln or furnace shaft and/or the location in the shaft at which it is introduced. For example, the air supply to the shaft adjacent a particular burner may be varied.

3. By selectively withdrawing gases from the shaft through ports in the shaft walls or constructions in the shaft. For example, if combustion air rising up the shaft is withdrawn from the shaft at a point substantially opposite an operating burner, the flame front associated with that burner will move across the shaft towards that point in response to the changed pressure distribution within the shaft. Air thus withdrawn can be re-supplied to the shaft; for example, it may advantageously be passed into the shaft through ports above, below, or at the same level as operating burners as combustion gas as in (1) above. Similarly, hot gas from within or above the heating zone may be selectively withdrawn and optionally re-supplied in whole or in part at selected locations in the shaft.

4. By varying the locations at which gases withdrawn from the shaft in technique (3) are returned to the shaft.

5. By varying the location(s) at which exit gases are removed from the shaft.

Each of the above variations may be continuous or may be stepwise or continuous between fixed levels, and may be in respect of quantity and/or location.

We regard techniques (1), (2) and (3) as especially important and prefer to use a combination which includes (1), (2) and (3).

The present invention also provides a vertical shaft kiln or furnace fired by hot gas or liquid or gaseous fuel having means to vary the pattern of flow of gases in the shaft and programming means arranged to provide a variation in the said pattern of flow in accordance with a pre-determined sequence whilst the general direction of flow remains unchanged.

The means to vary the pattern of flow whilst the general direction of flow remains unchanged may include one or more of the following:

1. Means to vary the fuel or hot gas supply to the burner(s), for example valves.

2. Means to vary the amount of combustion gas (air or oxygen) supplied to the shaft through ports adjacent to or above or below the burner(s) for example a system of ducts, fans and valves.

3. Means to vary the quantity of combustion gas (air or oxygen) admitted at the base of the shaft, for example valves and fans.

4. Means to variably withdraw gases from the shaft immediately below the heating zone, for example one or more closable ports in conjunction with one or more fans.

5. Means to variably withdraw hot gases from within or above the heating zone, for example closable ports.

6. Means to variably return to the shaft gases withdrawn by (4) or (5).

7. Means to vary the location(s) at which exit gas is withdrawn from the top of the shaft.

Each of the above means may provide for the variation of quantity and/or location. The selective operation of each of the above will affect the pressure distribution in the shaft and the pattern of flow of the gases in the shaft.

The programming means is arranged to provide a variation in the pattern of flow by operation of these means in a predetermined sequence, which will usually, but not necessarily, be a cyclic sequence. In this case the period of the cycle in which the variations are carried out and the duration of operation in any standing mode in the cycle will depend, in any given case, on a number of factors. These factors include:

i. the shape and dimensions of the shaft,

ii. the nature, and especially the size, of the pieces of material in the shaft,

iii. the number of variations (which may, but do not necessarily, give rise to standing modes of operation) in the cycle,

iv. the rate of passage of material down the shaft and the required treatment time, having regard inter alia to the temperature profile in the shaft and the heat requirement of the process.

These factors also influence the selection of a non-cyclic sequence.

When applying the method of the invention to lime kilns, i.e. kilns for calcining limestone, chalk or dolomite (or a combination thereof), we prefer to select a sequence that ensures that at no stage in the sequence does material in the heating zone fall below the calcining temperature. Typically, when calcining limestone, using a cyclic variation, the cycle will have a period in the range 5 minutes to 2 hours, for example 30 minutes to 1 hour will be used; if the cycle includes one or more standing modes of operation, the duration of operation

in any standing mode in the cycle will preferably be in the range 1 to 10 minutes, for example 5 minutes. However, in some cases times outside these ranges may be appropriate and may be used if desired.

In general, the desired sequence will be determined for each individual case. The determination can be readily carried out by a man skilled in the art by simple calculation and trial.

The present invention is directed to obtaining even or controlled distribution of heating effect upon the material being processed on the shaft and assists in solving the problems which have arisen from uneven or uncontrolled heating effect in the prior art. In particular the proportion of material which receives appreciably more or less than the desired degree of heating in the furnace can be kept low (thus reducing wastage or the need for re-processing) and the deterioration (for example localised failure) of the furnace or kiln lining due to sustained localised excesses of temperature can be reduced. The extent to which the evenness or control of heating can be achieved will depend to some extent upon the precise design and construction of the furnace or kiln concerned but, as noted above, it is a matter of calculation and simple trial to determine the pattern of variation best suited to any particular furnace or kiln.

