United States Patent [19]

Engel

[11] 3,836,323

[45] Sept. 17, 1974

[54] PRE-HEATING APPARATUS IN ROTARY KILN PLANT

[75] Inventor: Erland Christoffer Engel, Copenhagen-Valby, Denmark

[73] Assignee: F. L. Smidth & Co., Cresskill, N.J.

[22] Filed: Nov. 30, 1972

[21] Appl. No.: 310,999

[30] Foreign Application Priority Data

Dec. 2, 1971 Great Britain 56051/71

[52] U.S. Cl. 432/106, 432/117, 432/58, 34/57

[51] Int. Cl. F27b 15/00

[58] Field of Search ..... 432/106, 82, 105, 117, 432/129, 130, 133, 16, 58; 34/57 R, 95, 108, 113–115, 128–130, 140–141

[56] References Cited

UNITED STATES PATENTS

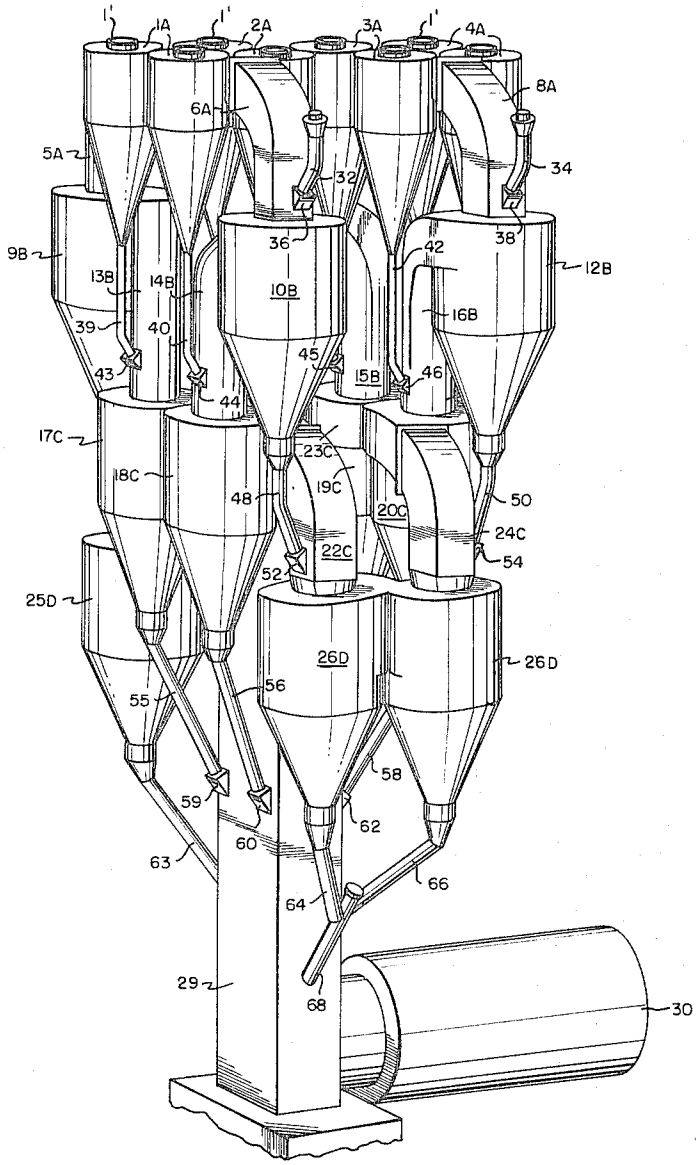
2,785,886	3/1957	Miiler	432/16
3,207,494	9/1965	Jager	432/58
3,653,644	4/1972	Polysius et al.	34/57
3,656,722	4/1972	Polysius et al.	34/57 R
3,664,650	5/1972	Weber et al.	432/117

