Nov. 19, 1940. J. F. SIMPSON 2,222,244

LIME BURNING AND KILN THEREFOR

Filed April 29, 1940 2 Sheets-Sheet 1

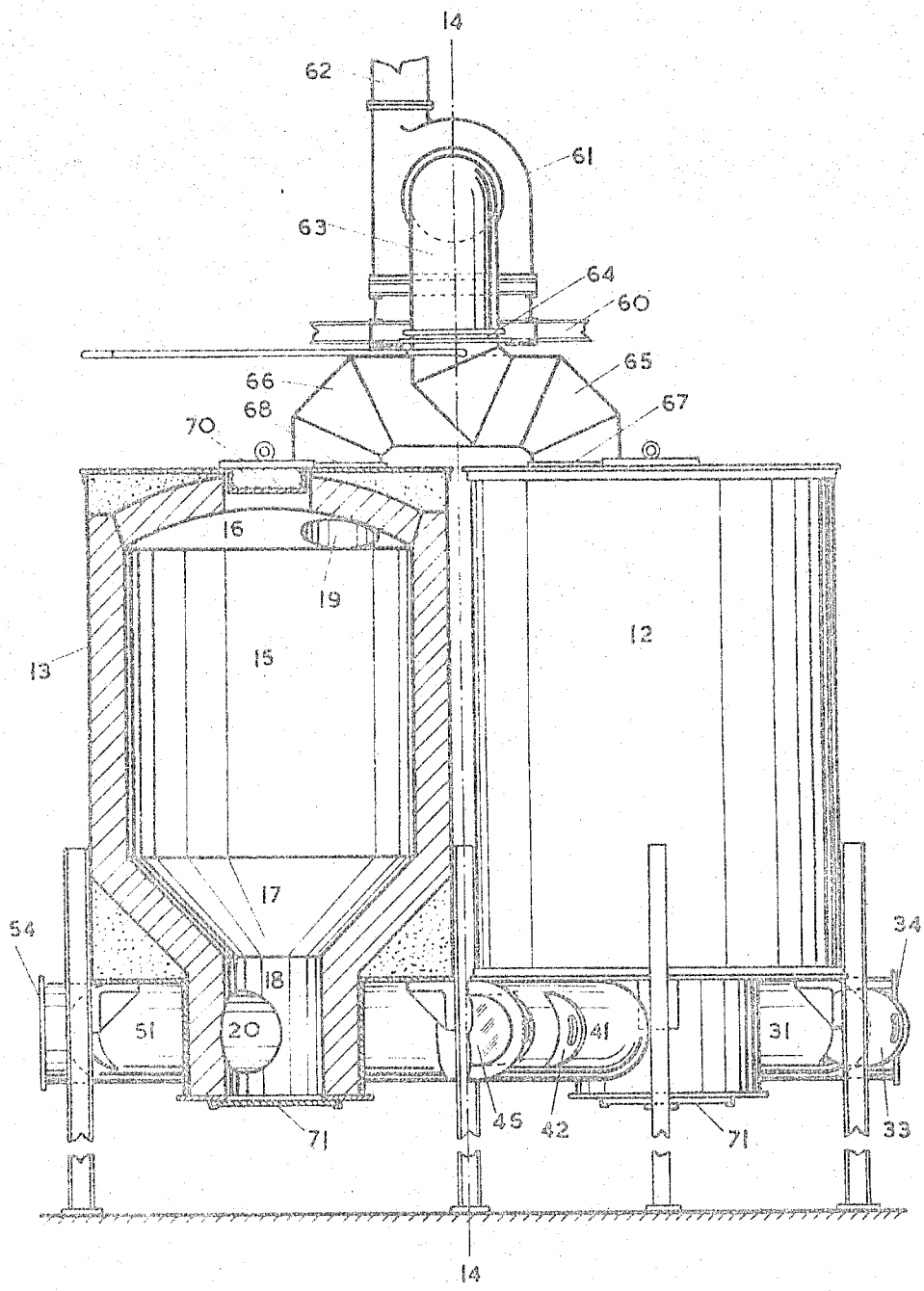


FIG. 1.

