COAL DRYING APPARATUS


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7 Claims. (Cl. 34—177)

This invention relates to apparatus and processing for the drying of materials such as coal, sand, gravel, sawdust, grain, etc., and more particularly to means for drying coal, including improvements in the drying operation, per se, as well as in the feeding and discharging of the coal to and from the reactor.

One of the objects of the invention is to so operate the apparatus as to reduce or eliminate the danger of spontaneous combustion of the coal during the drying operation.

Another object of the invention is to improve the means for discharging coal from the bin in which it has been dried. Still another object is to overcome some of the difficulties encountered in discharging materials which tend to bind and require bin vibrators or other complex mechanisms to keep them moving.

Various other objects and advantages of the invention will be obvious from the following particular description of embodiments of the invention.

The various features of novelty which characterize the invention are pointed out with particularity in the claims, annexed hereto and forming a part of this specification, but for a better understanding of the invention, however, its advantages and specific objects obtained with its use, reference should be had to the accompanying drawings and descriptive matter in which have been illustrated and described the best forms of the invention.

Referring now to the drawings:

FIG. 1 is an end sectional view of the invention;
FIG. 2 is a sectional view on the line 2—2 in FIG. 1;
FIG. 3 is an end view of the bin discharger mechanism shown in FIG. 1;
FIG. 4 is a sectional view taken on the line 4—4 in FIG. 3;
FIG. 5 is a top view of the mechanism shown in FIG. 4;
FIG. 6 is a modification of the structure shown in FIG. 4.

Referring to the drawings, an air rifle vessel or bin, identified generally by 9, has one of its side walls 10 opposite another side wall 11 and its end wall 12 opposite another end wall 13.

The bin's top wall 14 has an opening 15 connected to the outlet end of an air rifle duct 16 upwardly inclined; the opposite end of such duct connects with the upper end of an air rifle jacket 17, downwardly inclined, which encloses an endless conveyor.

The jacket is air tight down to the steam vent 18, located below the level of the bottom of the bin 9.

The conveyor is formed by an endless belt 19, with upstanding lugs 20 spaced at intervals through the length of the belt, to carry coal 21 to the duct 16, from which it slides by gravity down to the top of the bin 9.

The drying bin is equipped with horizontal grids of heat exchanger tubes 22 such as those with horizontal grids 22 being offset or staggered with respect to the next horizontal grids 23, as indicated in FIG. 2.

Such grids of heat exchanger tubes 22 and 23 are connected to and fed by steam main 24, and the opposite ends of such grids of heat exchanger tubes 22 and 23 are connected to the condensate return 25.

The bin 9 is open at the bottom so that the coal can be discharged continuously or otherwise as it becomes dried to any desired moisture content.

For this purpose there are provided ports 26, through which the contained material can flow by gravity on to wear plate 26 (which will be described later), on lower benches 27, which are in turn separated by ports 28 (FIGS. 1 and 4).

The metal wear plate runs the length of the bin 9 and is positioned on top of the bench 27, with ports in it corresponding to ports 28 and thus forming a removable top to bench 27, which can be conveniently removed and replaced when necessary or desired.

The benches 27 are of such size and positioned at such a distance under the bin bottom that the angle of repose of the material resting on the wear plates which in turn rest on benches 27 does not quite reach out to the edge of the wear plate 26 and the bench 27.

The material therefore comes to rest on wear plate 26 and bench 27 and does not flow down through ports 28.

Resting on the wear plate 26 on bench 27 is a push-rod 29, to which are attached cross-drags or rakes 30. These rakes are positioned under the ports 26 centrally, and rest on the wear plate 26 on the bench 27.

The push rod 29 and its attached rakes 30 are free to move back and forth and are given a reciprocating motion by proper mechanical means, not shown in the drawings.

This reciprocating motion moves the rakes back and forth and is of such amplitude that a controlled amount of coal is pushed over the edge of the wear plate 26 and bench 27, and falls through the ports 28, on to a shaking conveyor or other suitable means, such as a drag or belt conveyor and is removed continuously or in any other manner.

The amount of coal discharged per unit of time can be regulated by the length of stroke of the push-rod 29 and the number of strokes per unit of time, thereby furnishing a simple means to control the rate of discharge of the coal.

In the device shown, the stroke of the rakes is unlimited, so much so, that even with a long string multiplicity of ports and rakes, the rake assembly can be removed for repairs or replacement and returned to its place without emptying the bin.

The push-rod requires very little force to actuate it and power to drive it, and so does not have to be of heavy or expensive construction.

In place of the push-rod 29 there could be a continuous chain conveyor dragging along the wear plate 26 on the top of the bench 27, to which cross drags could be attached to drag the coal into the ports 28, but this is an alternative device which is not shown in the drawings.

In the drawings, the ports 26 are shown with sloping sides, as indicated by 31, but these sloping sides are not essential if there are no disadvantages to leaving the ridge of coal between the ports 26 that would remain there if the bin had a flat bottom, and a modification of ports 26 without sloping sides is illustrated in FIG. 6 of the drawings, the dimensions of which can be varied to meet specific conditions.

The bin discharger is practical, as provided by its successful use in the actual operation of the coal drying reactor or bin erected for drying and processing a large test sample of coal.

One of the advantages of the device is that both the push-rod and the wear plate can be removed for repair or replacement without emptying the bin, because the small piles or ridges of coal under ports 26 and resting on the wear plate on bench 27 offer little resistance to the removal or replacement of either or both the drag mechanism and the wear plate.