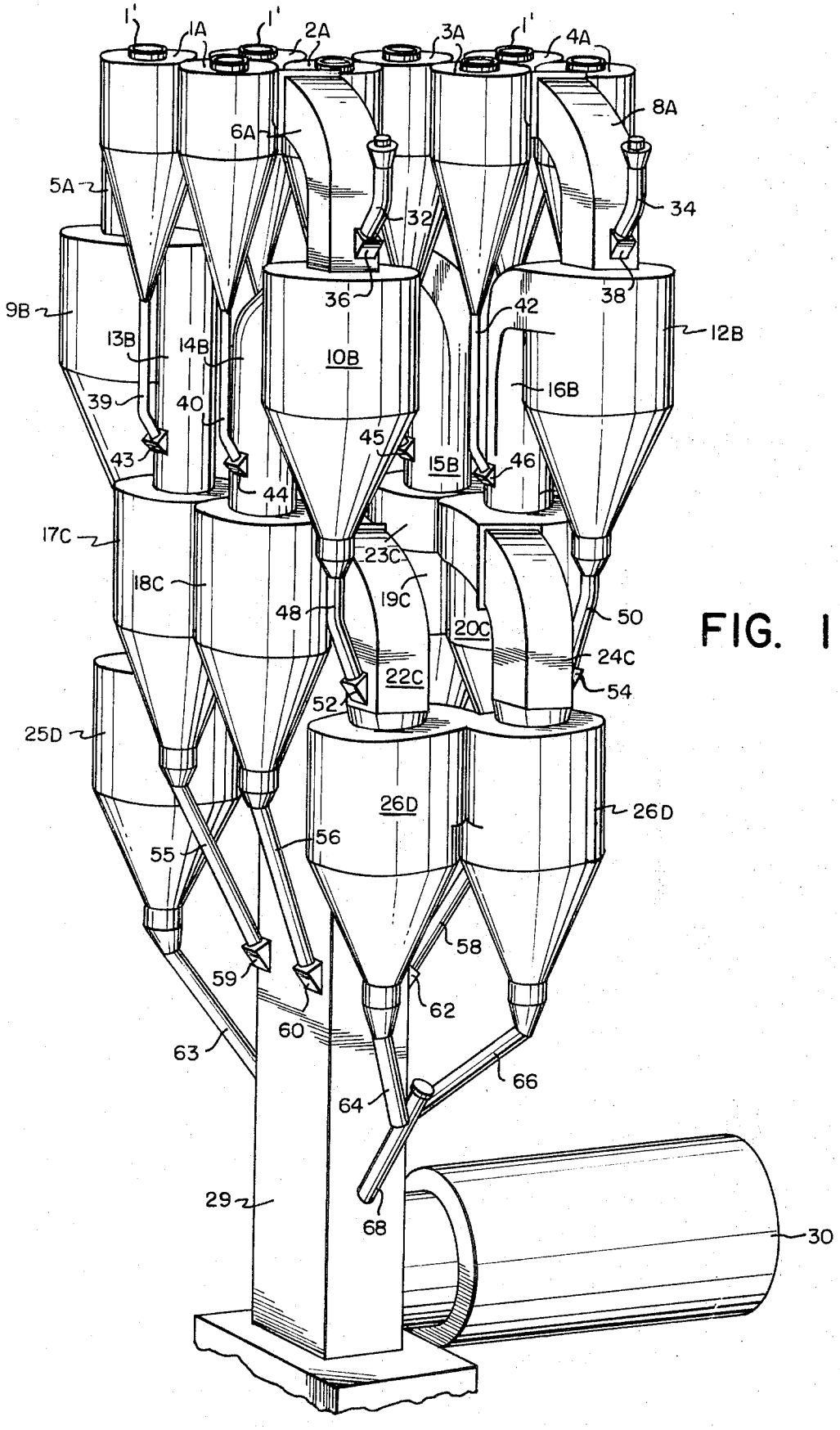
Primary Examiner—John J. Camby
Assistant Examiner—Henry C. Yuen
Attorney, Agent, or Firm—Pennie & Edmonds

[57] ABSTRACT

Pre-heating Apparatus for pre-heating pulverous raw material (e.g. cement raw meal) prior to its introduction into a rotary kiln for burning is disclosed. In construction the pre-heating apparatus includes four strings of treating units, each unit including separation and heat exchange zones, wherein the units of each string are disposed in series superimposed relationship in communication with the kiln and wherein the four strings are arranged symmetrically with respect to determined planes oriented with respect to the kiln axis and kiln outlet.