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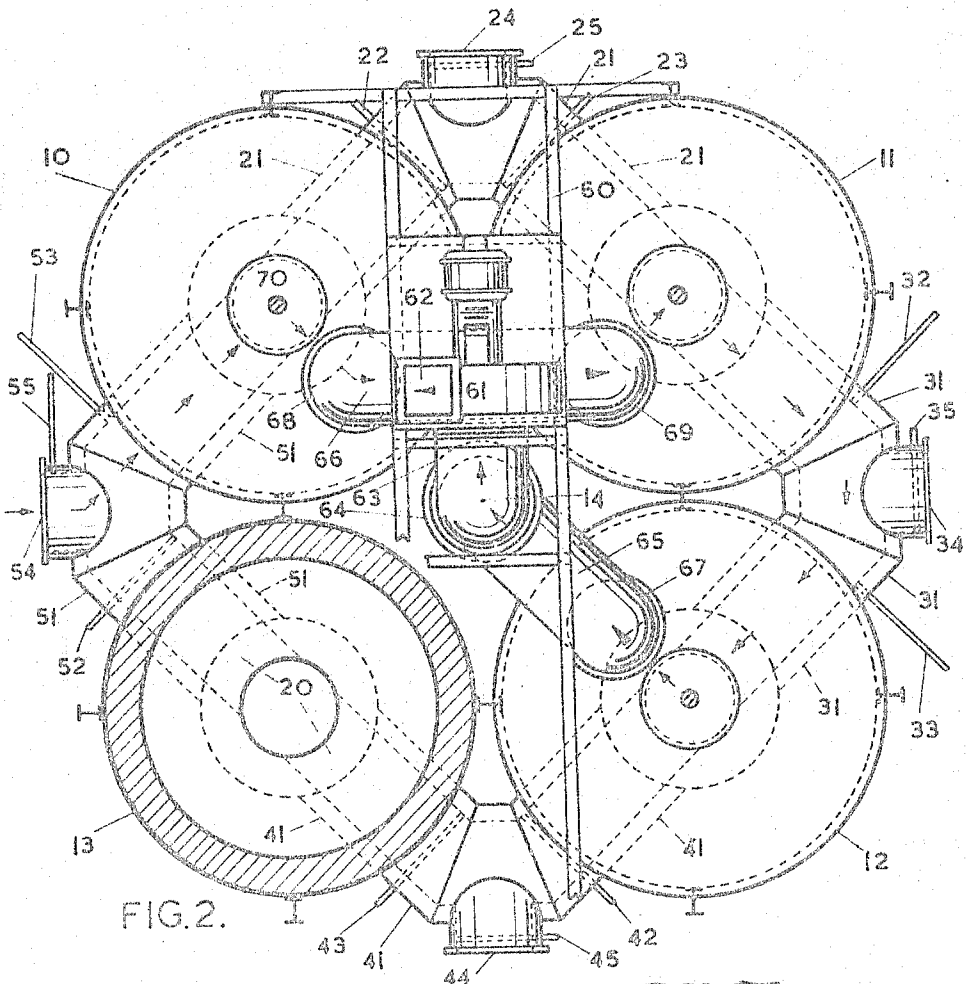


FIG. 2.

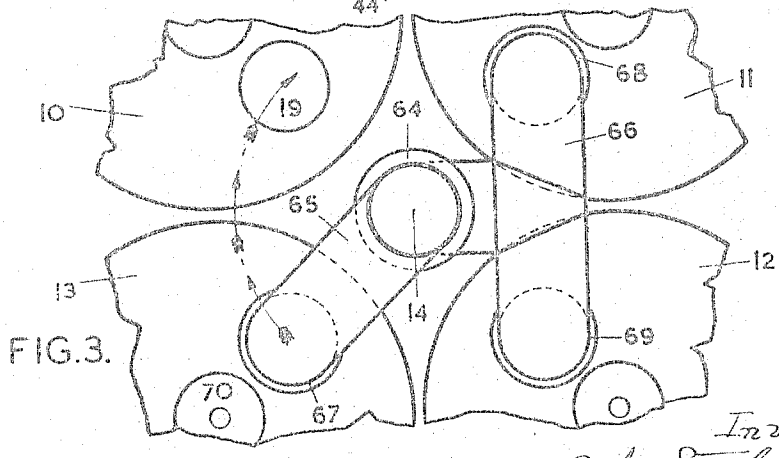


FIG. 3.

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UNITED STATES PATENT OFFICE

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LIME BURNING AND KILN THEREFOR

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Application April 29, 1940, Serial No. 332,387
In Great Britain April 4, 1939

8 Claims. (Cl. 263—53)

This invention relates to lime burning and to kilns therefor.