The invention is illustrated but not limited by the following description with reference to the accompanying drawings in which:

FIG. **1** is a diagrammatic vertical section through a vertical shaft lime kiln.

FIG. **2** is a section along the line II—II of FIG. **1.**

FIGS. **3, 4** and **5** are sections along the line III—III, showing diagrammatically the pattern of the flame fronts for different modes of operating the kiln.

FIG. **6** is a diagrammatic vertical section through a second vertical shaft lime kiln.

In FIGS. **1** and **2** of the drawings there is shown a lime kiln generally designated **1.** The kiln **1** has a lining **7** of refractory material and is divided into three zones, a preheating zone **2,** a calcining (heating) zone **3,** and a cooling zone **4.** Limestone is fed in batches to the top of the kiln through an inlet hopper **5** provided with sealing bells and progresses down the kiln through the pre-heating, calcining and cooling zones to the base **6** of the kiln, from where it is removed. A tier **10** of seven burners constituted by fuel inlet ports (**11—17**) is symmetrically disposed in the kiln wall. Means (not shown) for supplying gaseous or gasified liquid fuel to each burner and means to cyclically vary the quantity of fuel supplied to each burner are also provided. Combustion air for the fuel is supplied from the base **6** of the kiln as indicated by the arrows.

FIG. **3** shows the configuration of the flame fronts a short distance above the level of the burners that results when fuel is supplied at an equal rate through each burner in a conventional manner. Whilst the stone which is subject to the flame is fully-calcined or over-calcined, the stone between the flame fronts (at the points marked X) both at the centre of the kiln and close to the walls of the kiln, is incompletely calcined. Moreover, as the hottest parts of the flames impinge continuously at the same points (marked Y) on the refractory lining of the kiln, the lining tends to fail prematurely at these points.

One mode of operating the kiln in accordance with the present invention is illustrated in FIG. **4.**

In this figure there are shown seven burners each provided with a fuel supply line S which includes a valve V. A control line C connects each valve V with a programmer P. In the mode of operation shown, fuel is being supplied through the burners **12, 13, 14, 15** and **16** at equal rates, but no fuel is being supplied through burners **11** and **17.** After operation of the kiln in this way for a suitable interval, fuel is supplied through burner **11** at the same rate as to the other burners that are being fired and the fuel supply through the burner **16** is shut off. The pattern of the flame fronts consequently rotates through $2\pi 1/7$ radians about the vertical axis of the kiln. After a similar interval, fuel is applied through the burner **17** and the burner **15** shut off. The control of the fuel supply in this manner is continued, each pair of adjacent burners being shut off in turn. In this way, the configuration of the flame fronts is continually changing, and as a result the lime is more uniformly calcined and the refractory lining less liable to premature local failure. The above-described sequence of operation results in continual rotation of the pattern of gas flow around the kiln in one direction. A further sequence of operation is given in Table I.

A further mode of operation giving similar advantages is illustrated in FIG. **5.** In this case, no fuel is being supplied through burners **11** and **12,** fuel is being supplied through burners **14, 15** and **16** at the full rate, whilst fuel is being supplied through burners **13** and **17** at a reduced rate. After a suitable interval the firing pattern is changed and subsequently changed again in accordance with the cycle shown in TAble II.

TABLE 1

Burner	11	12	13	14	15	16	17
Pattern 1	X	X	F	F	F	F	F
Pattern 2	F	F	F	X	X	F	F
Pattern 3	X	F	F	F	F	F	X
Pattern 4	F	F	X	X	F	F	F
Pattern 5	F	F	F	F	F	X	X
Pattern 6	F	X	X	F	F	F	F
Pattern 7	F	F	F	F	X	X	F

TABLE II

Burner	11	12	13	14	15	16	17
Pattern 1	X	X	R	F	F	F	R
Pattern 2	F	F	R	X	X	R	F
Pattern 3	X	R	F	F	F	R	X
Pattern 4	F	R	X	X	R	F	F
Pattern 5	R	F	F	F	R	X	X
Pattern 6	R	X	X	R	F	F	F
Pattern 7	F	F	F	R	X	X	R

X = Fuel not supplied
R = Fuel supplied at reduced rate
F = Fuel supplied at full rate

In the embodiments described above, the variation of the pattern of flow of gases is achieved by cyclically varying the fuel supplied through the fuel inlet ports and thus cyclically varying the configuration of the flame fronts.

