May 19, 1970 F. E. JENSEN 3,512,764

ROTARY KILN HAVING PLANETARY COOLING TUBES

Filed June 6, 1968 2 Sheets-Sheet 1

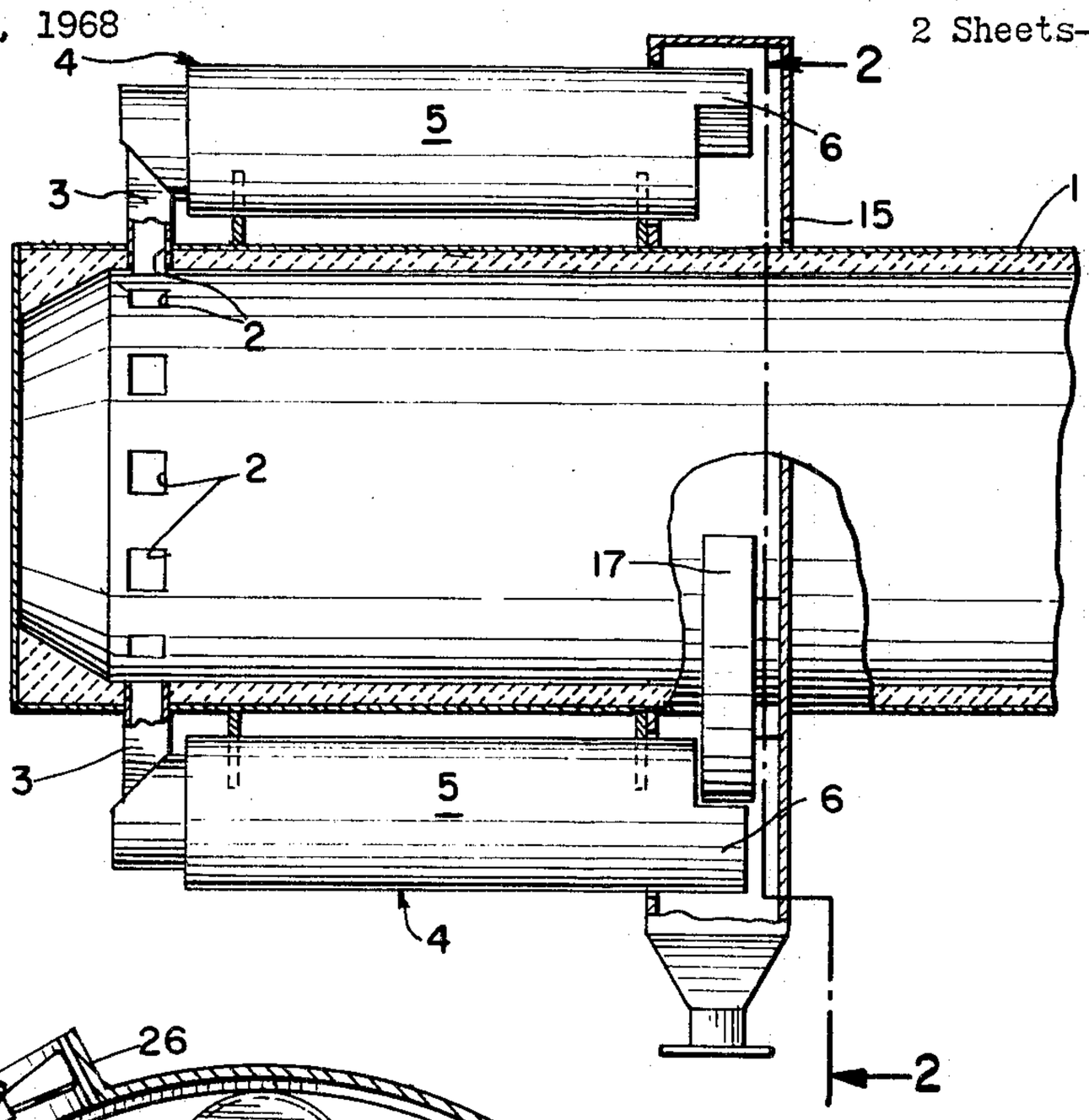