6 Claims, 4 Drawing Figures

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9B
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14B
10B
16B
39
40
45
43
15B
46
44
17C
23C
18C
19C
48
50
20C
24C
22C
54
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26D
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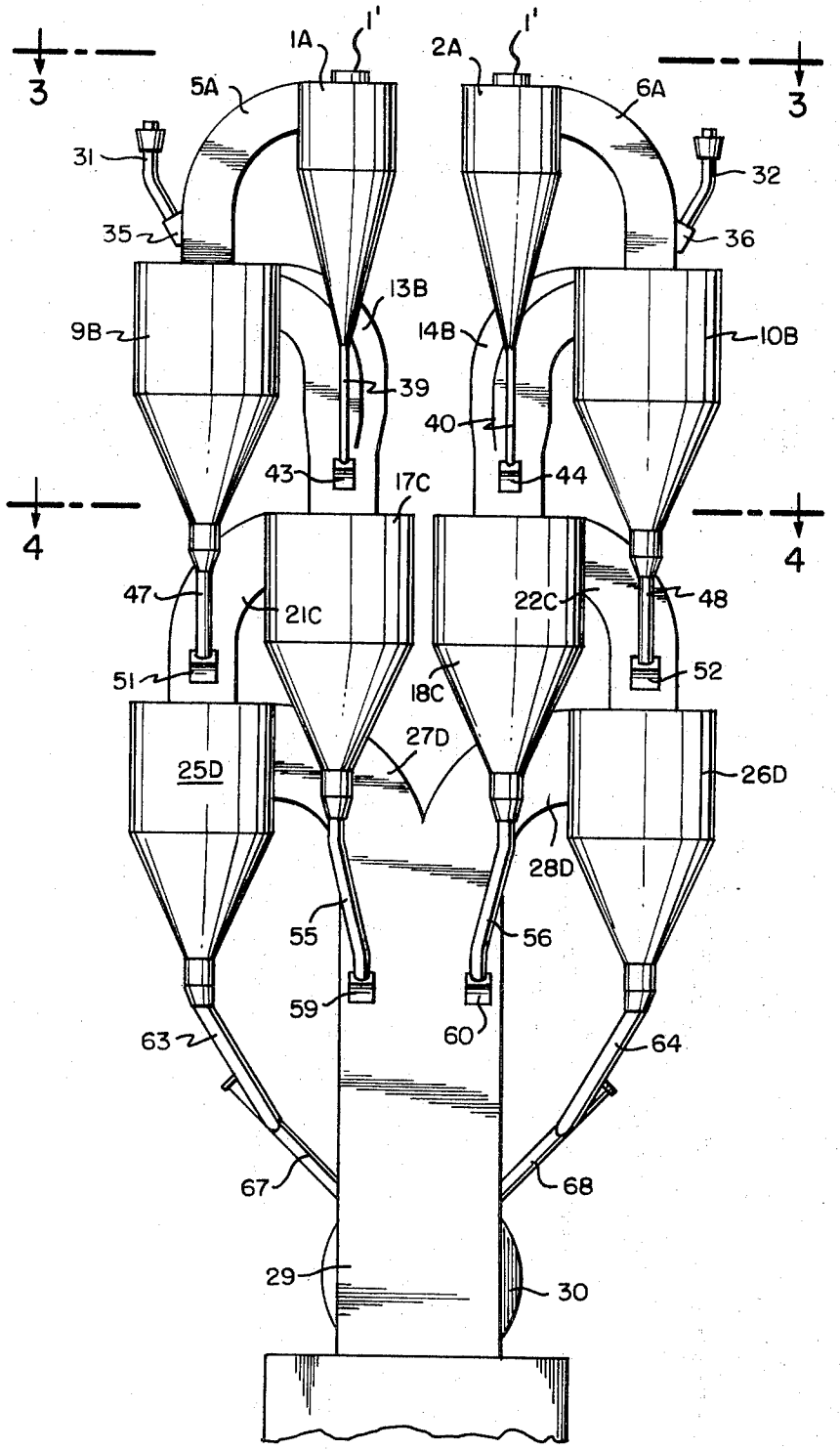
56
58
59
62
60
63
66
64
29
68
30

