

Oct. 22, 1946.

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2,409,707

CEMENT MANUFACTURE

Filed Jan. 29, 1943

3 Sheets-Sheet 1

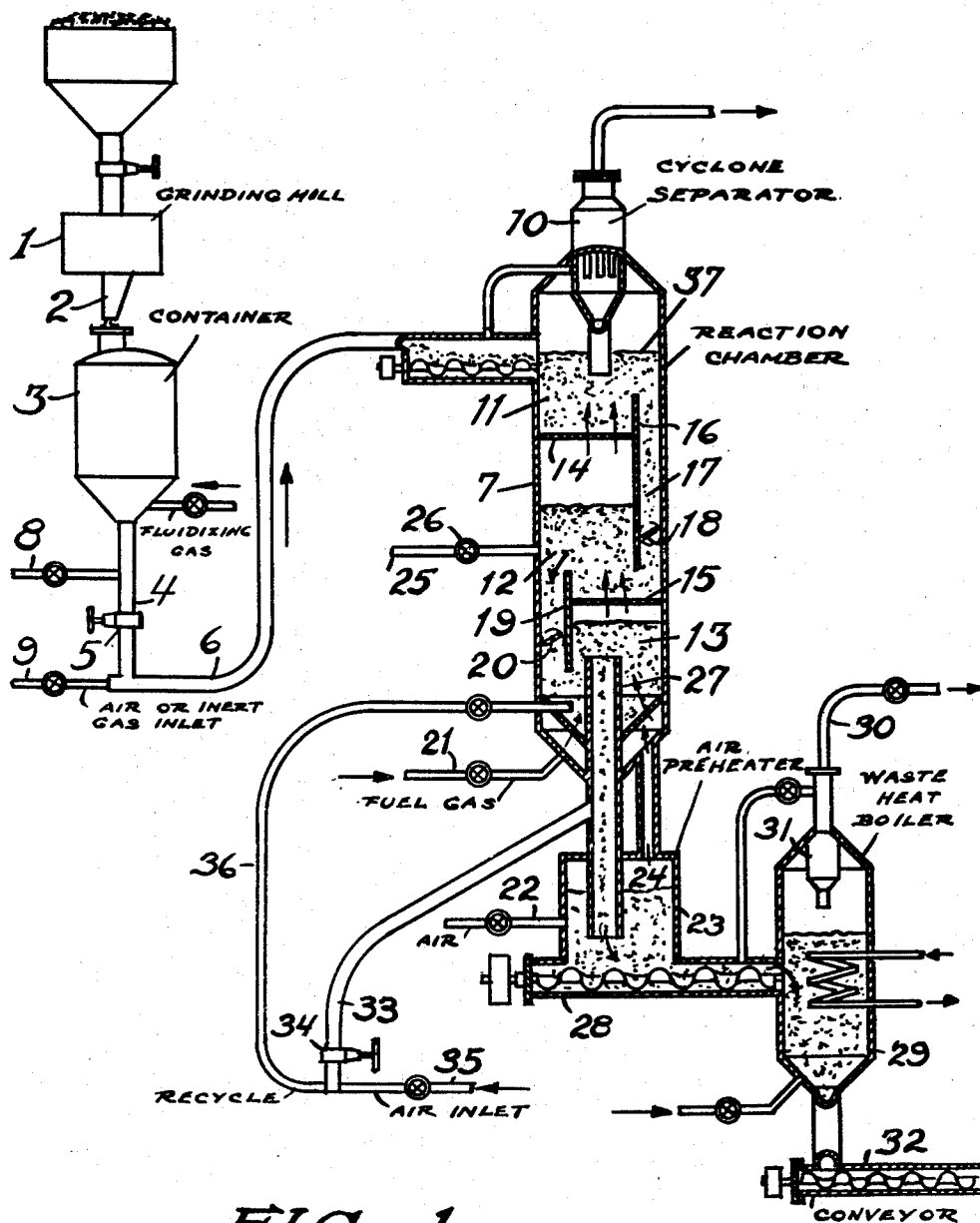


FIG.-1

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3 Sheets-Sheet 2

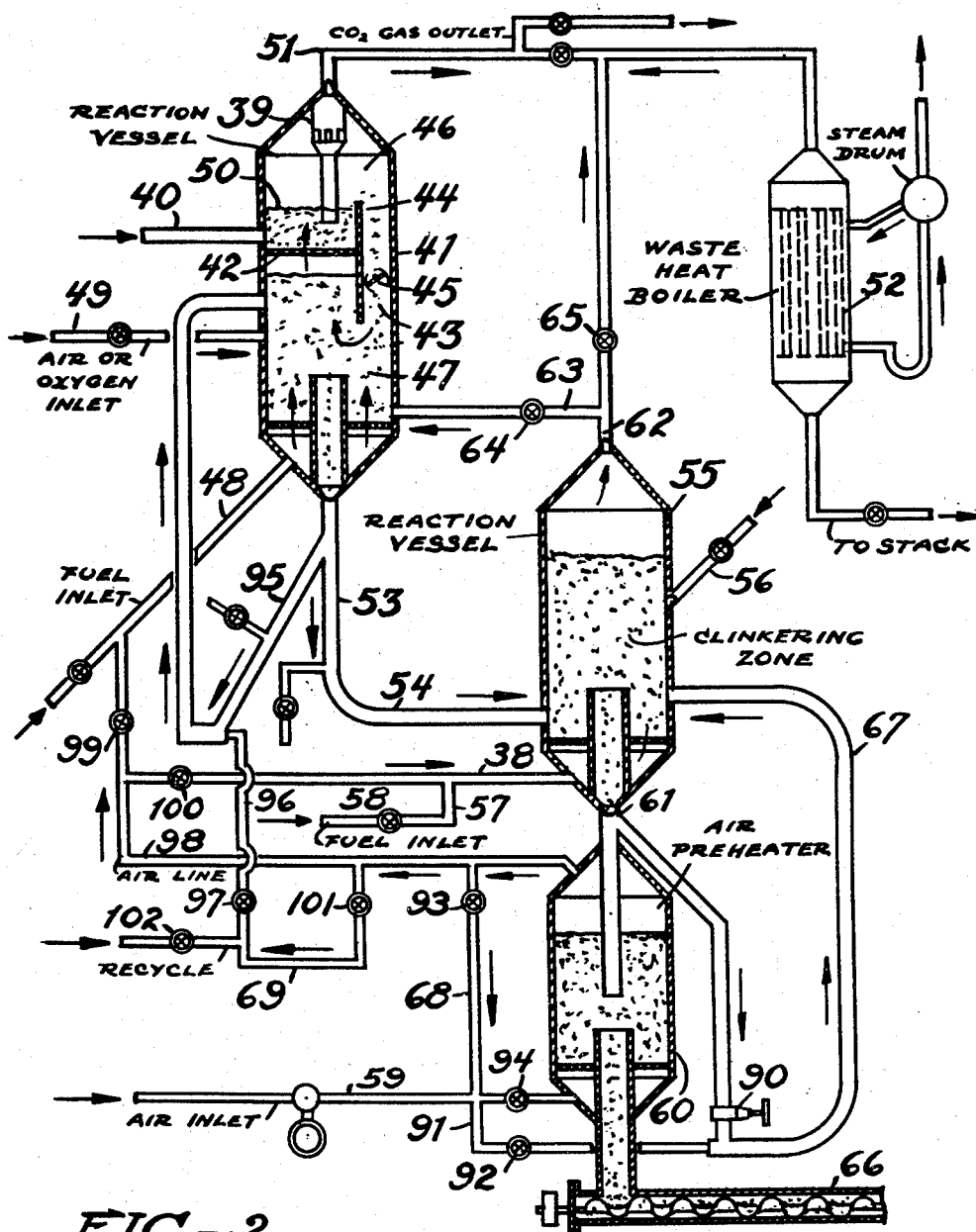


FIG.-2

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3 Sheets-Sheet 3

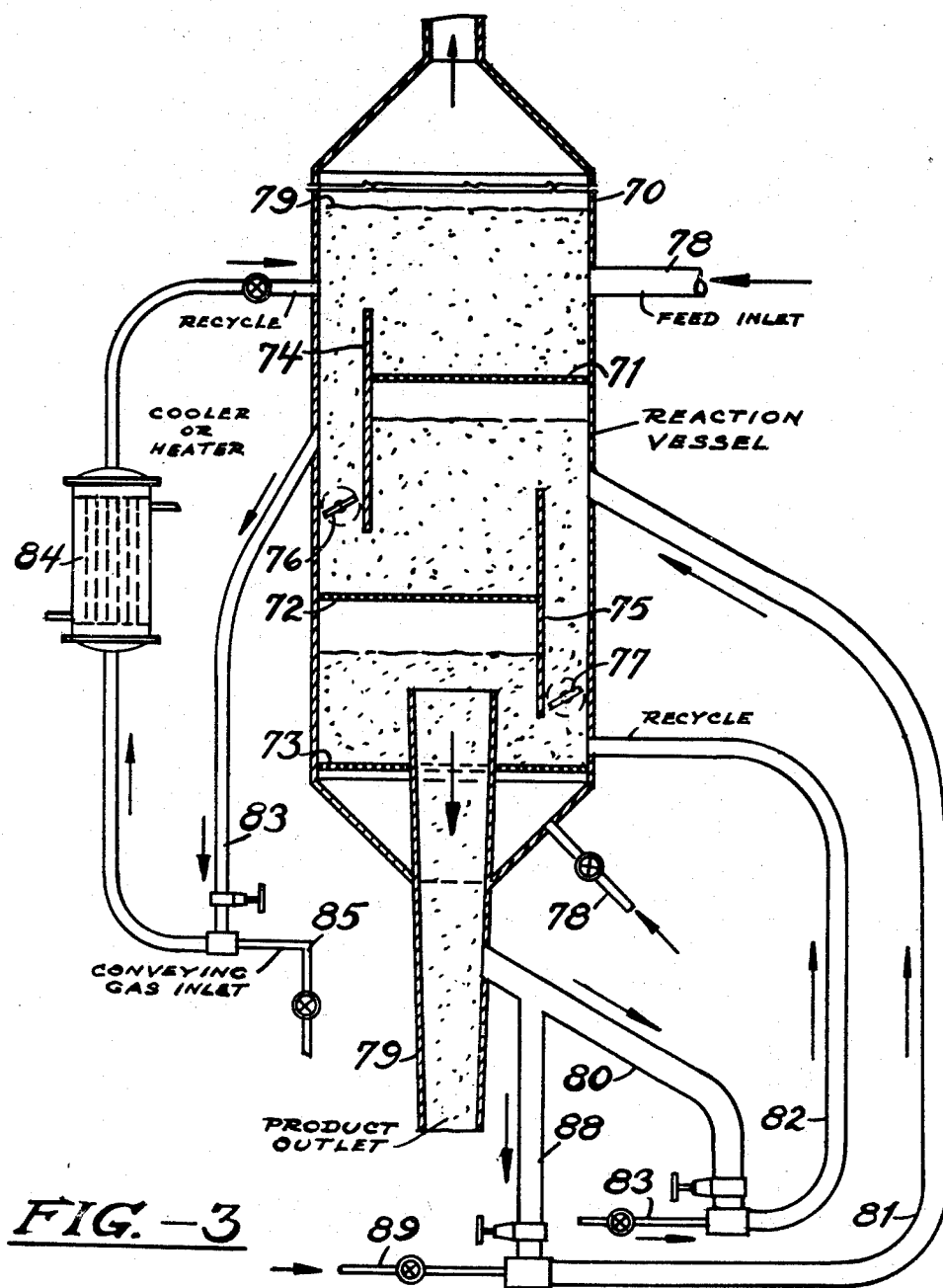


FIG. -3

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UNITED STATES PATENT OFFICE

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CEMENT MANUFACTURE

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Application January 29, 1943, Serial No. 474,008

7 Claims. (Cl. 106—100)

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This invention relates to improvements in the manufacture of cements and relates particularly to improvements in the methods of heating the compositions used in the manufacture of cements.

Two processes are employed for the manufacture of cements which are known respectively as the "wet process" and "dry process." The wet process is the older of the two and is used almost universally in Europe while the dry process is employed to a greater extent here. The essential difference between the two processes is that the limestone and the clay in the wet process is mixed with water, ground and burned wet while in the dry process the raw materials are ground, dried and burned.

