May 15, 1951 J. H. McNEILL 2,553,464

HEAT RECOVERY DEVICE

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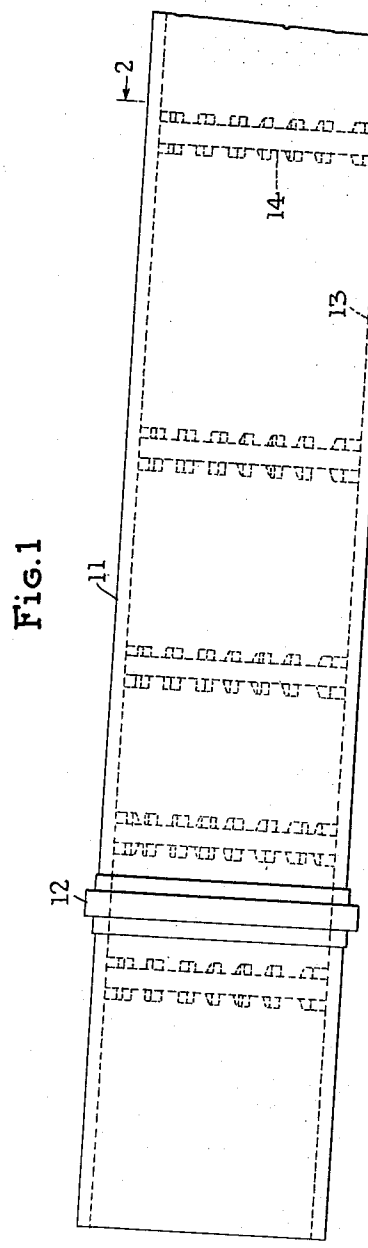


Fig.1

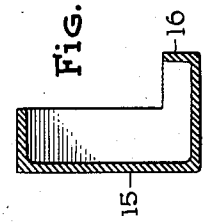


Fig.5

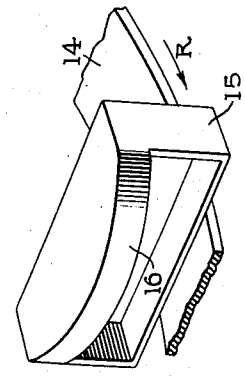


Fig.4

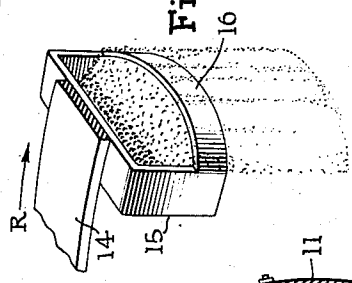


Fig.3

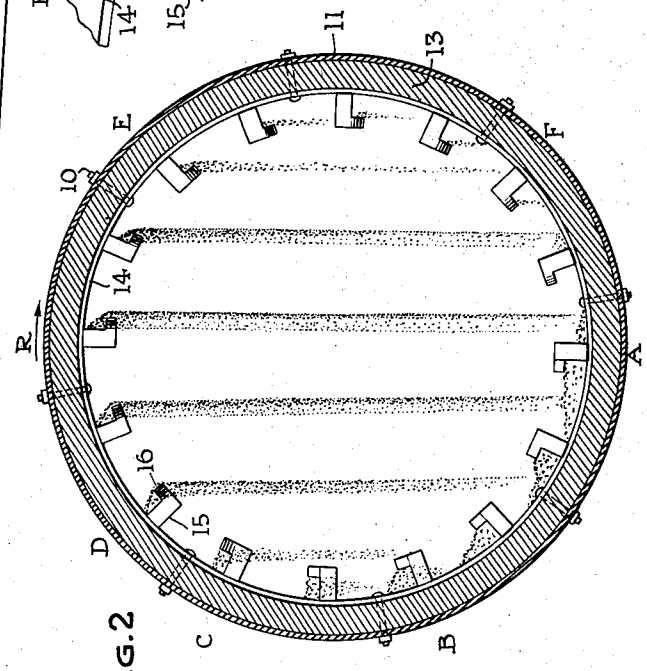


Fig.2

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HEAT RECOVERY DEVICE

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3 Claims. (Cl. 259—89)

1

This invention relates to heat recovery devices for inclusion in tube kilns and the like.

In the manufacture of cements, metallurgical fluxes and other products extensive use is made of long inclined tubular kilns.

In one type of kiln crushed rock is fed to the upper end of the inclined rotating tube and moves slowly in a rather shallow stream to the lower end of the kiln into which flames from burners are projected. The hot products of combustion discharge from the upper or feed end of the kiln, and for economy of operation it is desirable to transfer their heat as completely as possible to the feed.

In another type of operation it is desired to cool clinkers as they move through an inclined rotary tube.

The invention is applicable for these and similar purposes, one of which involves a heat exchange between gases and solids at the entrance end of the inclined tube, and the other involves a similar exchange at the exit end. So far as the inventive idea is concerned it can be applied at any point in the length of a tubular device such as a kiln.

Attempts have been made to use pockets or lifters attached to the interior of the kiln tube at the appropriate point. These lift the granular material flowing through the kiln as they rotate with the kiln and cause it to shower through the gas stream flowing longitudinally through the tube. In the forms heretofore used these pockets completely discharge themselves in the first 100° to 160° of rotation after they become loaded, so that the falling material does not cover the entire transverse area of the tube. As a consequence only a third to a half of the gases flow in contact with showered material and the heat transfer is inefficient.