FIG. 1

FIG. 2

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FIG. 3

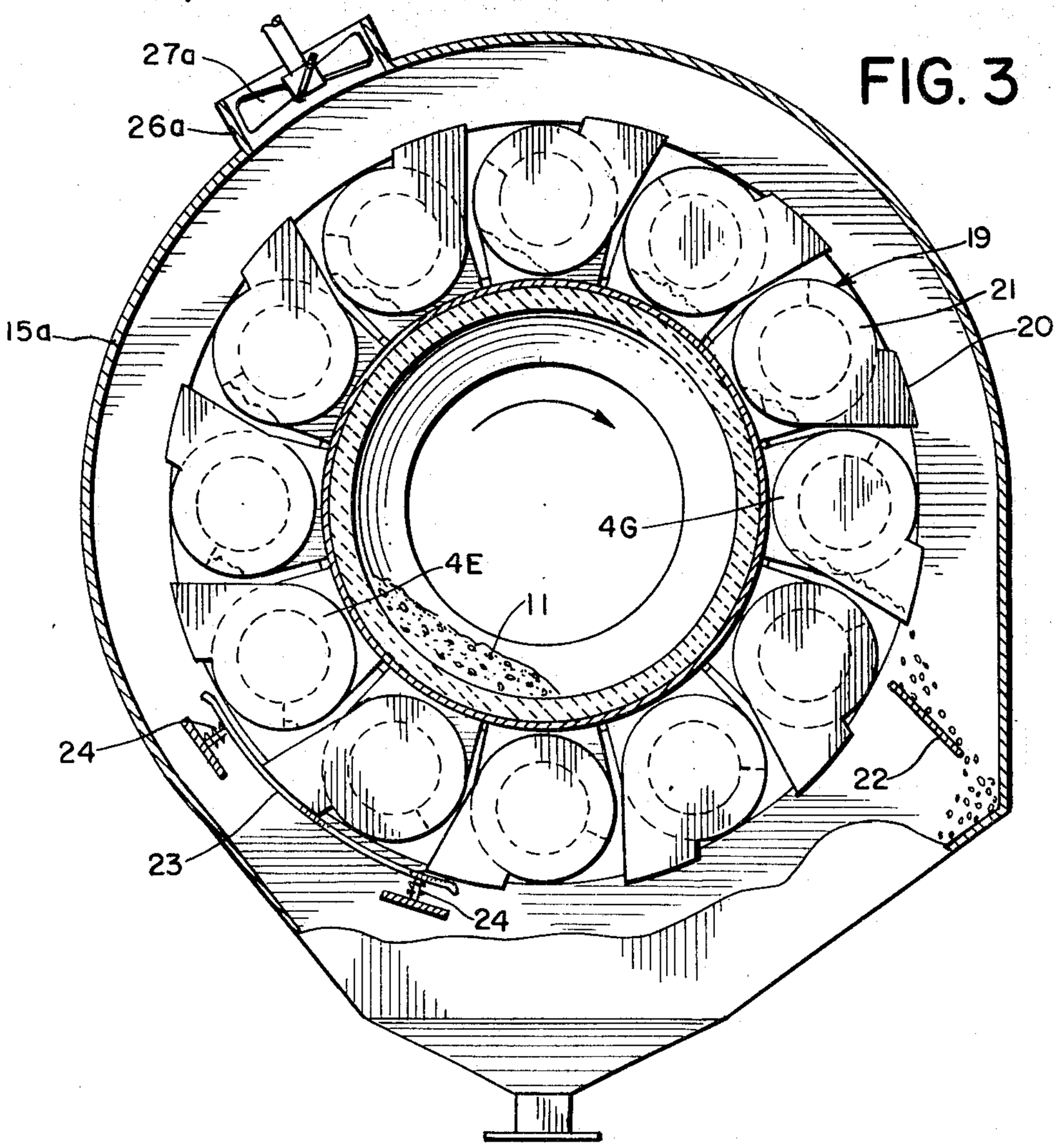
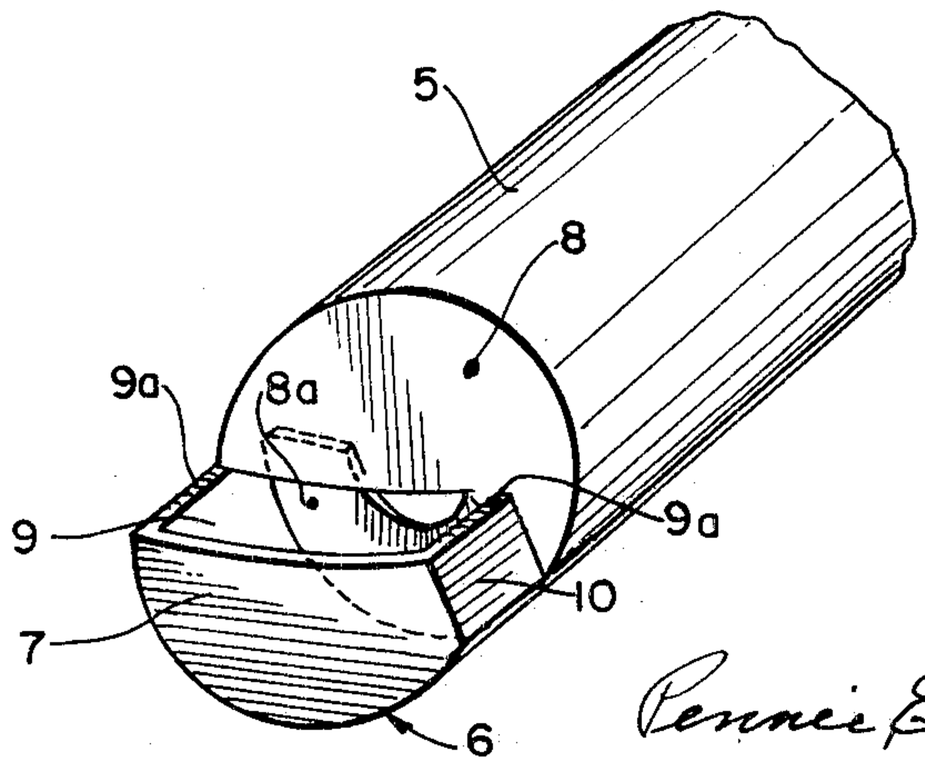