FIG. 1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14B
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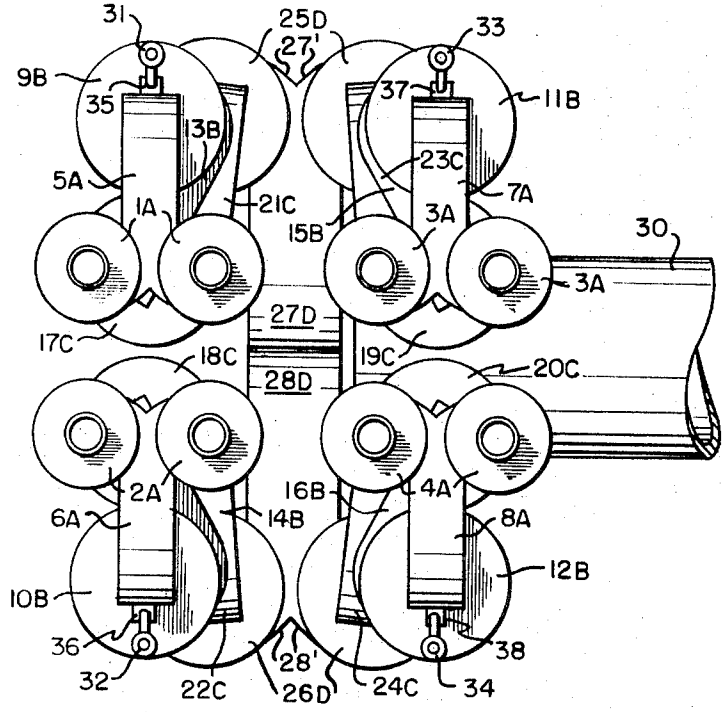
39
40
43
44
17C
47
21C
22C
48
51
18C
52
25D
27D
26D
28D
55
56
59
60
63
64
67
68
29
30

FIG. 2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35
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23C
5A
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21C
15B
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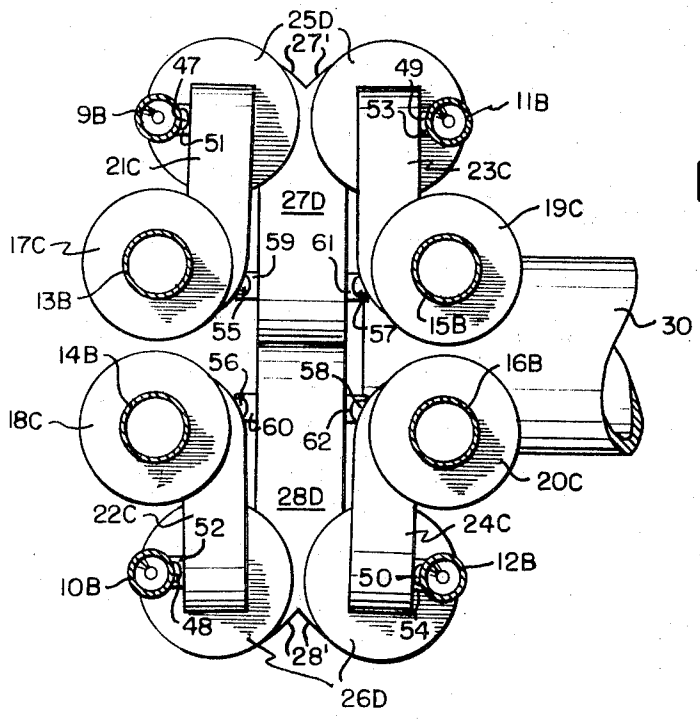
3A
27D
17C
18C
19C
20C
28D
2A
16B
4A
6A
14B
8A
12B
10B
36
38
32
22C
28'
26D
24C
34

FIG. 3


25D
27'
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9B
53
11B
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21C
23C
27D
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17C
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15B
30
14B
56
58
16B
18C
60
62
20C
28D
22C
52
24C
10B
50
12B
48
54
28'
26D