The operation of the invention using a combination of the techniques described above will now be described with reference to FIG. **6.** The reference numerals **2–6** have the same significance as in FIG. **1.** In addition, the lime kiln shown in FIG. **6** has:

A tier of six ports at level A for the withdrawal of hot combustion air rising up the kiln through the pre heating zone.

A tier of six burners (inlet ports) at each of levels B and D.

A tier of six inlet ports at each of levels C and E for the admission of air withdrawn through the ports at level A.

A tier of six outlet ports at level G (above the heating zone) for the withdrawal of hot gas.

A tier of six inlet ports at level F (in the heating zone) for the re-admission of hot gas withdrawn at level G.

A tier of six exit ports at level H for the withdrawal of exit gases from the kiln.

The ports in each tier are dispersed symmetrically around the kiln and each port is directly above and/or below the corresponding port(s) in the adjacent tier(s). The burners may supply hot gases, gaseous fuel or liquid fuel to the shaft.

Conduits L and valves V are provided for the withdrawal and admission of hot gases as described above. A similar conduit L and valve V are provided for admitting air or oxygen to the base **6** of the kiln. A control line C connects each valve V with a programmer P.

A sequence of operations for this kiln is shown in Table III:

TABLE III

Pattern	Tier	Position 1	2	3	4	5	6	
1	A, D, E, F	X	X	X	O	O	O	
	B, C, G, H	O	O	O	X	X	X	
2	A, D, E, F	O	O	X	X	X	O	
	B, C, G, H	X	X	O	O	O	X	
3	A, D, E, F	X	X	O	O	O	X	
	B, C, G, H	O	O	X	X	X	O	
4	A, D, E, F	O	X	X	X	O	O	
	B, C, G, H	X	O	O	O	X	X	
5	A, D, E, F	X	O	O	O	X	X	
	B, C, G, H	O	X	X	X	O	O	one
6	A, D, E, F	X	X	X	O	O	O	cycle:
	B, C, G, H	O	O	O	X	X	X	cycle
7	A, D, E, F	O	O	O	X	X	X	time
	B, C, G, H	X	X	X	O	O	O	30
8	A, D, E, F	X	X	O	O	O	X	minutes
	B, C, G, H	O	O	X	X	X	O	
9	A, D, E, F	O	O	X	X	X	O	
	B, C, G, H	X	X	O	O	O	X	
10	A, D, E, F	X	O	O	O	X	X	
	B, C, G, H	O	X	X	X	O	O	
11	A, D, E, F	O	X	X	X	O	O	
	B, C, G, H	X	O	O	O	X	X	
12	A, D, E, F	O	O	O	X	X	X	
	B, C, G, H	X	X	X	O	O	O	

O = port open
X = port closed

The above-described kilns and modes of operation are only examples of the apparatus and methods which may be used in the practice of the invention. As will be apparent to the instructed reader, an infinite number of variations is possible within the scope of our invention.

What is claimed is:

1. In a process for operating a vertical shaft kiln which has a plurality of burners disposed around the shaft and through which solid granular material passes downwardly through the shaft and is contacted while in the shaft with hot gaseous fluid, the improved method of obtaining substantially uniform heat treatment of the material leaving the shaft which comprises controlling the flow pattern of said hot gaseous fluid in a manner to obtain a temperature distribution of the hot gaseous fluid in the shaft which is asymmetrical in a horizontal plane at a given level in the shaft so that heating of the downwardly moving material passing through said plane is non-uniform across the shaft and varying the flow pattern of said hot gaseous fluid in a manner to change the asymmetrical temperature distribution at said given level in accordance with a predetermined sequence, all the granular material passing downwardly through the kiln receiving substantially the same overall heat treatment.

2. A method as in claim **1** wherein the kiln is fired by hot gases produced by combustion of fuel outside the shaft.

3. A method as in claim **1** wherein the kiln is fired by a normally gaseous fuel.

4. A method as in claim **1** wherein the kiln is fired by a normally liquid fuel supplied to the shaft in gaseous form.

5. A method as in claim **1** wherein the configuration of at least one flame front associated with at least one burner is varied in a predetermined sequence.

6. A method as in claim **1** wherein the pattern of flow is varied in a cyclic sequence.

7. A method as in claim **1** wherein burners are provided at at least two levels in the shaft, and burners at the said two levels are operated out of phase.

