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ROTARY COOLER

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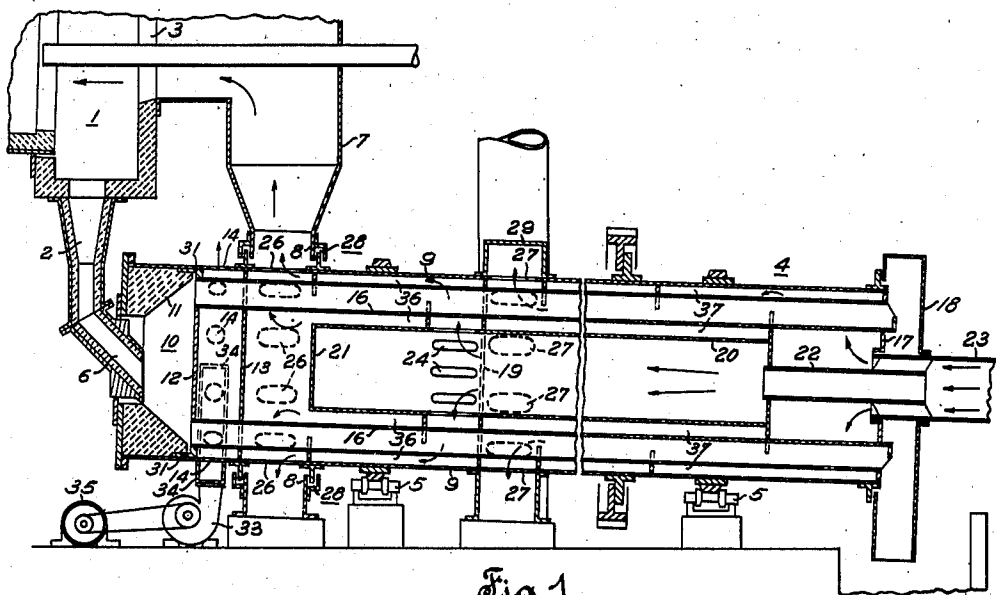


Fig. 1

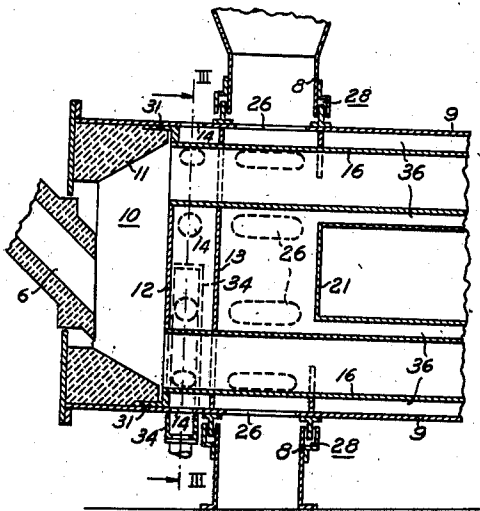


Fig. 2

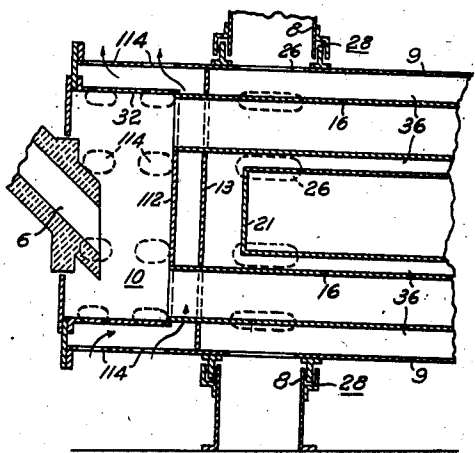


Fig. 4

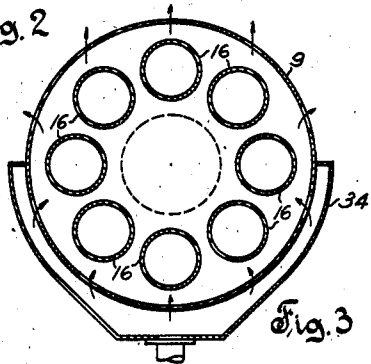


Fig. 3

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ROTARY COOLER

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12 Claims. (Cl. 263—44)

This invention relates to conveyors and indirect coolers for hot materials and their combination with furnaces discharging hot materials.