FIG. 4

PRE-HEATING APPARATUS IN ROTARY KILN PLANT

BACKGROUND OF THE INVENTION

This invention relates generally to apparatus for pre-heating pulverous material, such as cement raw meal, prior to its introduction into a rotary kiln for burning. More particularly this invention relates to pre-heating apparatus of the type which includes at least one string of series connected treating units in each of which pre-heating is accomplished by heat exchange between the pulverous material and the smoke gases from the kiln. Each treating unit of this type of pre-heating apparatus commonly includes a riser pipe through which smoke gas from the kiln flows and into which the pulverous material is introduced. This riser pipe defines a chamber in which heat exchange between the gas and pulverous material takes place. Such treating units also commonly include a separator, such as a single or twin cyclone separator, in which the pulverous material is separated from the kiln smoke gases after the heat exchange has occurred.

In a plant utilizing this kind of pre-heating apparatus, as for example, those commonly found in the cement industry, the hot gases from the rotary kiln are drawn by means of a fan successively through the individual treating units which are arranged in superimposed steps or stages. As far as the lowermost stage is concerned, i.e., the stage first passed by the smoke gases from the rotary kiln, the cyclone outlet pipe in that stage is commonly passed directly to the rotary kiln. In other stages of the apparatus, the outlet pipes of the respective cyclone separators commonly open into the riser pipe leading to the cyclone separator of the preceeding stage in the direction of flow of the smoke gases. Each riser pipe is provided with means for feeding it with the cement raw meal which, on its way through the treating units located at the various stages, is successively brought into contact with hotter and hotter smoke gas and is thereby heated to a high temperature. In each individual stage therefore the pulverous raw material is subjected to a separate pre-heating treatment.

In known plants utilizing the above described type of pre-heating apparatus, effective pre-heating of the raw meal (sometimes followed by a partial calcination or expulsion of CO_2) is carried out, it will be recognized, in such a manner that the heat content of the fuel fed to the rotary kiln is utilized in an economically advantageous manner.

The early pre-heating apparatus of this kind generally consisted of but a single string of treating units. The modern day tendency in the cement industry and in other industries is, however, to use continually larger capacity plants and larger rotary kilns, which means that the capacity of the corresponding raw meal pre-heaters must likewise be increased. One known way to meet this requirement for increased capacity is to provide the kiln with two parallel strings of treating units of the type described. This invention meets the requirement for increased capacity by providing a specially constructed pre-heating apparatus which has several other advantages over known pre-heaters of the type described.

SUMMARY OF THE INVENTION

In accordance with the present invention a pre-heating apparatus having four strings of treating units arranged symmetrically both with respect to a vertical plane through the kiln axis and with respect to another vertical plane, perpendicular to the former adjacent to or in front of the smoke gas outlet of the kiln is provided. Structurally, a pre-heating apparatus according to this invention is very compact, provides a very suitable riser pipe arrangement and lends itself to low material consumption for building up the necessary supporting structures.

Furthermore, a pre-heating apparatus constructed according to this invention ensures that the flow paths for the pulverous material and for the smoke gases are the same in each string, both media being equally distributed to the four strings. Moreover, the presence of the four strings affords a high degree of reliability for the total kiln plant, because in the case of failure or inspection of one or more strings, it is possible to continue operation with reduced production by working with a reduced number of strings without stopping the kiln.

Preferably each string includes four treating units and the four riser pipes belonging to the lowermost units preferably unite into a common shaft or conduit into which the rotary kiln opens. To achieve this, the four riser pipes may advantageously unite in pairs into two common intermediate riser pipes, and the two common riser pipes thus produced may unite downwards into the common conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a pre-heating apparatus constructed according to this invention.