Formerly the burning of the mixed raw materials was done in intermittent upright kilns. These were soon improved so as to economize fuels by making them continuous in action. Where upright kilns were used, the mixture of raw materials and fuel was introduced at the top and the finished material removed from the bottom and crushed to the desired size. Later rotary kilns were developed which are long cylinders supported at a very slight pitch ($\frac{1}{2}$ to $\frac{3}{4}$ inches to the foot) from the horizontal and are slowly rotated as the raw materials are added. This type of kiln is generally heated by powdered coal but sometimes natural gases or fuel oil are used. The coal is blown in by a blast of air supplied by a fan. Commercial rotary kilns vary in size from about 6 feet to 11 feet in diameter and have capacities from 200 to 2500 lbs. per day. The finished clinker material is ground to the desired size to impart hydraulic properties. In the rotary kiln process, drying, calcining of limestone and clinkering occurs to some extent concurrently at high temperatures with inefficient utilization of heat owing to by-passing of large volumes of hot gases.

One object of this invention is to reduce the amount of fuel necessary to manufacture cement.

Another object is to conduct the various stages of processing at temperatures most favorable to each stage.

These and other objects of the invention will be understood on reading the following description with reference to the accompanying drawings.

Fig. 1 is a diagrammatic plan view, partly in section, representing the method and apparatus.

Fig. 2 is a diagrammatic plan view partly in section representing an alternate arrangement of apparatus, and

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Fig. 3 is a partly sectional view of a multi sectional reaction vessel.

Referring to the drawings, Fig. 1, the raw material consisting of the properly adjusted quantities of calcareous materials, that is, limestone and clay materials, are introduced into grinding mills designated by the numeral 1. A plurality of mills may be used and the grinding is preferably done dry. The mixture of raw materials is reduced to a fineness so that at least 90% will pass through a 100 mesh sieve. This finely divided raw material is introduced by means of pipe 2, or any suitable conveying means, into a container 3. A finely divided material is then passed through pipe 4, provided with gate valve 5 into pipe 6 where it is conveyed to the reaction chamber 7.

The finely divided material is fluidized as it passes to the reaction chamber 7 by blowing a gas through the finely divided material at the rate of the order of at least 0.01 to 0.05 cubic foot per pound of powder. The gas is supplied by means of pipes 8 and 9. The fluidized finely divided material behaves like a liquid and has many of the hydraulic properties of a liquid in that

1. It flows through pipes under the influence of an unbalanced force such as gravity, differential pressures, etc.

2. It tends to assume the shape of the container.

3. It flows through conduits or pipes accompanied by a pressure drop.

4. Gas seals can be produced in the same manner as a liquid is used to seal a gas holder.

The reaction chamber 7 is provided with a cyclone separator 10 in the upper part and divided into three or more sections as 11, 12, and 13, by means of grids 14 and 15. The finely divided material in each section is in an ebullient state similar to that of a boiling liquid. In section 11 it is preheated and dried by hot gases passing upwardly through grid 14. The finely ground raw material as it dries continuously flows over baffle 16 through outlet 17 which is provided with a butterfly valve 18 to a second section 12 in reaction chamber 7 which is likewise supplied with a baffle 19 and butterfly valve 20. Fuel gas is introduced into lower part of section 13 by means of pipe 21 and air is provided by means of pipe 22.

Air is admitted through heater 23 and passes up through pipe 24 to section 13 of the chamber where the mixture of air and fuel gas burn and supply the desired temperature which may be as high as 1400° C. in order to "clinker" the finely divided material.

The calcined mixture from the section 12 flows over the baffle 19 into "clinkering" zone 13. The hot gases after passing through the ground mixture in section 13 pass upwardly through grid 15 to section 12 and are used to calcine the powdered mixture in section 12. The hot gases then pass through grid 14 to section 11 to dry the ground material first introduced into the reaction chamber. To avoid high temperatures in section 11 in the upper part of the chamber, cool gas, such as oxygen, CO₂ or a suitable inert gas may be introduced in section 12 by means of pipe 25, provided with valve 26 to cool the gases as they pass through grid 14. The "clinkered" material is removed from the bottom section 13 through pipe 27, through air preheater 23 and by means of screw propeller 28 passes to a waste heat boiler 29 where it is partially cooled and the heat used to provide steam for actuating pumps, drives, air compressors, etc. Any included gases are removed from the upper part of the waste heat boiler 29 through pipe 30 which is likewise provided with a cyclone separator or bag filter 31 to separate any solid particles. The calcined dry material is then removed by means of screw conveyor 32 from the lower part of the waste heat boiler 29 and passed to the grinding and packaging mills (not shown).