The present invention provides a novel type of lifter which does not completely discharge until rotated approximately 270° after they have become filled, with the result that material is showered across the entire cross-section of the tube. The distribution is remarkably even and a greatly enhanced heat exchange is afforded.

The pockets can be constructed as simple castings of heat-resisting-iron alloy, or steel, and have no moving parts. Thus they are inexpensive to install and are characterized by long life.

A preferred embodiment of the invention which has already demonstrated utility in full scale test operations will now be described by reference to the accompanying drawings, in which:

2

Fig. 1 is a side elevation of the feed end of a cement kiln, showing in dotted line possible location of rings of lifters.

Fig. 2, drawn on a larger scale than Fig. 1, is a cross-section through the kiln of Fig. 1 on the line 2—2. In this view only the ring of lifters adjacent the plane of section is shown, the purpose being to show how the lifters discharge through about 270° of kiln rotation.

Fig. 3 is a perspective view of a lifter discharging at the top of its path.

Fig. 4 is a similar view of a lifter at the lowest point in its path.

Fig. 5 is a section through a lifter on the median plane.

In Fig. 1 the tube of the kiln appears at 11 and the track on which the kiln turns at 12. The rollers which support track 12 are conventional and are not illustrated. As better shown in Fig. 2, the kiln has a refractory lining 13 of ordinary form.

According to the invention the kiln may have one or more circular rows of lifters, and for each such row there is an internal band or ring 14 attached to the tube 11 by bolts 10 which pass through the lining 13.

Attached to each ring 14 by any suitable means is a circular series of similarly mounted lifter pockets. Each lifter comprises a box-like rear portion 15, which geometrically defined is a rectangular parallelopiped, open at its front or leading face and closed on all other faces. The front face and rear face are very nearly radial. They lie in parallel planes between which the axis of the kiln lies and with which this axis is parallel. The front face is not entirely open for that side of the parallelopiped which is toward the axis of the kiln has an arcuate extension with a curved marginal flange 16 of a width less than the radial depth of the lifter so that it overhangs a minor portion of the open front face.

Fig. 2 shows a typical spacing of one circular series but the spacing could be closer or wider depending on the designer's preference and on flow characteristics of the material being handled.

In all figures the arrows R indicate the direction of motion. In Fig. 2 different ranges of travel are designated by letters.

The feed reaches the pockets near the lowest point in the rotary path, say at A and is caught ahead of the pockets and carried up. Between B and C a small amount of the material showers over the ends of the box-like portion. From D to E it showers over the curved lip afforded by

the flange 16. Somewhere in the neighborhood of E the curvature of flange 16 causes the remaining charge to crowd toward the middle and slows up discharge so that it continues to about F. The curved flange 16 causes the veil of showered material to assume the curved characteristic of this flange thus causing a more complete coverage of the cross-sectional area of the kiln. This curvature of the veil of material is at a maximum when the lifter is at its uppermost position. Thus the point where the material falls the greatest distance is also the point where the falling material is dispersed over the greatest latitudinal expanse of the area. This increased dispersion results in improved heat transfer, as it reduces the horizontal spacing between veils at the very point where it tends to become greatest.

The above description perhaps over-simplifies what takes place, but in any event a substantial amount of material is showered from the lifter throughout its travel in an arc longer than the top 180° of the lifter path. As a consequence, gases flowing longitudinally through the kiln tube do not escape contact with showered granular material. Several rings of lifters may be used as suggested in Fig. 1 to intensify the heat exchange to any practicable extent. In some cases it is preferred to stagger the lifters in adjacent rings as shown for the first and second rings in Fig. 1.

The form of lifter illustrated in the drawings was evolved by a series of tests in which form and proportions were closely studied. A lifter similar to the illustrated embodiment without the rearward box-like portion was tested, but it was found that too much material was discharged over the ends and that not enough was carried to the region E to F of the kiln. The addition of the box-like portion enabled the lifter to carry a greater load and resulted in less material being discharged over the ends from B to C.

The proportions illustrated in the drawing are those which have given good results with kilns of usual diameter (say 8') and crushed material of usual sizes. They can be modified to suit particular cases without departing from the general

principles of the invention. The number of rows of lifters to be used, the spacing of the lifters in the various rows and like details are also subject to considerable variation.

I claim:

1. Lifting and showering means for granular materials treated in rotary tube kilns, comprising in combination with the kiln tube, a plurality of box-like lifters arranged in series around the internal surface of the kiln tube, each lifter projecting radially inward from said surface of the kiln tube and being spaced from all adjacent lifters, the leading face of each lifter being open except for a minor portion thereof at the end toward the kiln axis, the end wall of the lifter toward the kiln axis having an extension which projects beyond the side walls in the direction of motion of the lifter and is bounded by a flange which overhangs said minor portion and is connected at its ends with said side walls.

2. The combination defined in claim 1 in which the margin of the end wall extension on the lifter is curved and the related flange arches over the minor portion of the filter from side wall to side wall.

3. The combination defined in claim 1 in which the margin of the end wall extension on the lifter is curved, the end wall at the crest of the curved margin has a height approximately double that of the side walls of the lifter, and the related flange arches over the minor portion of the lifter from side wall to side wall.

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