It is well known in the art to indirectly cool hot materials issuing from a furnace by feeding them into a header from which they are conveyed through material cooling tubes passing through a cooling space within a drum-like conduit. It is also well known to divide the cooling space into two or more stages and to conduct heated cooling medium from one or more of said stages to said furnace to support combustion, the cooler being arranged to keep dust from the material being cooled from mingling with the cooling medium. It is also well known to conduct cooling medium within the drum but out of contact with the cooling tubes to a highly heated point in said cooling space near the header and feed ends of the tubes.

This invention concerns an improved cooler in which the feed header is provided with a double tube sheet wall, that is, a shallow space is walled off from the cooling space proper adjacent the feed header plate, and a stream of cooling air is supplied to said space independently of the air supply to the cooling space proper, to cool the tube sheet or header plate and tube ends where they are in contact with hot material in the header, and provide a fluid current to carry away materials which might tend to leak from the feed header and for cooling medium which might leak from the cooling space proper into the header. This invention thus improves cooling of the header plate or tube sheet and tube ends and also aids in preventing dust from entering the furnace either through the hot material conduit carried by cooling air leaking into the header, or through the combustion air supply proper carried by the main stream of cooling air.

An object of this invention is to secure improved cooling of a cooler header plate.

A further object is to secure improved safeguard against carrying of dust from the cooler into a calcining furnace.

Other and further objects will appear in the following description with reference to the accompanying drawing in which:

Fig. 1 is a fragmentary vertical longitudinal sectional view of a cooler and furnace embodying the invention;

Fig. 2 is a fragmentary view to an enlarged scale of the feed header end of the cooler of Fig. 1;

Fig. 3 is a cross section taken on the line III—III of Fig. 2; and

Fig. 4 is a view similar to Fig. 2 of a modified cooler feed header structure.

Similar reference characters refer to similar parts throughout the several figures of the drawing.

In Figs. 1, 2 and 3 of the drawing is shown the discharge and firing end of a kiln or calcining furnace 1 having a hot material discharge opening 2 and a combustion air inlet 3. A cooler 4 is rotatably supported on bearings 5. A feed conduit 6 is arranged to conduct hot material discharged from furnace 1 into a feed header section 10 at one end of the cooler drum or shell 9. Feed header 10 is provided with a refractory lining 11. The feed header 10 may be considered as including as an outer wall, a portion of the drum or shell 9. The feed header plate 12 and the division plate 13 may be considered as spaced tube sheet walls separating the interior of header 10 from the interior of the drum 9 to the right of division plate or tube sheet wall 13, and enclosing a shallow space between them. Openings 14 are provided in the section of the drum shell 9 forming the outer wall of the feed header 10. These openings 14 communicate with the shallow space between spaced tube sheet walls 12 and 13 for a purpose to be described hereinafter.

Muffle tubes or imperforate hot material conveying and cooling tubes 16 have their ends supported in spaced relation in said tube sheet walls 12 and 13. These muffle tubes extend through spaced tube sheet walls 12 and 13 and open into the interior or material-receiving space of header 10. The portion of the cooler to the right of tube sheet wall or division plate 13 is briefly described hereinafter, and more fully described in A. J. Roubal United States Patent No. 2,283,129, dated May 12, 1942, in connection with a similar structure.