In the burning of lime heated gases have heretofore been passed upwardly through a column of broken limestone, the gases being heated by combustion of gaseous fuel admixed therewith or of solid fuel beneath or admixed in layers with the limestone. Difficulties have been experienced in obtaining uniform burning or calcining of the limestone throughout the column. Such difficulties appear to have been caused, at least in part, by the inherent instability of uniformity across the cross-section of the column of the upward flow of hot gases. If a locality of the cross-sectional area or the walls of a channel through the column in the direction of flow of the gases should become hotter than the remainder, there is a natural tendency for the rate of flow of the gases through that locality or channel to increase, even at the expense of the flow through other parts, with consequent tendency to further increase of temperature at the locality or channel and still further increase of the rate of flow. There is thus a cumulative tendency for the rate of flow of gases past, and the temperature of, a hot locality both to increase. At best the equilibrium of the rate of flow of hot gases across the cross section is unstable when the direction of flow is upwards.

The object of the invention is to provide an improved method of burning lime whereby more uniform burning or calcining of the limestone may be obtained throughout the column thereof which is contained in a kiln. To this end an object of the invention is to set up an inherent tendency to preserve uniformity of rate of flow of hot gases through the lime being burnt over the whole cross-section thereof.

Another object is to widen the field of raw material by providing an improved method enabling burnt lime to be produced in a given kiln or battery of kilns with equal facility from limestone, chalk or shells.

Another object is to provide an improved regenerative method of burning lime which method may be continuous by carrying it out in a succession of steps.

Another object of the invention is to provide a method of burning lime by the employment of which the height of a kiln in which the lime material is burnt may be reduced and the cross-sectional area increased without detriment to the product and without encountering the difficulties hereinbefore experienced in obtaining uniform burning throughout the charge.

A still further object is to provide improved apparatus for burning lime according to the invention and for controlling the operation.

In the method of burning lime according to the present invention a layer of solid fuel is superimposed upon the raw lime material, the fuel is ignited, air is passed downwards through the fuel and the gaseous products of combustion are caused to pass downwards through the infra-recumbent lime material together with the gaseous products of calcining. Preferably the lime is burnt in a battery of four kilns and in the preferred method of operation air or gas is passed up through the recently burnt and hot contents of one kiln, down through the burning contents of a second kiln, up through the unburnt contents of a third kiln and thence to a chimney flue or extractor fan. Meanwhile the fourth kiln may be discharged and re-charged.

It will be appreciated that the air may be admitted to the first kiln through a damper controlling an opening to atmosphere and that the contents of this kiln will be cooled by the passage of the air through them whilst the air will be pre-heated. In the third kiln the gaseous stream from the second will be cooled and will pre-heat the charge therein.

This operation may be repeated after the contents of the second kiln have been burnt by passing the air up this second kiln, down through the burning contents of the third and up through the newly charged fourth kiln and so on so that lime may be burnt in a succession of steps forming a continuous regenerative operation.

In the accompanying drawings, which are diagrammatic in character—

Figure 1 is an elevation of a battery of kilns according to the present invention, one of the kilns being shown in longitudinal section;

Figure 2 is a plan of Figure 1, the one kiln being shown in transverse section; and

Figure 3 is a fragmentary plan illustrating a different position of the upper conduits.

Like reference numerals indicate like parts, where applicable, throughout the several figures of the drawings.

The embodiment of the invention which is illustrated comprises a battery of four kilns 10, 11, 12 and 13 grouped around a common axis 14—14 equally spaced from one another and all equidistant from the axis.

Each kiln comprises a substantially vertical hollow structure providing a cylindrical chamber 15 having a domed roof 16 and a conical base 17 leading to a lower neck 18. An upper port 19 is

formed in the roof 16 of each kiln and the ports 19 of the four kilns 10, 11, 12 and 13 are all equally spaced and equi-distant from the common axis 14—14.

Two lower ports 20 are formed in the neck 18 of each of the kilns. One of the ports 20 of the kiln 10 is connected by a conduit 21 to a lower port 20 of the kiln 11 and this conduit is controlled by dampers 22 and 23, the damper 22 appertaining to the kiln 10 and the damper 23 to the kiln 11. Between the dampers 22 and 23 the conduit 21 is provided with an opening 24 leading to atmosphere controlled by a damper 25.

The other lower port 20 of the kiln 11 is similarly connected to a lower port of the kiln 12 by a conduit 31 controlled by dampers 32 and 33 and having an opening to atmosphere 34 controlled by a damper 35. The other lower port of the kiln 12 is connected to one of the ports 20 of the kiln 13 by a conduit 41 controlled by dampers 42 and 43 and having an opening to atmosphere 44 controlled by a damper 45.