8. A method as in claim **1** wherein hot gaseous fluid is withdrawn from the shaft and at least a portion of the same is variably returned to the shaft.

9. A method as in claim **1** wherein the pattern of flow is varied by variation of the location at which exit gases are removed from the top of the shaft.

10. A method as in claim **1** wherein the pattern of flow is varied in a cyclic sequence having a period in the range **5** minutes to two hours.

11. A method as in claim **10** wherein the duration of operation in any standing mode in the cycle is in the range 1 to 10 minutes.

12. A method as in claim **1** wherein the step of varying the flow pattern of said hot gaseous fluid includes supplying fuel at a variable rate to at least one burner.

13. A method as in claim **1** wherein the step of varying the flow pattern of said hot gaseous fluid includes supplying hot gas at a variable rate to at least one burner.

14. A method as in claim **1** wherein the step of varying the flow pattern of said hot gaseous fluid includes supplying air to the shaft in varying quantities.

15. A method as in claim **1** wherein the step of varying the flow pattern of said hot gaseous fluid includes supplying oxygen to the shaft in varying quantities.

16. In a vertical shaft kiln including a shaft through which solid granular material passes downwardly during operation of the kiln and a plurality of burners disposed symmetrically around the shaft at at least one level for introducing hot gaseous fluid into the shaft, the improvement which comprises means for controlling the flow pattern of the hot gaseous fluid in the shaft in a manner to obtain a temperature distribution of the hot gaseous fluid in the shaft which is asymmetrical in a horizontal plane at a given level in the shaft so that heating of downwardly-moving material passing through said plane is non-uniform across the shaft, and programming means for varying the flow pattern of the hot gaseous fluid in a manner to change the asymmetrical temperature distribution at said given level in accordance with a predetermined sequence so that all the granular material passing downwardly through the kiln receives substantially the same overall heat treatment.

17. A vertical shaft kiln as in claim **16** wherein burners are disposed at at least two levels in the shaft.

18. A vertical shaft kiln as in claim 16 wherein said programming means is arranged to provide a variation in the flow pattern of hot gaseous fluid in accordance with a cyclic sequence.

19. A vertical shaft kiln as in claim 16 wherein the means to vary the pattern of flow of hot gaseous fluid in the shaft includes means to withdraw gaseous fluid from the shaft and variably return at least a proportion of the withdrawn gases to the shaft.

20. A vertical shaft kiln as in claim 16 wherein the means for varying the flow pattern of the hot gaseous fluid in the shaft includes means for admitting air in variable amounts at the base of the shaft.

21. A vertical shaft kiln as in claim 16 wherein the means for varying the flow pattern of the hot gaseous fluid in the shaft includes means for admitting oxygen in variable amounts at the base of the shaft.

22. A vertical shaft kiln comprising: a shaft through which solid granular material passes downwardly during operation of the kiln; a plurality of burners disposed symmetrically around the shaft at a plurality of levels in the shaft for introducing hot gaseous fluid into the shaft; means for controlling the flow pattern of the hot gaseous fluid in the shaft in a manner to obtain at each of a plurality of levels a temperature distribution of the hot gaseous fluid which is asymmetrical in a horizontal plane so that heating of downwardly-moving material passing through each of said planes is non-uniform across the shaft; and programming means for varying the control means in a manner to change the asymmetrical temperature distribution at said levels in accordance with a predetermined sequence so that all the granular material passing downwardly through the kiln receives substantially the same overall heat treatment.

23. Apparatus as in claim 22 wherein said means for controlling the flow pattern of hot gaseous fluid in the shaft includes means for controlling said burners so as to control the position of the flame front produced by those burners which are disposed at at least one level.

24. Apparatus as in claim 22 wherein said means for controlling the flow pattern of hot gaseous fluid in the shaft includes means for withdrawing gaseous fluid from the shaft from at least two points at substantially the same level and for varying the rate of withdrawal at one of said points relative to the rate of withdrawal at the other of said points.

25. Apparatus as in claim 22 wherein said means for controlling the flow pattern of hot gaseous fluid in the shaft includes means for supplying air to at least two points at substantially the same level in the shaft and for varying the rate of supply at one of said points relative to the rate of supply to at least one other of said points.

26. Apparatus as in claim 22 wherein said means for controlling the flow pattern of hot gaseous fluid in the shaft includes means for supplying oxygen to at least two points at substantially the same level in the shaft and for varying the rate of supply at one of said points relative to the rate of supply to at least one other of said points.

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