FIG. 4



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ROTARY KILN HAVING PLANETARY COOLING TUBES

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Int. Cl. F22b 7/20
U.S. Cl. 263—32 3 Claims

ABSTRACT OF THE DISCLOSURE

Rotary kiln has a plurality of cooler tubes mounted at the discharge end. One end of each tube connects with the interior of the kiln shell and the opposite end of each cooler tube is provided with an extension having an opening with an arcuate discharge face through which particulate solid material is discharged after leaving the end of the kiln and passing through the cooler tube. Means is provided for either drawing or blowing air through the cooler tubes, the air entering through the discharge openings for the solid material and leaving the cooler tubes at their opposite ends to enter the kiln as secondary air of combustion. A semi-cylindrical or arcuate plate is arranged in stationary position so that the arcuate discharge faces of the cooler tubes successively come into register with this plate to reduce the entrance of air to the tubes during that portion of the rotation of the kiln during which the hot particulate solid material enters the opposite end of a particular cooler tube.

BACKGROUND OF THE INVENTION

In the production of cement clinker and other materials in a rotary kiln it is well known to cool the hot particulate solid material in cooler tubes mounted in planetary fashion around the outlet end of the kiln. Each of these cooler tubes has at one end an opening that forms an inlet for cooling air and an outlet for the cooled solid material, and at the other end an opening that communicates with the interior of the kiln through a chute and forms an outlet for the hot material leaving the kiln and an inlet for the cooling air entering the kiln. This cooling air flows through the chute into the kiln to act as secondary air of combustion. The cooling air may be either drawn or blown through the cooler tubes.

