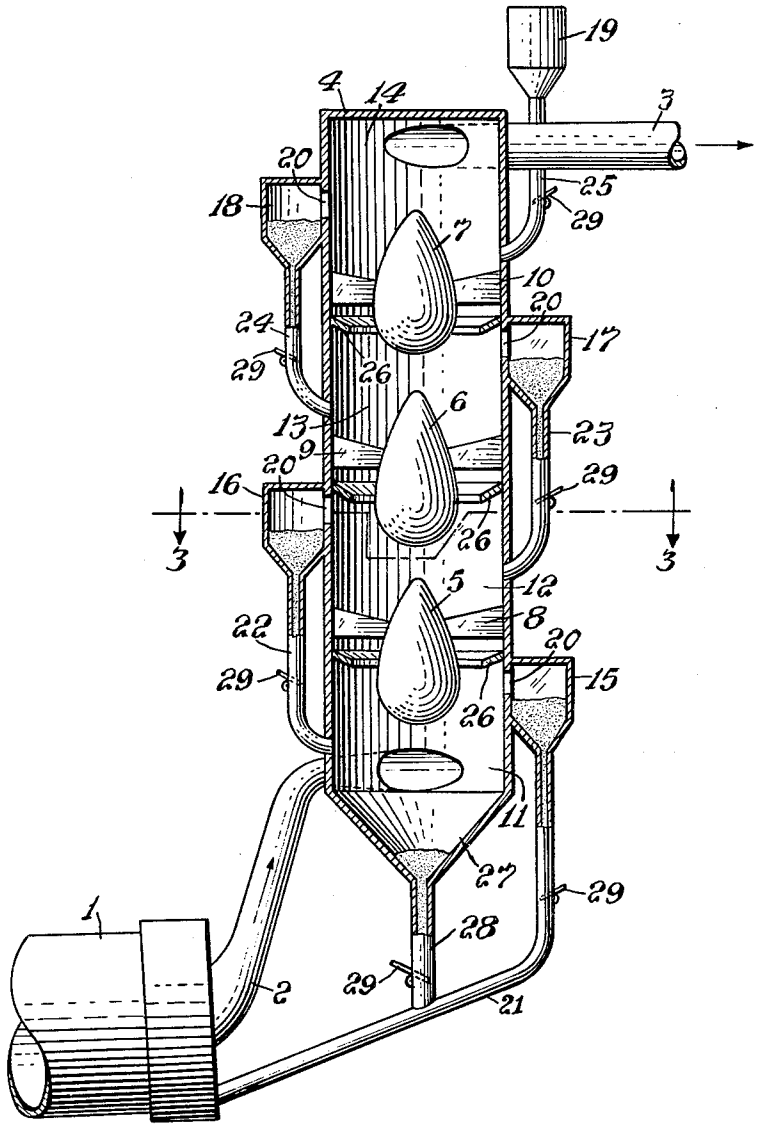
Dec. 11, 1962 Z. ZACPAL 3,067,990

APPARATUS FOR PREHEATING FINELY DIVIDED MATERIAL

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Fig. 1



INVENTOR.
Zdeněk Zacpal
BY
Richard Chmel
Agt

Dec. 11, 1962 Z. ZACPAL 3,067,990

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Fig. 3

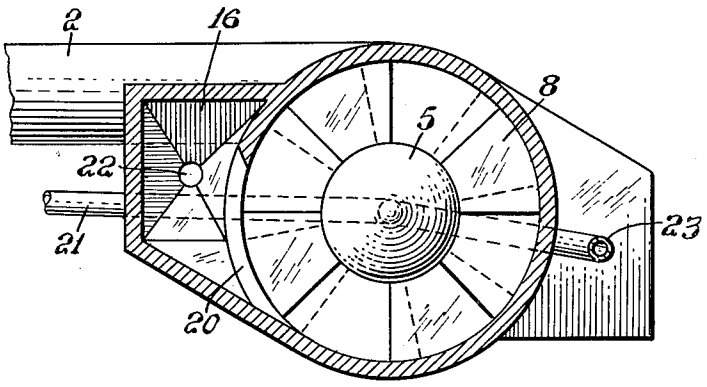
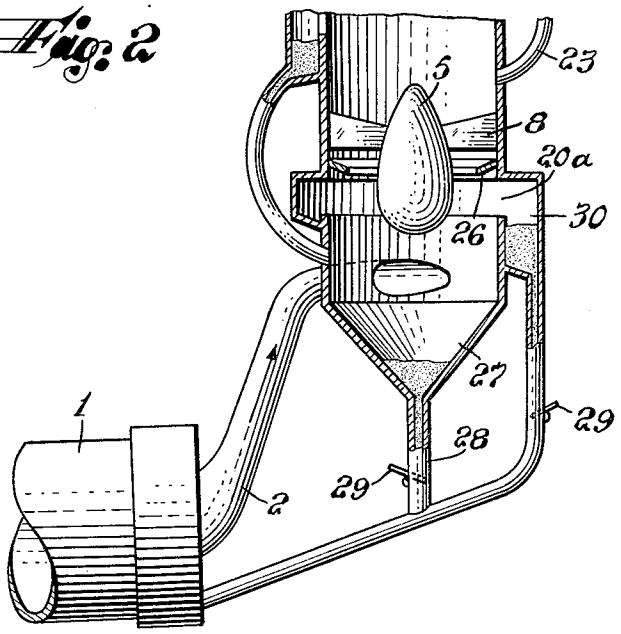


Fig. 2



INVENTOR.
Zdeněk Zacpal
BY
Richard Good
Agt

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APPARATUS FOR PREHEATING FINELY DIVIDED MATERIAL

Zdeněk Zacpal, Horni Mostenice, Czechoslovakia, assignor to Prerovske strojirny, Prerov, Czechoslovakia

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This invention relates to improvements in apparatus for heating finely divided material, and more particularly to an apparatus for preheating the dust-like material constituting the dry charge for cement rotary kilns.

The finely ground raw material is conventionally preheated either in the rotary kiln itself near the feed end thereof or in a separate heat exchanger unit installed in front of the kiln. The preheating equipment of the latter type usually consists of several interconnected cyclone heat exchangers arranged one above the other in which the raw material is heated in a counter current flow arrangement by a stream of hot waste gases discharged from the rotary cement kiln.

The known heat exchangers may also include electrically operated filters, blowers, control systems, and the like and contribute materially to the efficiency of the kiln.

An important disadvantage of the known heat exchangers is their great height of up to 40 meters. The erection of the apparatus is difficult and requires safety equipment, whereby the cost of the apparatus is increased.

The technical and economical disadvantages of the known heat exchangers are overcome by this invention which provides a structure extending transversely of the rotary kiln and comprising a vertical shaft which is divided into a series of sections arranged one above the other. On the outer surface of the vertical shaft, bins are arranged on alternating sides to separate the fine raw material from the heated gases discharged from the cement kiln. Each of the separating bins communicates with a respective shaft section through a tangential passage. Within the shaft vortex cores having the shape of an egg or of a drop are suitably arranged to vary the direction of gas flow and to divert the fine material particles into the individual separating bins. The finely divided cement raw material enters the preheating shaft at the top and most of it travels in succession through the several separating bins from the uppermost section of the shaft into the lowest one, being heated in suspension in the stream of hot gases passing the shaft in counterflow to the raw material, i.e. from the bottom to the top of the preheating shaft. The gas is discharged from the kiln into the lowest section of the shaft in a tangential direction so that the heated gas flows along the inner surface of the shaft generally in a helical line. The gas stream is divided by the curved surfaces of the vortex cores into a plurality of smaller streams spreading the cement material and carrying the fine particles into an adjacent separating bin. The bins are positioned on the periphery of each section and communicate with the next lower shaft section through suitably arranged tubes which lead the raw material from the higher to the lower section.

The preheating apparatus of the present invention includes other features which are described hereinafter in connection with the accompanying drawings showing two embodiments of the invention.

In the drawings:

FIG. 1 is an elevational sectional view of a preferred embodiment of the invention;

FIG. 2 illustrates the lower portion of a second embodiment of the invention in a view corresponding to that of FIG. 1; and

FIG. 3 is a plan view of the apparatus of FIG. 1, taken in section on the line 3—3 of FIG. 1.

In the apparatus of the invention shown in FIG. 1, the particles of finely divided raw material for making cement are preheated in suspension by direct heat transfer from the high temperature gases discharged from the rotary kiln 1 through the conduit 2, and introduced tangentially into the lower portion of a heat exchanger. This heat exchanger is installed in front of the feed end of the kiln and extends transversely of the kiln. The tangential connection of the conduit 2 with the heat exchanger causes the heated gases to rotate along the inner wall thereof in a generally helical path. The cavity of the heat exchanger is substantially cylindrical and constitutes a vertical shaft 4. The shaft 4 is divided vertically into four superimposed communicating sections 11, 12, 13, 14. The shaft 4 is provided with three vortex cores 5, 6, 7 mounted in axial alignment one above the other on respective radial supports 8, 9, 10. The cores 5, 6, 7 are egg or drop-shaped and are positioned to divide the rising gas stream and to divert the comminuted raw material so that fine material particles are driven into separating bins, described hereinafter. The generally upwardly flowing gas is exhausted from the shaft 4 through a gas duct 3, passed through dust collectors and the like, and is finally released through a stack. The gas duct 3 is connected to the top portion of the shaft 4 in a tangential direction.

The uppermost section 14 of the shaft 4 is connected with a raw material bin 19 by a feed duct 25. Each of the sections 11, 12, 13, 14 of the shaft 4 communicates with a respective separating bin 18, 17, 16, 15. These bins are arranged on alternating sides of the outer surface of the shaft 4. Each bin 18, 17, 16, 15 communicates with the adjacent section 14, 13, 12, 11 through a tangential passage 20 which has an orifice in the upper half of each section. The separating bins 18, 17, 16 are connected to the respective next lower sections 13, 12, 11 by ducts 24, 23, 22 while the lowest separating bin 15 is directly connected to the kiln 1 by a duct 21. The shaft 4 has a conical bottom 27 from the lowest point of which tube 28 leads into the duct 21. Each of the ducts and tubes 25, 24, 23, 22, 21, 28 is equipped with a rotary valve 29 for control of the delivery rate of the preheated material so as to keep each bin at least partly filled with solid material as shown in FIG. 1.

For a more complete separation of the solid raw material particles from the gas, an annular baffle plate 26 is secured to the inner surface of the shaft 4 closely above the orifice of each passage 20 of the separating bins 15, 16, 17, 18. The baffle plates 26 prevent the solid particles from being entrained by the rotating gases and carried back into a higher section.

The operation of the apparatus is as follows: The finely ground raw material is supplied from the bin 19 through the duct 25 to the uppermost section 14 and is heated by contact with the gases which flow in the opposite direction to that of the solid material. The material is divided by the heated gases into individual particles which travel through the shaft 4 in two different paths. The heaviest particles fall directly down from the uppermost section 14 through the shaft 4 into the conical bottom 27. They pass through the tube 28 into the duct 21 and into the kiln 1. Most of the material passes successively through the separating bins 18, 17, 16, 15 into which it is driven by the heated gases which rotate along the inner surface of the shaft 4. The vortex cores 5, 6, 7 are effective partly in breaking up the gas stream and causing rotary flow, and partly in diverting the fine raw material particles into the separating bins 15, 16, 17, 18. The raw material particles are thus repeatedly and

continuously subjected to heating by the gases discharged from the cement kiln 1. It will be appreciated that the lighter fine particles are separated from the heavier ones so that the latter particles remain in the shaft 4 and are subjected to more concentrated heating. All the material is preheated to a desired temperature, and is delivered from the lowest separating bin 15 and the conical bottom 27 into the kiln 1 through the duct 21.

It will be understood that many modifications of the arrangement illustrated are possible. Some of the modifications which are of industrial importance will now be described with reference to FIG. 2.

The separating bins 15, 16, 17, 18 may be replaced by annular overflow chambers 30 which are each connected to the next lower preheating section 11, 12, 13 through a respective duct 22, 23, 24. Each chamber 30 communiactes with the adjacent shaft section 11, 12, 13, 14 respectively through an opening 20*a* positioned in the upper half of each section.

The apparatus exemplified in the two embodiments described above provides a very effective heat exchange. The total radiation losses are smaller than in known heat exchangers employed for the same purpose. The heat content of the waste gases is therefore better utilized for preheating the cement raw material. Due to the better efficiency, the height of the preheating unit of the invention may be considerably smaller than that of conventional units so that the total cost of the apparatus according to the invention is lower than that of the known hea exchangers.

What I claim is:

1. In a heating apparatus for a comminuted solid material, in combination, a vertically extending continuous shaft; means for introducing the solid material to be heated to a top portion of said shaft; means for introducing a stream of hot gas to a bottom portion of said shaft, whereby said gas moves upward in said shaft substantially against the movement of the solid material; deflector means in said shaft for maintaining the upward movement of said gas in a substantially helical path over a portion of said shaft, said shaft portion being formed with a plurality of vertically spaced openings; a receptacle mounted on said shaft adjacent each of said openings and communicating with the corresponding opening; a plurality of conduits each connecting a respective one of said receptacles with a portion of said shaft lower than the opening in said shaft corresponding to the respective receptacle, each conduit having an effective cross section smaller than that of the respective receptacle.

2. In an apparatus as claimed in claim 1, said shaft being of circular cross section and having a conical bottom for discharge of the heated material.

3. In an apparatus as claimed in claim 1, said deflector means including a plurality of vortex cores arranged one above the other in said shaft, said vortex cores being each substantially drop-shaped and secured to said shaft in substantially vertical alignment.

4. In an apparatus as claimed in claim 1, said shaft being of arcuate cross section, and said stream of gas being introduced to the bottom portion of said shaft in a substantially tangential path.

5. In an apparatus as claimed in claim 1, said shaft being of arcuate cross section, and said openings extending substantially tangentially relative to said shaft.

6. In an apparatus as claimed in claim 1, annular baffle means in said shaft above each of said openings and adjacent thereto.

7. In an apparatus as claimed in claim 1, valve means in each of said conduits.

8. In an apparatus as claimed in claim 1, at least one of said receptacles being annular and extending about said shaft.

9. An arrangement for preheating the solid raw material being fed to a movable cement kiln, comprising a kiln; a vertically elongated continuous shaft; means for feeding said raw material in comminuted form to a top portion of said shaft; means for feeding a stream of hot gas from said kiln to a bottom portion of said shaft, whereby said raw material descends in said shaft and said gas ascends therein, and said material is heated by said gas; a plurality of deflector means vertically spaced in said shaft for inducing at least partially rotary flow of said ascending gas, each of said deflector means defining a vertical section in said shaft; a receptacle mounted on said shaft adjacent each of said sections and communicating therewith through an opening in said shaft section; a conduit connecting each of said receptacles with a section of said shaft lower than the section adjacent the respective receptacle; throttle means in said conduit for maintaining said receptacle at least partly filled with said material during operation of said arrangement; and means for feeding said material from said bottom portion to said kiln.

10. An arrangement as set forth in claim 9, wherein said shaft is of arcuate cross section, and said stream of hot gas is fed to said shaft in a substantially tangential path.

11. An arrangement as set forth in claim 9, wherein said receptacle is annular and extends substantially about the respective section of said shaft.

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