Muffle tubes 16 extend longitudinally through drum 9 in a concentric row and pass in sealed relation through the header plate 17 opening into discharge header or hood structure 18. Muffle tubes 16 also are supported by and extend through a division plate or partition 19. A central air tube 20 having a closed end 21 extends through division plate 19 and is supported within the drum as described in said Roubal Patent 2,283,129, but with its closed end 21 spaced from tube sheet 13. Air or other cooling fluid is conducted to air tube 20 through conduit 22 and to the space surrounding air tube 21 through conduit 23 extending through discharge header or hood 18 and header plate 17 as in Roubal Patent 2,283,129. Apertures 24 are provided in air tube

20 to the left of division plate 19. Apertures 26 are provided in drum shell 9 to the right of and adjacent to tube sheet wall 13, and apertures 27 are provided in drum shell 9 to the right of and adjacent to division plate 19. A conduit 7 and a cooling medium collecting housing 8 form a conduit for conducting combustion-supporting medium from apertures 26 to furnace air inlet 3. The housing 8 surrounds the drum 9 in relatively rotatable sealing relation as shown at 28. A cooling medium collector for apertures 27 is shown at 29.

As shown in Figs. 1 and 2 the feed header plate or tube sheet wall 12 may be provided with an annular flange 31 and mounted in relatively slidable sealing relation with the inner surface of header section 10 of drum shell 9.

The interior of the drum 9 to the right of feed header division plate 13 is seen to be divided into a precooling chamber 36 extending to division plate 19 and a final cooling chamber 37 extending to discharge header plate 17.

A modified form of header is shown in Fig. 4. In this form, an inner cylindrical header wall 32 is radially spaced inwardly from outer wall 9. The feed header takes the form of an inner tube sheet wall 112 circumferentially attached to inner header wall 32. The tube sheet wall or division plate 13 is spaced from the header or tube sheet wall 112 and attached circumferentially to the drum shell 9. The space between walls 112 and 13 is now seen to be extended to include the annular space between drum shell 9 and inner header wall 32. Apertures 114 are provided in header section 10 of drum shell 9.

A blower 33 driven by a motor 35 may be provided and may be connected to a semiannular air chest 34 partially surrounding header 10 and communicating with apertures 14, or 114. The blower arrangement is shown in Figs. 1, 2 and 3 but may be modified in an obvious manner to be applied to the modified header of Fig. 4.

The operation of the device as to the portion to the right of the tube sheet or division plate 13 is similar to that of the device disclosed in the Roubal Patent 2,283,129. Combustion air for furnace 1 enters air tube 21 and flows through apertures 24 around the muffle tubes 16, being guided by suitable baffles, and passes out apertures 26 through housing 8 and conduit 7 to furnace air inlet 3. This air is highly heated by the time it reaches the vicinity of tube sheet wall 13 and apertures 26. Final cooling air enters through conduit 23 and flows around air tube 21 and around the muffle tubes 16 guided by suitable baffles and is exhausted through apertures 27 to a stack or other means, not shown, connected to collector 29. Cooling of the header plate or tube sheet wall 12, and the extreme ends of muffle tubes 16 which are in direct contact with the hot material from the furnace and improved cooling of tube sheet wall or division plate 13 at the hottest part of the material cooling space proper are specially provided for by this invention. The shallow space between the tube sheet walls 12 and 13 (and the space in Fig. 4 surrounding inner header wall 32 and extending between tube sheet walls 112 and 13), forms a special separate space for independent cooling of the hottest header parts. Air flow through apertures 14 (114) will be induced by gravity due to the hot parts bordering the enclosed shallow space and this air is fresh cool air which has not passed through the cooler body prior to its entry through openings 14 (114).

If gravity flow is insufficient, a blower 33 may be used to augment flow.

The flow of air between walls 12 and 13 (112 and 13) and discharged to atmosphere has a sealing function in addition to its cooling function. Joints where the tubes 16 are passed through tube sheet walls 12 and 13 and joints between these walls 12 and 13 and the drum shell 9 (and inner wall 32 in Fig. 4) are difficult to keep tight. In a single walled structure like that of Roubal 2,283,129, dust from the interior of the material receiving chamber (26 in the Roubal patent) which might leak through the header plate (11 in the Roubal patent) will be carried by the flow of cooling and combustion-supporting medium into the furnace 1. Also cooling and combustion-supporting medium which might, in such a structure, leak past the header plate (11 in Roubal) will stir up and carry dust from the material receiving chamber (26) to the furnace (1) through the furnace discharge (3). In the device of this invention any leakage of dust from feed header 10 through tube sheet wall 12 will be discharged through apertures 14 without entering the furnace 1. Also any leakage of cooling medium through tube sheet wall 13 will be discharged through apertures 14 without entering the material receiving space in the header.