As the kiln rotates, the mouth of each chute in turn comes into register with the particulate material lying along the bottom of the kiln and thus the passage of material down each chute is intermittent, occurring only during a comparatively small angle of rotation of the kiln. Material burnt or otherwise treated in a rotary kiln is usually granular and contains a proportion of dust or fines which may be picked up by the cooling air as it passes through the chute while the material is also passing from the kiln through the same chute into the cooler tube.

Now it sometimes happens that so much dust is carried back into the kiln by the cooling air as to create undesirable operating conditions and various proposals have been made to overcome this difficulty. None is wholly satifactory. One method has involved controlling the discharge opening of the cooler tubes by means of sector-shaped plates mounted to rotate with the kiln and cam-operated to close the outlet opening of each cooler tube while the solid material is entering the opposite end of the tube from the kiln. However, in this construction there are parts which must be moved during the rotation of the kiln and these are found to become warped very

rapidly and need extensive maintenance. Moreover there is a risk that they will not act properly, since the material discharged from the cooler tube may accumulate on them and interfere with the whole operation.

SUMMARY OF THE INVENTION

In the present invention the object is again to prevent air entering each cooler tube while hot particulate material is entering the tube from the kiln. According to the invention the outlet openings for solid material in the cooler tubes (which are inlet openings for air) lie in the surface of an imaginary cylinder concentric with the kiln shell, and throughout that part of the rotation of the kiln during which hot material may enter the cooler tube through the inlet at the other end these outlet openings successively come into register with a semi-cylindrical plate by which the passage of air through them is stopped or reduced.

It is not essential that the plate should completely prevent the passage of cooling air through each cooler tube in turn, as a reduction of the air stream through the cooler tube during the periods in which material slides into the tube is normally sufficient to minimize the dust nuisance. Accordingly the plate may be adjusted in position to allow a small amount of air to flow through the tube.

The plate is external to the cooler tubes and thus easy to adjust or replace, and as it is not a moving part it has no operation which can be interfered with by the material. Preferably, however, the plate is resiliently mounted to move radially to yield if any lumps of material become trapped between it and the cooler tubes so that neither the plate nor the cooler tubes will then be damaged. Moreover, as a result of thermal expansion the outlet openings of the cooler tubes may depart slightly from the imaginary cylinder, and the resilient mounting of the plate allows any such departure to occur without harm.

Two constructions according to the invention will now be described by way of example with reference to the accompanying diagrammatic drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical central section of the lower end of a rotary kiln having planetary cooler tubes, only two of which are shown;

FIG. 2 is a view in vertical section in the planes indicated by broken line **2—2** in FIG. 1;

FIG. 3 is a view similar to FIG. 2 showing a modification; and

FIG. 4 is a perspective view of the outlet end of one of the cooler tubes of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows the lower or discharge end of a rotary kiln **1** of conventional construction with openings **2** in its wall, each opening **2** forming the mouth of a discharge chute **3** for the solid particulate material which is joined to a planetary cooler tube **4**. Discharge chute **3** also serves to deliver cooling and combustion air through opening **2** into the kiln **1**. Cooler tube **4** consists essentially of a cylinder **5** through which the particulate material to be cooled moves from left to right as seen in FIG. **1**, and an outlet section **6** from which it is discharged.

As shown in FIG. 4 each outlet section **6** comprises a semi-cylindrical extension of the cylinder **5** and is closed at the end by a plate **7**. That part of the end of cylinder **5** which is not in register with the section **6** is closed by a plate **8** (FIG. 4), which has a tongue **8***a* forming a half turn of a screw inside the cylinder **5** so as to bar the direct passage of solid material into the outlet section **6**.

The outlet section **6** has a transverse opening **9** forming the outlet for cooled solid material, the edges **9***a* of the walls that bound this outlet lying in an imaginary cylinder concentric with the kiln shell. One of these walls is formed by a plate **10** which is flat instead of being semi-cylindrical and is inclined inwardly towards the axis of the cooler tube so as to serve as a guide for the material to be discharged as will appear later on.