Likewise the other port 20 of the kiln 13 is connected to the other port 20 of the kiln 10 by a conduit 51 controlled by dampers 52 and 53 and having an opening to atmosphere 54 controlled by a damper 55.

A staging 60 erected above the battery of kilns supports an extractor fan 61 the outlet of which is connected to a chimney 62. A flue pipe 63 is connected to the inlet of the fan 61 and the lower portion of the flue pipe 63 is concentric with the axis 14—14 and comprises a joint 65 with a manifold 66, 66 such that the manifold is rotatable in relation to the flue pipe 63 about the common axis 14—14.

The manifold comprises a flue portion 66 connected to the fixed flue pipe 63 at the joint 64 and a bridging portion 66. The flue portion 66 of the manifold has a downwardly opening mouth 67 adapted to register with any one of the upper ports 19 of the kilns 10, 11, 12 and 13. The bridging portion 66 of the manifold likewise has two downwardly opening mouths 68 and 69 adapted to register with the upper ports 19 of two adjacent kilns when the mouth 67 is in register with a port of another kiln.

Each of the kilns is provided with a charging opening at the top having a detachable cover 70 and with a discharging opening at the base of the neck portion 18 normally closed by a sliding shutter or like closure means 71.

The battery of kilns may be operated in a continuous regenerative process in the following manner:

Assuming each kiln to be charged with raw limestone, chalk or shells upon which a layer of solid fuel is superimposed and the contents of the kiln 10 to have been recently burnt, the kilns 11 and 12 will be charged with raw lime and solid fuel and the controlling devices of the conduits connected to the ports 19 and 20 are adjusted into the position shown in Figures 1 and 2. In this position the bridging portion 66 of the manifold connects the upper port 19 of the kiln 10 to the upper port 19 of the kiln 11 and the flue portion 65 of the manifold connects the upper port 19 of the kiln 12 to the inlet of the fan 61 and thence to the chimney 62.

The dampers 55, 53, 32 and 33 are opened and all the other dampers are closed. The fan 61 will induce a current of air through the opening 54 into the base of the kiln 10 through the lower port 20 thereof which is connected to the conduit 51. The air will then pass up through the recently burnt and hot contents of the kiln 10 into the bridging portion 66 of the manifold and thence through the upper port 19 of the kiln 11. During its passage through the kiln 10 the air will be heated sufficiently to ignite the layer of solid fuel at the top of the kiln 11 (the contents of this kiln having been pre-heated as hereinafter described). Thence the air and products of combustion will pass in a downward flow to burn the raw material in this kiln. On arriving at the base of the kiln 11 the gaseous stream will pass through the conduit 31 into the base of the kiln 12 and up through the charge therein which will thus be pre-heated and the gases will be cooled, thus reducing any tendency to ignite the layer of fuel at the top of this kiln, though the amount of air admitted through the opening 54 is preferably so regulated that the gases will not be able to support combustion when they arrive at the kiln 12. From the top of the kiln 12 the gaseous stream passes through the flue portion 6 of the manifold and thence through the extractor fan 61 to the chimney 62.

Whilst the contents of the kiln 11 are being burnt the kiln 13 is discharged and re-charged. When the burning of the lime in the kiln 11 is completed the manifold is turned clockwise into the position shown in Figure 3 so that its flue portion 65 connects the upper port 19 of the kiln 13 to the chimney 62 through the fan 61 and its bridging portion 66 connects the upper ports 19 of the two kilns 11 and 12.

The dampers 53 and 55 are closed, the dampers 23 and 25 are opened, the dampers 32 and 33 are closed and the dampers 42 and 43 are opened. Air will now enter the conduit 21 through the opening 24, pass up through the recently burnt contents of the kiln 11 to be pre-heated and to cool such contents, thence through the bridging portion 66 of the manifold, down through the kiln 12 to ignite the pre-heated layer of fuel therein and to burn the pre-heated lime contents, the gaseous stream passing through the conduit 41 into the base of the kiln 13, up through the contents of that kiln to pre-heat its charge, the cooled gases finally passing through the flue portion 65 of the manifold and the fan 61 to the chimney 62. Meanwhile the cooled contents of the kiln 10 are being discharged and this kiln re-charged.

When the contents of the kiln 12 are completely burnt the manifold 65, 66 is again turned clockwise for its mouths to register with the upper ports of the kilns 13, 13 and 12 and the dampers are manipulated to enable the contents of the kiln 13 to be burnt in a similar manner to that described above the process being repeated so that the contents of the various kilns are successively burnt.