Undue strain on the tube sheet wall 12 due to expansion and contraction of the ends of tubes 16 is avoided by use of a slidable joint with the drum shell as shown at 31.

The invention is of general application and although it has been disclosed in connection with a muffle tube cooler of the type shown in Roubal 2,283,129, it should be understood that it is not intended to limit the invention to the exact details of construction and mode of operation herein shown and described. Such modifications and equivalents as may readily occur to persons skilled in the art are intended to be included within the scope of the invention as defined by the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A cooler for indirect cooling of hot materials comprising a substantially horizontal elongated rotary drum, a feed header plate closing said drum adjacent one end, a discharge header plate closing said drum adjacent the other end, a plurality of spaced imperforate material conveying and cooling tubes extending between and connecting said header plates, a division plate in said drum adjacent said feed header plate and transversely enclosing a shallow space adjacent said feed header plate and surrounding the walls of said tubes adjacent their feed ends, means effecting flow of a stream of cooling air in the interior of said drum between said discharge header plate and said division plate, and means effecting flow of a separate stream of cooling air through said shallow enclosed space adjacent said feed header plate, said streams of cooling air being in non-mixing relation and free of contact with heated material in said cooler.

2. A cooler for indirect cooling of hot materials comprising a substantially horizontal elongated rotary drum, a feed header plate closing said drum adjacent one end, a discharge header plate closing said drum adjacent the other end, a plurality of spaced imperforate material conveying and cooling tubes extending between and connecting said header plates, a division plate in said drum adjacent said feed header plate and transversely enclosing a shallow space adjacent said

feed header plate and surrounding the walls of said tubes adjacent their feed ends, means effecting flow of a stream of cooling air in the interior of said drum between said discharge header plate and said division plate, and a plurality of peripheral apertures in said drum between said division plate and said feed header for effecting flow of a separate stream of cooling air through said shallow enclosed space adjacent said feed header plate in non-mixing relation to said first stream and free of contact with heated material in said cooler.

3. The cooler of claim 2, said drum having its feed header plate axially slidable in sealing relation with the inner surface of said drum, and said division plate being rigidly secured in sealing relation with said drum and the outer walls of said tubes.

4. A cooler for granular materials comprising an elongated drum, feed and discharge headers enclosing the ends of said drum, said feed header having spaced tube sheet walls enclosing a shallow space therebetween, a division plate dividing the interior of the drum between said headers into separate non-communicating precooling and final cooling chambers, a central air tube extending through said discharge header and final cooling chamber and through said division plate into said precooling chamber, at least one imperforate muffle tube connecting said headers and extending through said precooling and final cooling chambers, means including said central air tube for effecting a flow of separate streams of cooling air through said precooling and final cooling chambers, and means for effecting flow of still another separate stream of cooling air through said shallow space between said spaced tube sheet walls.

5. In combination with a furnace, means for conveying and cooling the hot material discharged from said furnace, comprising an elongated drum, a feed header enclosing one end of said drum for receiving and transmitting said hot material, a discharge header enclosing the other end of said drum, a plurality of spaced material conveying tubes connecting said headers and extending longitudinally therebetween through the said drum, means for effecting a flow of combustion-supporting cooling medium through the interior of said drum between said headers and externally of said tubes, fluid conduit means for conducting at least a part of the combustion-supporting cooling medium from the interior of said drum to said furnace to support combustion therein; said feed header having spaced parallel tube sheet walls enclosing a fluid cooling space surrounding the said tube walls adjacent their ends, and means to effect a flow of cooling fluid through said space between said tube sheet walls entirely independent of the flow of cooling medium through the interior of said drum and furnace.

6. In combination with a furnace, means for conveying and cooling the hot material discharged from said furnace, comprising an elongated drum, a feed header enclosing one end of said drum for receiving and transmitting said hot material, a discharge header enclosing the other end of said drum, a plurality of spaced material conveying tubes connecting said headers and extending longitudinally therebetween through the said drum, means for effecting a flow of combustion-supporting cooling medium through the interior of said drum between said headers and externally of said tubes, fluid conduit means

for conducting at least a part of the combustion-supporting cooling medium from the interior of said drum to said furnace to support combustion therein; said feed header having spaced parallel tube sheet walls enclosing a fluid cooling space surrounding the said tube walls adjacent their ends, and means to effect a flow of cooling fluid through said space between said tube sheet walls entirely independent of the flow of cooling medium through the interior of said drum and furnace, said tube sheet wall facing the interior of said drum being rigidly attached to the periphery of said drum, and said other tube sheet wall facing the header chamber engaging the inner surface of said drum in slidable sealing relation.

7. A header for a plurality of hot material conveying tubes comprising a drum-like box, closely spaced parallel tube sheet walls surrounding the walls of said tubes adjacent one end thereof and enclosing a shallow space therebetween, and means effecting a flow of cooling fluid directly to, transversely through, and from, said shallow space between said spaced parallel tube sheet walls in non-contacting relation to said hot material.

8. In a cooler for hot materials, a rotating drum with its axis slightly inclined to the horizontal, a feed end sealing header plate closing said drum at the higher end thereof, a plurality of spaced imperforate material conveying tubes opening through said feed end header plate and extending longitudinally of said drum toward the lower end thereof, a discharge header plate closing the drum at the discharge end thereof between said tubes, means to effect a flow of cooling air through a portion of the enclosed space within said drum between said hot material conveying tubes throughout a major portion of the length thereof, means transversely dividing said enclosed space immediately adjacent said feed end header plate, and means to effect a flow of cooling air through the space between said feed end sealing header and said division means free of contact with said hot material and in independent non-mixing relation to said first mentioned flow of cooling air.

9. A cooler for indirect cooling of hot materials, comprising a substantially horizontal elongated rotary drum, a feed header closing said drum adjacent one end, a discharge header closing said drum adjacent the other end, a plurality of spaced imperforate material conveying and cooling tubes extending between and connecting said headers, a division plate in said drum adjacent said feed header and transversely enclosing a shallow space adjacent said header and surrounding the walls of said tubes adjacent their ends, said drum being constructed and arranged to provide an annular cooling space surrounding said header and freely communicating with said shallow space adjacent said header, means effecting flow of a stream of cooling medium in the interior of said drum between said discharge header and said division plate, and means effecting flow of a separate stream of cooling fluid through said shallow enclosed space and said annular cooling space, said streams of cooling fluid being in non-mixing relation and free of contact with heated material in said cooler.

10. A cooler for indirect cooling of hot materials, comprising a substantially horizontal elongated rotary drum, a feed header closing said drum adjacent one end, a discharge header closing said drum adjacent the other end, a plurality of spaced imperforate material conveying and

cooling tubes extending between and connecting said headers, a division plate in said drum adjacent said feed header and transversely enclosing a shallow space adjacent said header and surrounding the walls of said tubes adjacent their ends, said drum being constructed and arranged to provide an annular cooling space surrounding said header and freely communicating with said shallow space adjacent said header, means effecting flow of a stream of cooling medium in the interior of said drum between said discharge header and said division plate, and a plurality of peripheral apertures in said drum communicating with said shallow enclosed space adjacent said feed header and said annular space surrounding said feed header for effecting flow of a separate stream of cooling fluid therethrough in non-mixing relation to said first mentioned stream and free of contact with the heated material in said cooler.

5 11. A header for a plurality of hot material conveying tubes comprising a drum like box having radially spaced inner and outer walls, spaced parallel tube sheet walls surrounding the walls of said tubes adjacent their ends, and connected respectively to said radially spaced inner and outer walls to define a cooling space, and means effecting a flow of cooling fluid through said cooling space.

10 12. A header for a plurality of hot material conveying tubes comprising a drum like box having radially spaced inner and outer walls, spaced parallel tube sheet walls surrounding the walls of said tubes adjacent their ends, and connected respectively to said radially spaced inner and outer walls to define a cooling space, and apertures in the said radially spaced outer wall for effecting a flow of cooling fluid through said cooling space.

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