FIG. 2 is a side elevation view of the pre-heating apparatus shown in FIG. 1;

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2; and

FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIG. 1, the pre-heating apparatus shown includes four strings each of which includes four treating units which are disposed in series communicating relationship with respect to each other. As will become apparent as the description proceeds the treating units of each string are also disposed in superimposed relationship with respect to each other and each treating unit includes basically a riser pipe defining a heat exchange chamber and a communicating single or twin cyclone separator. Pulverous material, such as cement raw meal, is thus subjected to four stages or steps of treatment as it passes through the riser pipe and cyclone separator of each treating unit in a given string. The treating stages to which the pulverous material is subjected in each string are counted in the direction of transport of material to the kiln. Thus the first stage is uppermost, i.e., it is located most remotely to the kiln. In the Figures the relationship of the individual components of the pre-heating apparatus to the individual stages or steps of treatment is indicated by the addition of a letter index following the particular reference numeral used. Thus, the four stages of treatment are denoted by the letters A to D, commencing from above.

Located at the first stage are four twin cyclones 1A, 2A, 3A and 4A with corresponding communicating

riser pipes 5A, 6A, 7A and 8A. These riser pipes lead from the top of four single cyclones 9B, 10B, 11B and 12B in the second stage which also includes corresponding communicating riser pipes 13B, 14B, 15B and 16B leading, in turn, from the tops of four single cyclones 17C, 18C, 19C and 20C in the third stage. To the cyclones in the third stage belong communicating riser pipes 21C, 22C, 23C and 24C leading, in turn, from the top of two twin cyclones 25D and 26D in the fourth stage. The treating units in the fourth stage also includes riser pipes 27D and 28D each of which includes two branches 27', 28' which, in turn, lead into one section of one of the twin cyclones 25D, 26D of the treating unit in the fourth stage. As shown best in FIG. 2 riser pipes 27D, 28D lead directly into a common shaft 29 opening into the rotary kiln 20.

As will be best seen in FIGS. 3 and 4, the four strings of the pre-heating apparatus are arranged symmetrically both with respect to a vertical plane through the kiln axis and with respect to another vertical plane at right angles to the former located in front of or adjacent to the smoke gas outlet of the kiln.

In normal operation the hot gases from the rotary kiln 30 are drawn, by means of a fan (not shown), successively through the individual treating stages of the apparatus in equal quantities through the individual strings. Thus, one quarter of the smoke gas proceeds along the path from the rotary kiln 30 defined by shaft 29, riser pipe 27D, one of the twin cyclones 25D, riser pipe 21C, cyclone 17C, riser pipe 13B, cyclone 9B, riser pipe 5A and both twin cyclones 1A at which point the smoke gas is removed by suction through the central outlets 1' via a pipe system (not shown). In analogous manner one-quarter of the smoke gas from the kiln passes through each of the remaining strings in the pre-heater. The flow paths through the four strings are of equal and uniform length, and the cross-sectional area along the four flow paths varies equally. Thus the gas flow advantageously is distributed exactly equally to the four flow paths defined by the four strings.

The pulverous raw meal is fed to the individual strings at the uppermost treating stage through feed pipes 31, 32, 33 and 34. The raw meal then passes, via gate valves 35, 36, 37 and 38 which act to prevent the smoke gases from entering the feed pipes while permitting passage of the raw meal, into the riser pipes 5A, 6A, 7A and 8A. In its further conveyance the raw meal flows suspended in the smoke gases through the riser pipes 5A, 6A, 7A and 8A. During passage through these riser pipes, heat exchange between the raw meal and the gas occurs heating the raw meal and cooling the smoke gas. From the first stage riser pipes 5A, 6A, 7A and 8A the smoke gases and the raw meal suspended therein pass into the twin cyclones 1A, 2A, 3A and 4A in the first treating stage. In these cyclones, and in the cyclones at other treating stages, centrifugal force and gravity cooperate in a conventional manner to separate smoke gas and raw meal from each other.

The raw meal leaves the first stage cyclones through raw meal outlet pipes 39, 40, 41 and 42 via built-in gate valves 43, 44, 45 and 46 which act to prevent the smoke gases from moving rearward through outlet pipes 39, 40, 41 and 42 into the cyclones 1A, 2A, 3A and 4A, but to permit passage of raw meal into the second stage riser pipes 13B, 14B, 15B and 16B where renewed heat exchange takes place in the same manner as in the first stage riser pipes.