Since the hot gases are forced to flow downwardly through the limestone which is being burnt, the equilibrium of flow is stable across the cross-section. If a locality tends to become over heated, the density of gases thereabout is reduced and the tendency is for the downward flow in that locality to be diminished and to be increased elsewhere. The diminished rate of flow in the overheated locality tends to cause a reduction in temperature and thus there is an inherent tendency to preserve uniformity of rate of flow over the whole cross-section.

In the result the limestone is more uniformly burnt throughout the volume of the column and more precise regulation of temperature and duration of treatment are rendered possible with

resulting improved fuel economy and more uniform product.

What I claim is:

1. The method of burning lime in which a layer of solid fuel is superimposed upon the raw lime material, air pre-heated to at least the ignition temperature of the fuel is passed downwards through the fuel and the gaseous products of combustion are caused to pass downwards through the infra-recumbent lime material together with the gaseous products of calcining.

2. The method of burning lime in a battery of at least four kilns in which a layer of solid fuel is superimposed upon the raw lime material when charging each kiln, air is passed up through the recently burnt and hot contents of one kiln, downwards through the fuel and infra-recumbent lime material in a second kiln, the gaseous stream from which is passed up through the unburnt contents of a third kiln and thence to a chimney flue, the fourth kiln being discharged and re-charged meanwhile.

3. The method of burning lime in a battery of at least four kilns and in a continuous regenerative operation comprising a succession of steps in each of which one kiln is discharged and a layer of solid fuel is superimposed upon raw lime material to be burnt in that kiln, air is pre-heated by being passed up through the hot lime burnt in a second kiln in the previous step, is passed downwards through the fuel of a third kiln which had been pre-heated in the previous step and the gaseous products of combustion are caused to pass downwards through the infra-recumbent lime material in that third kiln together with the gaseous products of calcining, and the gaseous stream from that third kiln in which the lime is being burnt is passed upwards through to pre-heat the unburnt contents of a fourth kiln which had been charged during the previous step.

4. The combination of a plurality of lime kilns exceeding two in number and grouped around a common axis, each kiln having ports opening to the interior, one near the top thereof and another near the base thereof, the upper ports being all equally spaced and equi-distant from the common axis, a chimney flue having a portion concentric with said axis and a manifold jointed to the chimney flue to be rotatable about the common axis and having three or more mouths each capable of registering with an upper port of any kiln, one of the mouths being connected in the manifold with the chimney flue, the other mouths being interconnected in the manifold.

5. The combination of a plurality of lime kilns exceeding two in number and grouped around a common axis, each kiln having ports opening to the interior, one near the top thereof and others near the base thereof, the upper ports being all equally spaced and equi-distant from the common axis, a chimney flue having a portion concentric with said axis, a manifold jointed to the chimney flue to be rotatable about the common axis and having three or more mouths each capable of registering with an upper port of any kiln, one of the mouths being connected in the manifold with the chimney flue, the other mouths being interconnected in the manifold, conduits providing passages connecting the lower ports of adjacent kilns and controlling devices enabling selection to be made of those kilns whose lower ports are operatively connected by a passage.

6. The combination of a plurality of lime kilns exceeding two in number and grouped around a common axis, each kiln having ports opening to the interior, one near the top thereof and others near the base thereof, the upper ports being all equally spaced and equi-distant from the common axis, a chimney flue having a portion concentric with said axis, an extractor fan connected in said chimney flue, a manifold jointed to the chimney flue to be rotatable about the common axis and having three or more mouths each capable of registering with an upper port of any kiln, one of the mouths being connected in the manifold with the chimney flue, the other mouths being interconnected in the manifold, conduits providing passages connecting the lower ports of adjacent kilns and controlling devices enabling selection to be made of those kilns whose lower ports are operatively connected by a passage.

7. The method of burning lime in which a layer of solid fuel is superimposed upon the raw lime material, the fuel is ignited, air is passed downwards through the fuel and the gaseous products of combustion are caused to pass downwards through the infra-recumbent lime material together with the gaseous products of calcining.

8. The method of burning lime in a battery of at least four kilns in which a layer of solid fuel is superimposed upon the raw lime material, air is passed up through the recently burnt and hot contents of one kiln, downwards through the fuel and infra-recumbent lime material in a second kiln, the gaseous stream from which is passed up through the unburnt contents of a third kiln and thence to a chimney flue, the fourth kiln being discharged and re-charged meanwhile.

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