A portion of the clinkered material in pipe 27 may be withdrawn through pipe 33 provided with valve 34, fluidized by means of air provided by pipe 35 and recycled through pipe 36 to the clinkering section 13. Control means may be provided on the valve 4, and the screw propeller 28 actuated by level 37 in order that the required levels in reaction chamber 7 may be automatically maintained.

Alternately, separate drying, preheating, and clinkering chambers may be provided as shown by Fig. 2. Referring to the drawing, the powdered raw material is introduced by means of pipe 40 into the upper part of a reaction vessel 41 which reaction vessel is provided with a grid 42 dividing the reaction vessel into two parts. An opening 43 formed by baffle 44 and the outside wall of the reaction vessel 41 affords a passage between the upper section 46 and the lower section 47. The opening 43 is provided with a butterfly valve 45. Into this reaction vessel 41 is also passed a fuel, such as fuel oil or powdered coal, by means of pipe 48 and oxygen or an oxygen-containing gas such as air by means of pipe 49. The powdered raw material introduced by means of pipe 40 in reaction vessel 41 is furnished with a sufficient quantity of gas to fluidize the powdered raw material and to maintain a level 50. It is there dried by heat supplied by the hot gases rising upwardly through grid 42. The fluidized dried material as it is dried, overflows baffle 44 through passage 43 to a lower section where it is still heated further to drive off carbon dioxide. The carbon dioxide and moisture are removed from the reaction vessel 41 by means of pipe 51 after passing through cyclone separator 39 and passed to a waste heat boiler 52. The powdered material, after being heated in reaction vessel 41, passes through pipes 53 and 54 to a second reaction vessel 55 into which fluidized powdered material is introduced clay or other ingredients used in preparing cement by means of pipe 56. Fuel is likewise passed through pipe 57 provided with valve 58 and pipe 58 into the reaction vessel 55. Oxygen or oxygen-containing gas such as air, is likewise provided through pipe 59 which air after passing through a preheater 60, passes

through pipe 61 into the second reaction vessel 55. The heated gases removed from reaction vessel 55 may be passed to reaction vessel 41 by means of pipes 62 and 63 provided with valves 64 and 65 or through pipes 62 and 51 to the waste heat boiler 52. The clinkered material from reaction vessel 55 is removed through pipe 61 and preheating vessel 60 in which sensible heat from the clinker preheats the air for combustion. A screw conveyor 66 removes the clinkered material from vessel 60 for further grinding and packaging. A fraction of the clinkered material may be withdrawn from pipe 61 through pipe 67 provided with valve 90 and returned to the clinkering zone. Air is passed into pipe 67 by means of pipe 91 provided with valve 92 where the fraction is recycled to the clinkering zone valves 93 and 94 being used to regulate the flow. The powdered material being removed through pipe 53 may likewise be separated into two parts. The part removed through pipe 95 being recycled to the lower section 47 of the reaction vessel 41, air being furnished through pipe 96 provided with valve 97. Pipe 98, with valves 99, 100, 101, and 102 being provided to regulate the air supply to reaction vessels.

Referring to Fig. 3, a reaction vessel is represented by the numeral 70 which is provided with a plurality of grids 71, 72, and 73, baffles 74 and 75, and butterfly valves 76 and 77. Into the upper part of the reaction vessel is passed powdered material by means of pipe 78. The powdered material is provided with sufficient gas which together with the gas arising upwardly through grid 71 is sufficient to fluidize and to maintain a level of 79 above the grid 71. The fluidized powder is heated by means of the gases arising through grid 71, dried and continuously passed over baffle 74 through the passage formed by baffle 74 and outside wall of reaction vessel 70 to the lower section above grid 72 where it is further heated to drive off carbon dioxide. The fluidized powder above grid 72 as it is being heated, continuously passes through the passage formed by baffle 75 and into the section above grid 73 where fuel, such as fuel oil, and air is provided through pipe 78 which on combustion, is sufficient to raise the temperature to any desired degree. Flue gases and other reacting gases may likewise be introduced into the lower part of the reaction vessel 70 to maintain the solid in a fluidized condition. The product in a clinkered state is removed through pipe 79. Portions of the product passing through pipe 79 may be withdrawn through pipes 80 and 88 and passed through pipes 81 and 82 into which is also provided gas by means of pipes 83 and 89 for recycling clinkered solids to the desired levels of the reaction vessel, that is, the level above grid 72 or the level above grid 73 as desired. A portion of the material may likewise be withdrawn as it passes through a passage such as is formed by baffle 74 by means of pipe 83 and passed through a heat exchanger 84 and recycled to an upper part of the reaction vessel 70 such as a level above grid 71.

