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3,279,775

COOLER FOR ROTARY KILN

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2 Sheets-Sheet 1

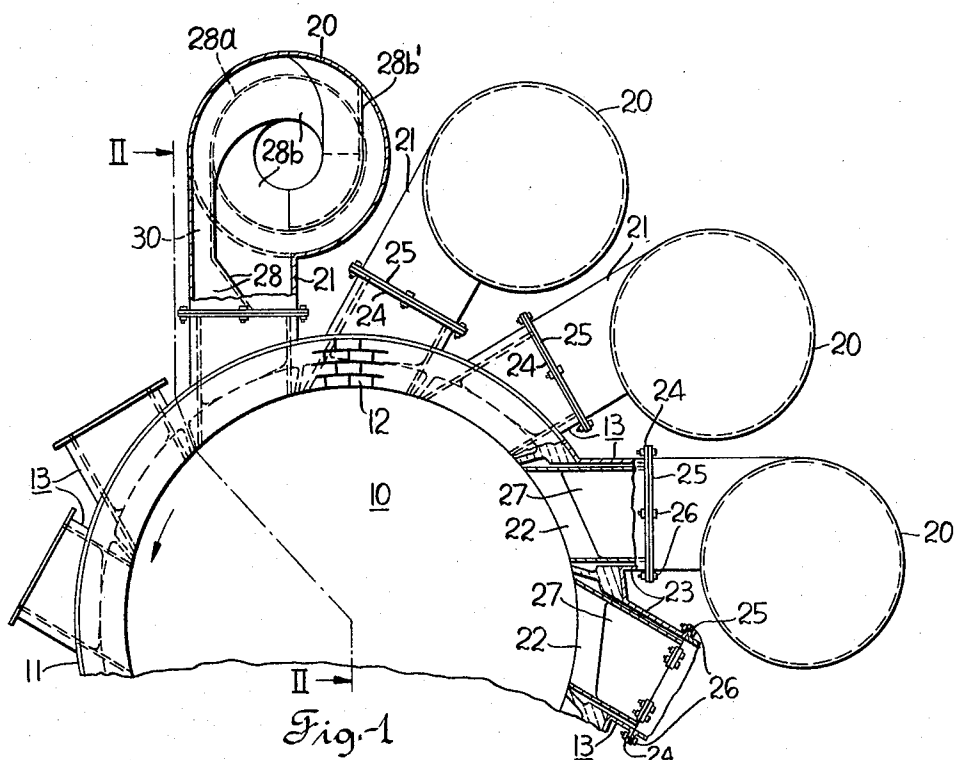


Fig. 1

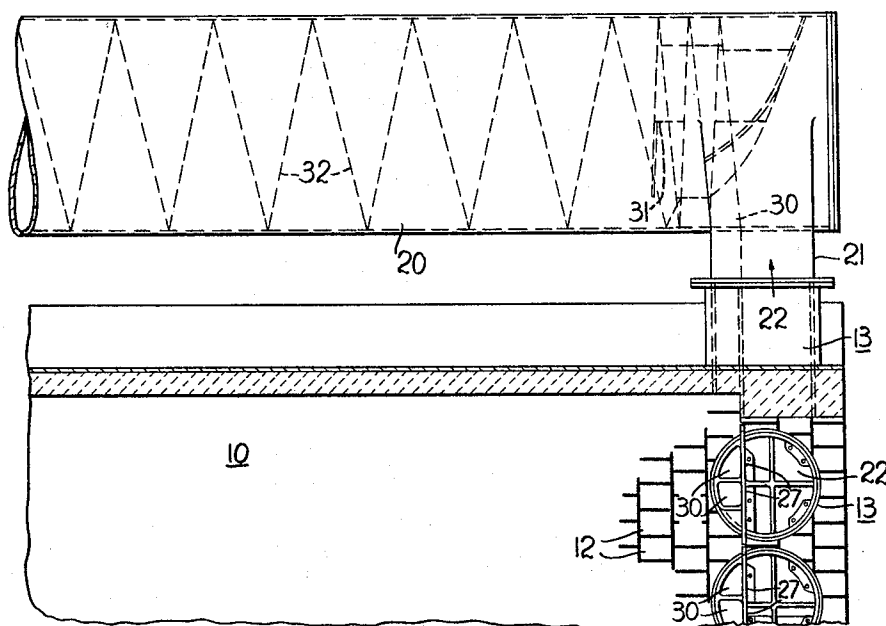


Fig. 2

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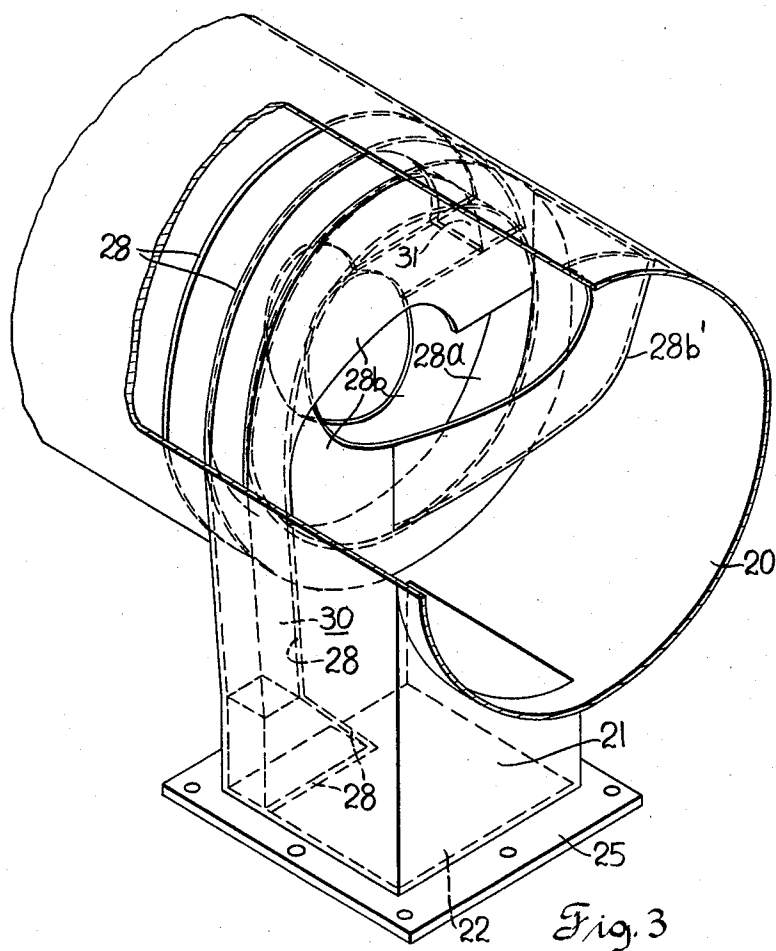


Fig. 3

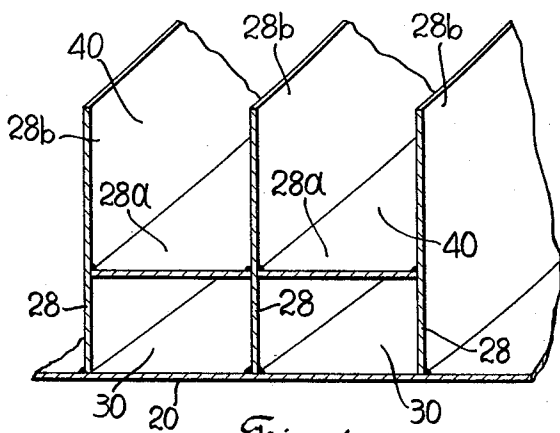


Fig. 4

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COOLER FOR ROTARY KILN

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This invention relates to rotary kilns and in particular coolers for generally horizontal or slightly inclined rotary kilns of the type disclosed in United States Patent 828,555 granted to Paul O. Krottnaurer on August 14, 1906.

In assemblies such as disclosed in the Krottnaurer patent hot material was discharged through radially extending peripheral openings in the kiln into cooling tubes mounted in axially parallel alignment around the circumference of the discharge end of the kiln. These tubes rotate with the kiln around the central axis of the kiln and as each tube is carried through the lowest segment of its circular path a portion of the hot material in the kiln is discharged into each tube. Each tube is provided with internal spiral flights projecting inwardly from inner surface of the tube and as the kiln and cooler assembly rotate the spiral flights move the material through the tubes in the opposite direction to movement of material in the kiln. When material reaches the opposite end of a tube, from the charge end, the material is discharged into collecting or transporting devices as desired. As material moves through the tubes it is exposed to cooling air that is passed through the tubes in the direction opposite to material flow through the tubes. The counterflow of the air through material in the tubes cools the material and heats the air. The heated air passes into the kiln and provides pre-heated secondary air which combines with fuel and primary air from a nozzle to provide rapid combustion of fuel in the kiln.

A problem associated with assembly disclosed in the Krottnaurer patent was that the capacity of the cooling tubes was reduced by the fact that some of the material discharged from the kiln into each tube, as each tube passed through the lowest segment of its path of travel, fell back into the kiln as the tubes approached and passed through the highest segment of its path around the central axis of the kiln. For relatively heavy, dustless or large particle material this problem was substantially overcome by providing an oblique passage from the kiln to cooler tubes rather than the radial path shown in the Krottnaurer patent. For light, dusty or fine particle material the oblique passage was not as effective. When processing a very fine material such as alumina a still serious problem remained because undesirably dusty conditions have prevailed in the kiln. It is with this problem that the present invention is concerned.

According to the present invention the material flowing out of the kiln into the cooling tubes and the preheated air flowing out of the cooling tubes into the kiln are kept out of contact with each other. It has been determined that most of the dust pickup by the preheated air occurs near the air discharge end of the cooling tubes and in the passages connecting the tubes with the kiln. The material is kept out of contact with the air in this portion of the system by providing an enclosed duct within each passage connecting a cooling tube to the kiln. The duct for the material is of smaller cross sectional area than the remaining portion of the passage devoted to air passage. The entry to the duct is located at the upstream edge of passage opening in the kiln so substantially all of the material drops into the duct and little or none of the material spills over into the air conveying portion of the passage where it can be picked up by the air and carried back into the kiln. Each enclosed duct extends from the port of the passage connecting the kiln to a tube, through the passage into the tube where the enclosed duct makes at

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least about $1\frac{1}{2}$ spiral turns around the inner surface of the tube before dumping material within the tube where the usual spiral flights will take over and move the material through the remaining length of the cooling tube.

It is an important feature of the present invention that the duct is enclosed for at least about $1\frac{1}{2}$ spiral turns within a tube. This is important because a portion of the material entering a duct will act as a plug to seal the duct against air passing through the duct and picking up dust, and about $1\frac{1}{2}$ spiral turns is enough to insure that a second plug of material will be sealing the duct before a preceding plug of the material passes out of the enclosed duct. Thus a seal of the material itself will be constantly maintained to prevent air flowing through the duct on its way to the kiln. All of the air will therefore be forced to flow through the air passage out of contact with the dusty material.

In a preferred embodiment of the present invention the enclosed duct is defined by a pair of parallel wall members projecting inwardly from the inner surface of the tube. The duct is enclosed by a capping member that extends between the pair of walls and is parallelly spaced inwardly of the inner surface of the tube. However, the pair of wall members project inwardly of the capping member to also define an open trough. This trough is provided because bricks that line the kiln sometimes fall out during operation and while it is not desired that the opening of the duct in the port opening in the kiln to be large enough to receive bricks, such bricks will pass over the opening to the duct and drop through the larger air conveying portion of the passage. The open spiral troughs that are defined inwardly of the enclosed spiral ducts will move the bricks through the charge end of the tubes and the usual spiral flights can then take over and move the bricks out of the tubes along with the material being cooled.

The invention will now be described in greater detail with reference to the drawings in which:

FIG. 1 is a partial end view of a kiln assembly according to the present invention, with various portions broken away to show other portions partly in section;

FIG. 2 is a view taken along line II—II of FIG. 1 taken in the direction indicated by the arrows;

FIG. 3 is an enlarged view of the material inlet end of one of the tubular coolers shown in FIGS. 1 and 2;

FIG. 4 is a fragmentary cross sectional view of an enclosed material conveying duct and open trough for conveying material through a portion of the material inlet end of a tubular cooler.

Referring to FIG. 1 and FIG. 2, a rotary kiln assembly comprises a cylindrical shell 11 lined with refractory brick 12. The kiln assembly 10 is supported and driven by means (not shown) to turn as indicated by the arrow in FIG. 1. A plurality of port castings 13 project obliquely through shell 11 and lining 12 and open to the interior of the kiln 10. A plurality of material cooling and air preheating tubes 20 are arranged around the discharge end of the kiln 10 with a central axis through each of the tubes 20 being parallel with a central axis through kiln 10. Referring now to FIG. 3 as well as FIGS. 1 and 2, each of the tubes 20 has a tangential neck 21 connected to one of the port castings 13. Each of the connected port castings 13 and necks 21 provides a passage 22 from the interior of kiln 10 to the interior of one of the tubes 20. The port casting 13 (see FIG. 2) has a circular cross section while neck 21 is rectangular (see FIG. 3). In order to provide for the assembly of these parts a cylindrical collar 23 having rectangular flange 24, is secured (as by welding) around the portion of the cylindrical casting 13 projecting outwardly of shell 11.

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The flange 24 may be connected to a similar flange 25 on neck 21 by such as bolts 26.

Each of the passages 22 extending between the interior of kiln 10 and one of the tubes 20 is internally divided by wall structure 27 in casting 13 (see FIG. 2) and wall structure 28 in neck 21 and tube 20 (see FIG. 3) to define within passage 22 an enclosed duct 30. As shown in FIG. 2, the opening to duct 30 is located at the upstream edge of port casting 13 so that as material advances through kiln 10 toward port castings 13 substantially all of the material drops from kiln 10 into ducts 30 with little or none of the material spilling over the wall structure 27 into the remainder portion of passage 22. The enclosed duct 30 defined by the wall structure 27 (in casting 13) and wall structure 28 (in neck 21 and tube 20) opens within kiln 10 and extends through port casting 13 neck 21 and into the tube 20 where duct 30 preferably makes at least about 1½ turns around the internal surface of tube 20 and then opens at 31 (see FIG. 2) to dump material out of duct 30. The usual flights of lifters (indicated by the broken lines 32) are provided throughout the remaining length of each tube 20.

With reference to FIG. 4, the duct 30 is shown as being defined by the inner surface of tube 20 and the wall structures 28 which project radially inward from the inner surface of tube 20. Capping wall structure 28a parallel to the inner surface of tube 20 covers a space to complete the definition of an enclosed duct 30. A portion 28b of the walls 28 project radially inward beyond the capping wall structure 28a to additionally define a spiral open trough 40 radially inward of the spiral enclosed duct 30. The purpose and function of both the ducts 30 and troughs 40 will be described with reference to the operation of the entire assembly.

In the operation of the described assembly hot material will advance through kiln 10 toward the discharge end of the kiln and the port castings 13 as the kiln is rotated about its central axis in the direction indicated by an arrow in FIG. 1. As can be seen from FIG. 2, the hot material will spill over the upstream edge of castings 13 and drop into duct 30. Refractory bricks 12 that become dislodged from shell 11 will be too large to drop into the opening for duct 30 and will be tumbled over the edge of wall structure 27 shown in FIG. 2 and such bricks will tumble until they drop into passage 22. Material entering duct 30 will pass through the portion of duct 30 in casting 13, then through the portion of duct 30 in neck 21 and then through the spiral portion of duct 30 in tube 20. The rotational motion of the entire assembly will move material in the spiral portion of duct 30 in tube 20 and out the terminal opening 31. Thereafter material will be moved through tubes 20 by the flights 32 to the discharge ends of tubes 20 (not shown). Cooling air may be admitted into tubes 20 through the material discharge ends of the tubes by any conventional arrangement (not shown) which may be such as disclosed in the earlier mentioned Krottnaurer patent. The plug of material moving in duct 30 counter to air flow in tube 20 prevents air flowing through duct 30. As previously explained, the number of turns of the enclosed spiral duct 30 is sufficient to insure that there will always be at least one plug of material blocking air flow through the ducts 30 and air will therefore be forced to pass through the central opening in tubes 20 defined by the inner edges of walls 28b and then through the relatively dust free passage 22 to kiln 10. Refractory bricks 12 falling through passage 22, counter to air flow, will be picked up by the leading edge 28b' of the wall 28b (see FIGS. 2 and 3) and the rotation of the entire assembly will cause the bricks to move in the spiral trough 40 (see FIG. 4) in the same manner material moves through the totally enclosed ducts 30. Since an open passage is provided for bricks that is separate of the enclosed passage for fine material, bricks can be moved out of the assembly without interfering with or

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possibly jamming the ducts 30. Making ducts 30 too small to accept bricks also insures that a plug or material will fill a sufficient length of duct 30 to insure a good air seal. The enclosed duct 30 advances spirally toward the material discharge end of each tube a distance that spaces opening 31 at least the width of duct 30 away from neck 21. This locates opening 31 less than one-half of the distance from neck 21 toward the discharge end of tube 20 but this locates the point at which material is directly exposed to cooling air far enough down stream in the path of material flow to substantially reduce dust pickup by the air that flows into the kiln through passage 22.

From the foregoing it will be understood that the present invention is possessed of unique advantages. However, such modifications and equivalents of the disclosed concepts such as readily occur to those skilled in the art are intended to be included within the scope of this invention and thus the scope of this invention is intended to be limited only by the scope of the claims such as are, or may hereafter be, appended hereto.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a rotary kiln assembly having a plurality of cooling tubes attached in parallel alignment around the periphery of the material discharge end of the kiln and having oblique means defining a passage between each tube and the interior of the kiln for conducting hot material from the kiln to the tube and air from the tube to the kiln, wall structure within said passage defining an enclosed duct that opens on one end to the interior of said kiln and with the enclosed duct extending through said oblique means into said tube and more than one complete spiral turn around the internal surface of said tube where said duct defines a second opening within said tube, said wall structure defining said duct including a pair of wall members projecting radially inward of said enclosed duct to define an open spiral trough to receive objects that have passed through the oblique passage around said duct and transport such objects through the tube and away from the oblique passage.

2. In a rotary kiln assembly having a plurality of cooling tubes attached in parallel alignment around the periphery of the material discharge end of the kiln and having oblique means defining a passage between each tube and the interior of the kiln for conducting hot material from the kiln to the tube and air from the tube to the kiln, wall structure within said passage defining an enclosed duct that opens on one end to the interior of said kiln and with the enclosed duct extending through said oblique means into said tube and at least one and one-half spiral turns around the internal surface of said tube where said duct defines a second opening within said tube, said wall structure defining said duct including a pair of wall members projecting radially inward of said enclosed duct to define an open spiral trough to receive objects that have passed through the oblique passage around said duct and transport such objects through the tube and away from the oblique passage.

3. In a rotary kiln assembly having a plurality of cooling tubes attached in parallel alignment around the periphery of the material discharge end of the kiln and having means defining an oblique passage between each tube and the interior of the kiln for conducting hot material from the kiln to the tube and air from the tube to the kiln, wall structure within said passage defining an enclosed duct that opens on one end to the interior of said kiln and with the enclosed duct extending through said oblique means into said tube and more than one complete spiral turn around the internal surface of said tube where said duct defines a second opening within said tube, said wall structure defining said duct including a pair of wall members projecting radially inward of said enclosed duct to define an open trough, and the wall member of said

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pair nearest to the material inlet end of said tube having a portion open to receive objects into said open trough that have passed through the oblique passage around said duct.

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