From the second stage riser pipes the raw pulverous material passes into the second stage cyclones 9B, 10B, 11B and 12B where smoke gas and raw meal are again separated in the same manner as in the first stage cyclones. From the second stage cyclones the raw material passes through raw meal outlet pipes 47, 48, 49 and 50 via gate valves 51, 52, 53 and 54 where the raw meal is fed into the third stage riser pipes 21C, 22C, 23C and 24C for further heat exchange with still hotter gases. In the third stage cyclones 17C, 18C, 19C and 20C gases and raw meal are again separated as in the first and second stage cyclones. The separated raw meal then passes through raw meal outlet pipes 55, 56, 57 and 58 via gate valves 59, 60, 61 and 62 into the shaft or conduit 29, from which the raw meal, suspended in heat exchange relationship with the smoke gases passes through the fourth stage riser pipes 27D and 28D for further heating by ever hotter gases and into the twin cyclones 25D and 26D of the fourth treating stage for separation. From the fourth stage cyclones separated raw meal passes through raw meal outlet pipes 63, 64, 65 and 66 which unite, in pairs, into intermediate outlet pipes 67 and 68 which, in turn, lead directly into shaft 29.

The inlet pipes 31, 32, 33, and 34 for introducing raw meal into the first stage riser pipes are provided with distributing devices (not shown) which serve to aid uniform mixing of the raw meal in the smoke gas flow.

With a pre-heater constructed according to this invention, the raw meal on its way through the individual cyclones and, more particularly, through their respective riser pipes, is brought successively into intimate contact with smoke gas of continually higher temperature and is thereby ultimately brought up to a high final temperature. The uniformly distributed pipe connections 55, 56, 57 and 58 to the shaft 29 ensure a favorable, uniform distribution of the pre-heated raw meal which is introduced into the fourth stage twin cyclones 25D and 26D. The intermediate outlet pipes 67 and 68 likewise open symmetrically into the shaft 29 within which they continue as channels serving to feed the raw meal into the rotary kiln 30.

Similarly to the smoke gases the raw meal flows along four identical paths, and, provided that the amount of raw meal fed to the rotary kiln 30 is distributed equally per unit of time between the four feed pipes 31, 32, 33 and 34, the quantity and temperature of the meal delivered to the kiln from each string will be the same.

I claim:

1. Apparatus for pre-heating pulverous raw material used for producing cement or the like in a rotary kiln having a gas outlet end comprising:

a. four strings of raw meal treating units, each including a heat exchange zone in which the pulverous material and kiln smoke gases are brought into heat exchange relationship, and a separation zone in which the pulverous material entrained in a smoke gas stream from the kiln is separated from the gas, each string separately communicating with a single through-going substantially vertical smoke gas conduit connected to the gas outlet end of the kiln such that they are disposed independently of the three other strings in a manner which permits independent operation of one or more strings when one or more strings is entirely inoperable from the out-

let of the kiln, each string including a plurality of said treating units arranged in series superimposed communicating relationship with respect to each other with said strings being interconnected at the lower portions by material outlet pipes to said single through-going conduit, said strings being arranged substantially vertically and symetrically with respect to a first plane extending vertically through the kiln axis and with respect to a second plane disposed in perpendicular relationship to said first plane adjacent the kiln outlet such that the gas flow and the raw material flow in each string is along independent and substantially similar paths;

b. supply means for delivering the pulverous material into each string via the treating unit thereof most remotely located relative to the kiln outlet; and

c. means for moving the hot kiln gases through the treating units of each string in a direction countercurrent to the direction of flow of pulverous material therethrough.

2. Apparatus according to claim 1 wherein each string includes four of said treating units.

3. Apparatus according to claim 1 wherein the treating units of each string located nearest the kiln are disposed in communicating relationship with respect to the single substantially vertical conduit which is disposed in direct communicating relationship to the kiln.

4. Apparatus according to claim 3 wherein the treating units of each string located nearest the kiln communicate in pairs with an intermediate conduit which is disposed in communicating relationship with respect to said common conduit.

5. Apparatus according to claim 4 wherein each string of treating units comprises four stages of left and right cyclones in staggered relationship to one another.

6. Apparatus according to claim 5 wherein the upper treating unit of each string includes a twin cyclone separator.

* * * * *