As the kiln rotates a layer of solid material **11** moves down the kiln from right to left in FIG. 1 and when any of this material comes into register with an opening **2** it falls through the opening and down the corresponding chute **3** and into one of the cooler tubes **4**. It will be seen from FIG. 2 that the cooler tubes may receive hot particulate material in this way when they are about in the positions of those marked **4**A and **4**B, and at any given angle of rotation there may be two cooler tubes receiving hot material at once. This hot material passes along the tube as described above while it is being cooled by the air flowing in the opposite direction through the tube, and the layers of solid material in the tubes are shown at **12**.

During each rotation some of the material that has reached the end of the tube is moved by the screw tongue **8***a* of plate **8** into the outlet section **6** of the tube. Once it is in this section it will fall out through the opening **9** under gravity when the cooler tube is about in the position of that marked **4**D. The angular position of the guide plate **10** to some extent determines the angle at which the solid material should be discharged from the outlet section on its route.

The material falls onto a chute **14** not on drawings. All the outlet sections **6** and the chute **14** are enclosed in a housing **15** shaped at the bottom as a hopper **16** from which the cooled material is continuously carried away. The cooling air is either drawn or blown into housing **15**. It may enter through the opening at the bottom of hopper **16** where the solid material is discharged. It may also be supplied through an entrance collar **26** at one side of the housing **15**. Any desired source of air may be used such as for example a motor driven fan **27** mounted within this housing.

From within the housing the air enters the cooling tubes **4** through the solid material discharge sections **6** of each tube. The plate provided according to the invention to close the openings **9** is arcuate in form and shown at **17** and is mounted on springs **18**. The plate lies within the ring of outlet sections **6** and is urged radially outwards by the springs **18**. It will be clear from FIG. 2 that each opening **9** in turn comes into register with the plate **17** when the cooler tube in question is in a position, as indicated at **4**B, to receive material from the kiln.

In the modification shown in FIG. 3 outlet sections **19** are essentially cylindrical extensions of the cylinders **5** with spout-like parts, the mouths **20** of which form the outlet openings for the solid material. Each section **19** is separated from the interior of the cylinder **5** by a partition **21** corresponding to tongue **8***a* and formed as at least one full turn of a screw thread.

Material will thus start to pass into the section **19** of the cooler tube in a position of the tube as shown by the tube **4**E, and is discharged onto a chute **22** at the position in the rotation of the kiln shown by the tube **4**G. In this case an arcuate plate **23** provided according to the invention to close the mouths **20** lies outside the ring of the outlet sections **19** and is urged radially inwards by springs **24**. The shape of the housing **15***a* is changed somewhat in order to accommodate the chute **22**. The cooling air may enter through collar **26***a* and fan **27***a*.

I claim:

1. The combination of a rotary kiln and a plurality of cooler tubes mounted in planetary fashion around the outlet end of the kiln, each cooler tube having at one end an opening that forms an inlet for cooling air and an outlet for cooled particulate solid material, and at the opposite end an opening that communicates with the interior of the kiln through a chute and forms an inlet for hot particulate material for the kiln and an outlet for the cooling air, so that this air flows through the chute to act as secondary air of combustion in the kiln, in which the outlet openings for said material in the cooler tubes lie in the surface of an imaginary cylinder concentric with the kiln shell and, throughout that part of the rotation of the kiln during which hot material may enter the cooler tube through the inlet at the other end, successively come into register with a semi-cylindrical plate and sufficiently close thereto so that the passage of air through said openings is substantially prevented.

2. The combination according to claim **1** in which the said plate is resiliently mounted to move radially.

3. The combination according to claim **1** in which each cooler tube comprises a cylinder formed with an extension having a spout-like portion the mouth of which forms the outlet opening for the solid material, and which is separated from the interior of the cylinder by a partition formed as at least one full turn of a screw thread.

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JOHN J. CAMBY, Primary Examiner

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3512764 Dated May 19, 1970

Inventor(s) Flemming E. Jensen

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column	Line	Reads	Should Read
1. 1	64	satifactory	satisfactory
2. 4	26	(clm. 1) for	from
3. 3	32	The material falls onto a chute 14 not on drawings.	The material falls onto a chute 14.

SIGNED AND
SEALED
SEP 15 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents