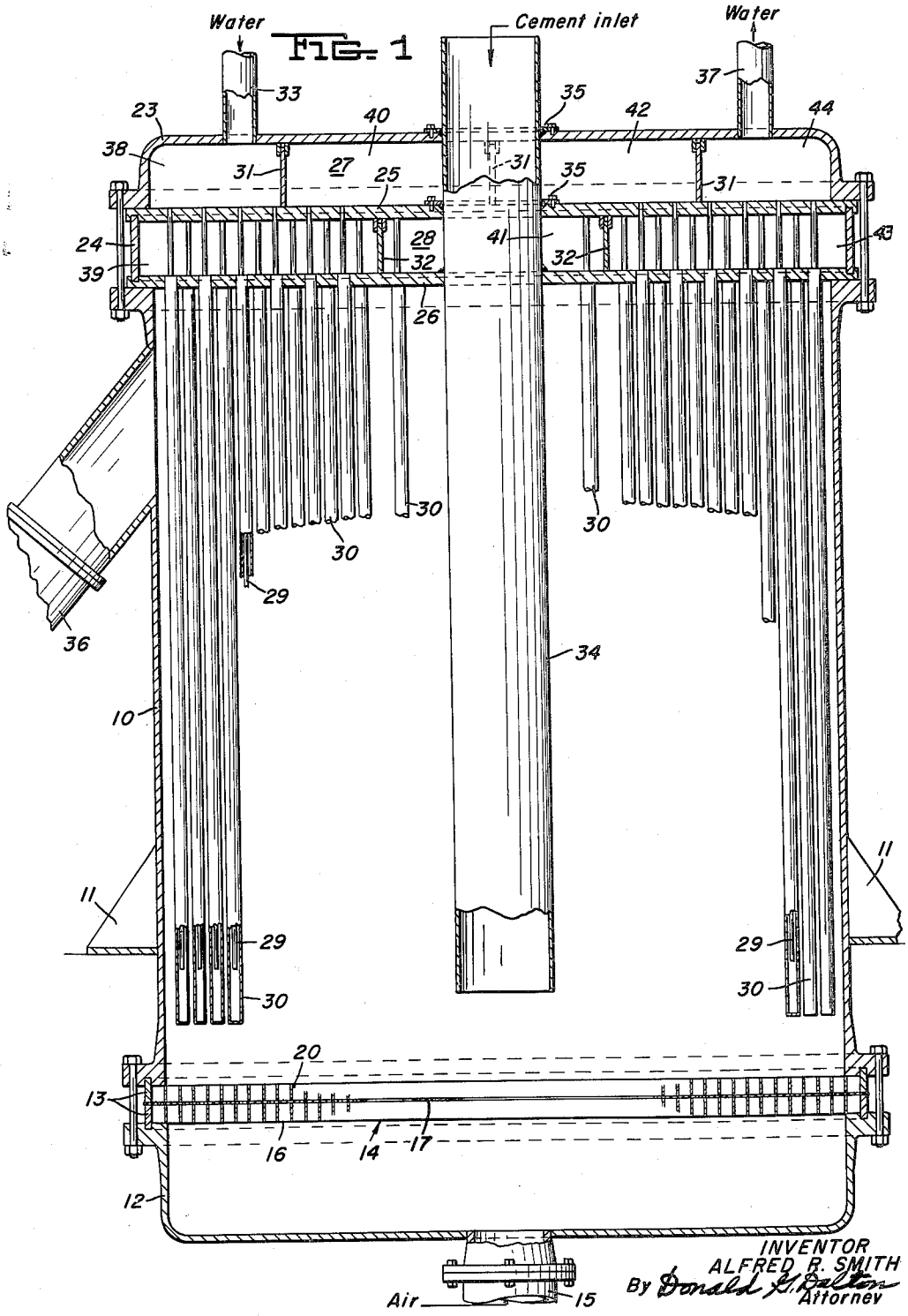
March 27, 1962 A. R. SMITH 3,026,626

HEAT EXCHANGER FOR PULVERULENT MATERIAL

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FIG. 1



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FIG. 5

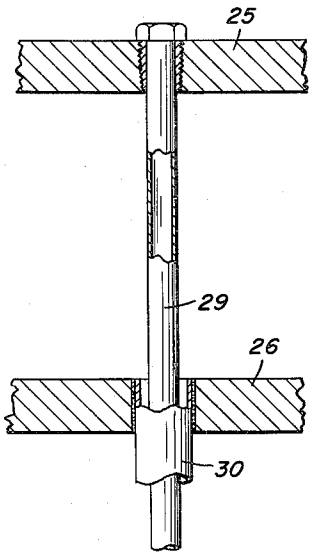


FIG. 2

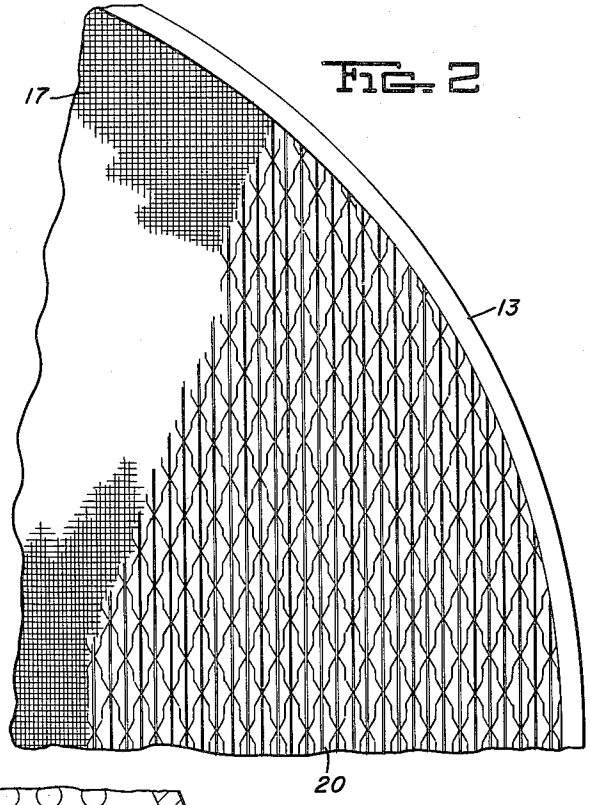


FIG. 4

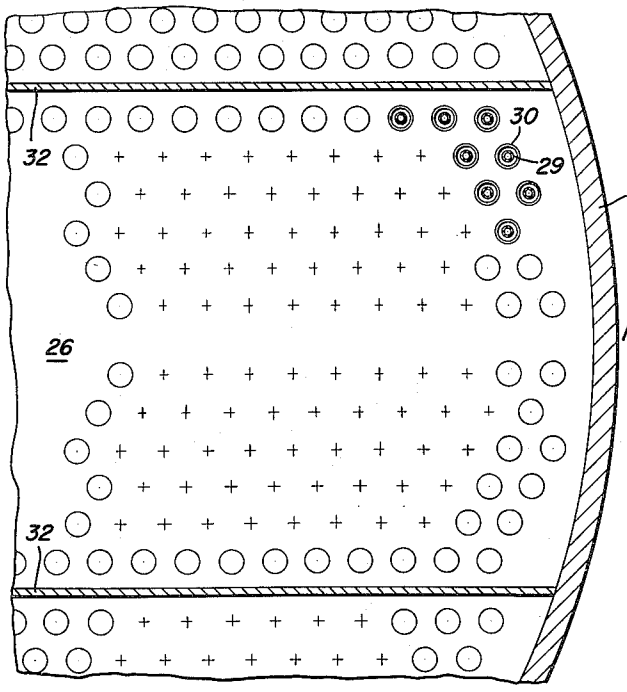
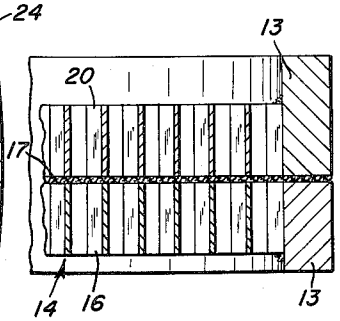


FIG. 3



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3,026,626
HEAT EXCHANGER FOR PULVERULENT MATERIAL

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Filed July 7, 1959, Ser. No. 825,458
3 Claims. (Cl. 34—57)

This invention relates to heat exchangers and, in particular, to apparatus for absorbing heat from pulverulent material, specifically a cement cooler.

Portland cement as it comes from the clinker mills has a substantial heat content and must be cooled before shipment or use. Apparatus used for this purpose heretofore has been bulky, costly and troublesome to keep in operation. It is therefore the object of my invention to provide a cement cooler which is compact, simple, relatively inexpensive and unlikely to require extensive maintenance.

The cooler of my invention comprises an elongated chamber standing vertically, having a gas permeable bottom panel and a wind box therebelow. Bayonet-type cooling tubes extend downwardly into the chamber from vertically spaced tube sheets forming superposed entry and exit water boxes above the chamber proper. A central inlet pipe for cement also extends downwardly through the water boxes into the chamber and an outlet is formed in the side wall of the chamber. Hot cement entering the inlet has its fluidity increased by air passing upwardly through the bottom panel and flows repeatedly over and around the tubes, losing heat largely to the air which is then cooled by the water circulating through the tubes, but to some extent also by contact with the tubes. Eventually the cement, after being cooled, rises to the level of the outlet and is discharged thereby for bagging and shipment.

A complete understanding of the invention may be obtained from the following detailed description and explanation which refer to the accompanying drawings illustrating the present preferred embodiment. In the drawings:

FIGURE 1 is a central vertical section through the cooler of my invention;

FIGURE 2 is a partial plan view of the bottom panel;

FIGURE 3 is a partial radial section through the edge of the bottom panel;

FIGURE 4 is a partial section taken between the tube sheets and parallel thereto; and

FIGURE 5 is a portion of FIGURE 1 to enlarged scale.

Referring now in detail to the drawings and, for the present, particularly to FIGURE 1, the cooler of my invention comprises a chamber 10, preferably cylindrical, standing vertically and provided with feet 11 adapted to rest on any suitable supports, not shown. The chamber wall is flanged at the top and bottom. A dished flanged cover 12 is bolted to the bottom of the chamber with spacer rings 13 therebetween and constitutes a wind box. Rings 13 carry a gas-permeable panel 14 which forms the bottom of chamber 10. Cover 12 is provided with an air inlet 15 connected to any suitable source of air under moderate pressure.

As clearly shown in FIGURES 2 and 3, panel 14 is made up of a lower grating 16 and a sheet of cotton duck 17 thereon. A second grating 20 holds the duck sheet down against the upward pressure of air in box 12. Gratings 16 and 20 are welded to one of two rings 13 clamped between cover 12 and chamber 10.

A dished flanged cover 23 is bolted to the top flange of the chamber with a spacer ring 24 therebetween. Tube sheets 25 and 26 between the cover and spacer ring and between the ring and the chamber, respectively,

define water boxes 27 and 28. Telescoped pairs of fall and riser tubes 29 and 30 depend from the sheets, respectively, the inner tubes having their upper ends fitted into sheet 25 and the outer tubes having their upper ends fitted into sheet 26. The lower ends of the outer tubes are closed. The inner tubes are open at their lower ends and terminate above the ends of the outer tubes. Baffle plates 31 and 32 in the water boxes 27 and 28 respectively subdivide the entire tube bundle into six approximately equal portions with equal water flow areas and substantially equal cooling surface exposed to flow of cement. An inlet connection 33 extends from the upper water box 27 to a suitable source of cooling water under pressure.

A cement inlet pipe 34 extends centrally down through cover 23 and tube sheets 25 and 26. It is welded to sheet 26. The joints between pipe 34 and cover 23 and sheet 25 are closed by seal rings 35. Pipe 34 terminates slightly above the lower ends of tube 30 and above panel 14. One or more cement outlets 36 extend laterally from the wall of chamber 10 at a level slightly below the top thereof. Inlet pipe 34 may be suitably connected to a clinker mill and outlet 36 to a storage space.

In the operation of the apparatus described, baffle plates 31 and 32 in upper and lower water boxes establish a total of seven chambers through which water flows from inlet pipe 33 to an outlet pipe 37. The chambers are indicated by progressive numerals from 38 to 44 in the sequence of flow. Water from pipe 33 enters chamber 38, flows down tubes 29 and up corresponding tubes 30 into chamber 39. Water leaves chamber 39 by flowing down the remaining tubes 30 connected to chamber 39 and thence up the corresponding tubes 29 and into chamber 40. Flow continues in like manner from chamber 40 in succession through chambers 41, 42, 43 and 44 by way of corresponding tubes 29 and 30. From chamber 44 the water is conducted to a suitable point for disposal through outlet 37. Air is admitted to inlet 15 and passes through the panel 14. Cement entering the chamber 10 by inlet 34 is thus aerated, has its fluidity increased and is caused to circulate repeatedly in the space between the inlet pipe and the chamber wall. The cement is quickly and efficiently cooled by the circulating air and by contact with tubes 30, the heat of the cement being absorbed by the cooling water circulating through the tubes. As the level of the cement rises to outlet 36, discharge takes place and eventually an equilibrium condition is reached at which the outflow is equal to the input of hot cement.

The invention has numerous advantages over previously known cement coolers. It is compact and simple in construction and efficient in operation so it has a high hourly capacity. It presents no maintenance problem but can readily be taken apart if necessary. Since only moderate pressures are involved the apparatus may be designed to be relatively light in weight yet adequately rugged and durable for long life. The bayonet tubes offer little resistance to cement flow yet show no tendency to collect a deposit of cement. The invention does not employ true fluidization but rather a dense phase condition with adequate flow characteristics to permit the powdered solid to move through the apparatus by hydraulic head provided and to recirculate over the tube surface thereby increasing velocity of particles over the surface to promote heat transfer.

It is believed that the solid particles give up their heat to the air which in turn transfers it to the surface of the tube. Conduction from particle to tube seems unlikely as the point contacts between particles and tubes would involve high resistance to heat flow over the limited area of such contact. The direct cooling effect of the air is negligible and I view the matter as a transfer of heat from solids to air to tube to water. Cooling by air is

less than 2% of total. From considerations of mixture density as well as flow rates, both volume and weight, it can be shown that recirculation of solids must take place within the cooler. No quantitative results can be established since the extent of recirculation in terms of the average number of times any given portion of feed recirculates before discharge is dependent upon the average density of the recirculating material. If this be assumed to be 60 lbs./cu. ft., the number of recirculations may be computed to be about 30.

Although I have disclosed herein the preferred embodiment of my invention, I intend to cover as well any change or modification therein which may be made without departing from the spirit and scope of the invention.

I claim:

1. A heat-exchanger for pulverulent material comprising a vertically elongated chamber, a gas-permeable panel mounted horizontally in the bottom of said chamber, a wind box below said panel, vertically spaced tube sheets on top of said chamber, a water box, said water box being divided into at least three fluid chambers, a plurality of heat-exchange tube means connecting said fluid chambers in series and extending into said elongated chamber, one of said fluid chambers having a fluid inlet, another of said fluid chambers having a fluid outlet, an inlet pipe for said material extending downwardly through said sheets into said chamber to a level adjacent said panel and an outlet for said material opening through the side wall of said chamber at a level adjacent the lower sheet, said outlet for said material being adjacent the heat-exchange tube means connected to said fluid chamber having the fluid inlet.

2. The device of claim 1 further characterized by said heat-exchange tube means being telescoped fall and riser tubes.

3. In the device of claim 2 at least two of said fluid chambers being upper chambers and at least one of said fluid chambers being a lower chamber, one of said upper fluid chambers having a fluid inlet and another upper fluid chamber having a fluid outlet.

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