I claim:

1. In the manufacture of cement, the improvements which comprise reducing the lime and clay materials used in the manufacture of cement to a fineness so that at least 90% will pass through a 100 mesh sieve, fluidizing the fine powder by contacting with continuously flowing gas and progressively raising the temperature of the fluidized powder by passing a heating gas in

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countercurrent flow to said material at reduced velocity adjusted to maintain a dense turbulent body of said solid materials to first drive off the moisture, second the carbon dioxide and third, to clinker the finely divided material.

2. In the manufacture of cement, the improvements which comprise reducing ingredients used in the manufacture of cement to a fine powder so that at least 90% will pass through a 100 mesh sieve, blowing the fine powder continuously with sufficient gas to maintain the fine powder in a fluid condition and progressively raising the temperature of the fluidized finely divided material by passing a heating gas in countercurrent flow to said material at reduced velocity adjusted to maintain a dense turbulent body of said solid materials to 1400° C., withdrawing the finely divided material which has been clinkered by the said high temperature and grinding to a fine powder.

3. In the manufacture of cement, the improvements which comprise grinding limestone to a fine powder, fluidizing the limestone by blowing with continuously flowing gas, raising the temperature progressively by passing a heating gas in countercurrent flow to said material at reduced velocity adjusted to maintain a dense turbulent body of said solid materials to 1000° C. to remove first the moisture and then the carbon dioxide, mixing the residual fluidized powder with clay and raising the temperature to about 1400° C. to clinker the finely divided material, separating the clinkers and grinding to a finely divided powder.

4. In the manufacture of cement, the improvements which comprise grinding limestone and clay to a fine powder, blowing the finely divided mixture of limestone and clay with a continuously flowing volume of gas sufficient to fluidize the said mixture and progressively raising the temperature of the finely divided fluidized mixture of limestone and clay by passing a heating gas in countercurrent flow to said material at reduced velocity adjusted to maintain a dense turbulent body of said solid materials to first separate the moisture, second, the carbon dioxide and third, to clinker the residual fine material and grinding the clinkers to a fine powder.

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5. In the manufacture of cement the improvement which comprises continuously passing a stream of solid material comprising lime and clay material into an enlarged reaction zone,

5 passing a heating gas, while at a temperature sufficient to convert said solid material into cement, upwardly through said enlarged zone at reduced velocity adjusted to maintain a dense turbulent body of solid material within said zone, maintaining said solid material in contact with said heating gas for a period of time sufficient to convert said solid material into cement, withdrawing the stream of solids from the lower portion of said reaction zone and withdrawing the heating gas from the upper portion of said zone.

6. In the manufacture of cement the improvement which comprises continuously passing lime and clay materials used in the manufacture of cement, reduced to a fineness so that at least 90% would pass through a 100 mesh sieve, through a series of enlarged reaction zones, passing a heating gas in countercurrent flow with said finely divided material as it passes into a first reaction zone, passing a heating gas through the said reaction zones at a temperature sufficiently high to maintain a temperature of 1400° C. in the last reaction zone, and 1000° C. in the first reaction zone, the said heating gas passing upwardly to the said reaction zones in countercurrent flow to the said material and at a reduced velocity adjusted to maintain a dense turbulent body of solid material within said zone, maintaining said solid material in contact with said heating gas for a period of time sufficient to first drive off the moisture, then the carbon dioxide and finally to clinker the finely divided material in the last reaction zone where a temperature of 1400° C. is maintained, and continuously withdrawing, in the last reaction zone, cement and the heating gas from the upper part of the first reaction zone.

7. In the manufacture of cement according to claim 6 the heating gas is contacted with the clinkered material being withdrawn from the last reaction zone before passing into the last reaction zone.

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