In operation, the coal moves at a controlled rate of
speed up the conveyor 19 until it falls by gravity down the inclined airtight duct 16 through the opening 15 in the top of bin 9, and then the coal falls down by gravity over the grids of heat exchanger pipes 22 and 23, which as stated before, are staggered, so that as the coal moves down through the dryer, it comes in contact with the pipe surfaces, which results in a higher factor of heat exchange.

Of particular economic importance is the fact that steam, for example, in the tubes or pipes 22 and 23 operate effectively at low pressure such as about 175 pounds per square inch, corresponding to a temperature of approximately 400 degrees F., but this temperature and pressure can be varied to meet specific conditions, and various other heating agents.

Effective operation at such low temperature and pressure obviously offers many advantages both as to economy of structure and operation, and to the quality of the coal finally produced.

The heat in the heat exchanger tubes 22 and 23 is also absorbed in the surrounding coal, and the inherent moisture of the coal is driven off in the form of saturated steam. The saturated steam contacts the exterior of the heat exchanger tubes and regenerates as dry steam. This dry steam circulates through the coal in the bin and is free from the dust and dust-laden air, and is also enclosed in the feed conveyor and such dry steam is discharged through a discharge pipe 18 which opens out from the conveyor at a point below the level of the lowest level of drying coal in the dryer.

By this means the drying coal is surrounded entirely by an atmosphere of hot vapor or steam, which prevents air reaching the coal, thereby very greatly reducing or eliminating spontaneous combustion of the coal.

This is an essential factor or feature of the dryer. The tendency towards spontaneous combustion has been one of the principal hazards of previous apparatus and processes.

In the design shown, the coal moves at a controlled rate of speed up the conveyor countercurrent to the flow of the escaping steam and in a common duct with it. The coal is thus preheated before being discharged into the dryer.

This also provides a regenerative effect because the latent and sensible heat of the steam is captured by the cold incoming coal and is thus returned to the dryer, providing substantial saving in fuel consumption.

The design as shown also allows a major part of the moisture of condensation on the incoming coal to drain off without getting into the dryer.

The character and function of the duct 16 and jacket 17 are novel.

The upward and downward directions of the duct 16 and the jacket 17, with which it is joined, and the position of the escape vent, make it possible to sustain appropriate steam pressure in the drying bin, and to prevent air from entering the bin either through the duct or through the bottom of the bin drier and to retard escape of the steam until it has given up its latent and sensible heat to the cold incoming coal, thereby preheating said coal before it enters the drier and thereby effecting a substantial saving in fuel for total heat requirement.

This is believed to be novel and a new application of principle.

From the foregoing it is clear that this invention provides improved means for drying coal, including the dryer, per se, as well as the feeding of wet coal to the dryer, and discharging coal after being dried.

There is nothing theoretical about this invention. The entire structure has been erected, including all its parts and equipped with multiple ports and rakes to serve the dryer.

Among the essential features of this invention are:

The rake is kept low in relative height. This is one of the factors making possible the removal and replacement of the rake assembly without emptying the bin.

It is positioned centrally in the pile of coal on the bench and discharges coal on movement in either direction, making the device double acting, which is believed to be unique.

The device requires but one bin opening and one rake to get continuous discharge. This is also believed to be unique.

The device as shown is a very practical means to empty a bin of very large horizontal area and capacity, to do so uniformly, that is, to have uniform movement of the material and yet require only a relatively few inches of head room. This is a factor of distinct advantage in structure, operation and economy. The conventional bin of large capacity is a high expensive structure with long sloping bottom and the material does not usually move through it uniformly, but tends to segregate out by sizes and to channel. Even with very steep bottom slopes, some materials tend to pack and refuse to move, requiring bin vibrators to keep them discharging.

While in accordance with the statutes, there have been illustrated and described the best embodiments, now known, of the invention, it will be apparent to those skilled in the art that changes may be made in the subject matter and form of the invention disclosed without departing from the spirit of the invention as set forth in the claims annexed. Wherefore it is intended that the patentee be awarded certain features of the invention can be used to advantage without a corresponding use of other features.

I claim:

1. Apparatus for continuously drying combustible solids having high inherent moisture at a controlled rate comprising, an upwardly directed conduit for solids to be dried having an inlet for solids to be dried at its bottom and an outlet for solids at its top, means in the conduit to move solids from the inlet to the outlet, a heat exchanging chamber having an outlet for dried solids at its bottom and an inlet for solids at the top in air-tight communication with the outlet of the conduit, whereby solids may move from the conduit outlet through the said chamber by gravity, heat exchange means extending across said chamber over which solids will cascade in flowing gravitationally through the chamber, said communicating conduit and chamber forming an airtight passageway through which solids will pass during the drying operation, means on the conduit forming an outlet for hot vapor generated by passage of moisture laden solids through the passageway, said means being located below the level of the chamber outlet so that the interior of the passageway will be filled with hot vapor before the hot vapor can escape through said means and solids will be surrounded by hot vapor-filled air-free atmosphere while passing through the apparatus.

2. Apparatus for continuously drying combustible solids having high inherent moisture at a controlled rate as claimed in claim 1 wherein said heat exchange means comprises, a plurality of superposed grids having a plurality of parallel arranged pipes.

3. Apparatus for continuously drying combustible solids having high inherent moisture at a controlled rate as claimed in claim 2 wherein said adjacent superposed grids are staggered relative to one another.

4. In apparatus for continuously drying combustible solids having high inherent moisture at a controlled rate as claimed in claim 1, means for controlling the discharge of dried solids from the chamber outlet.

5. Apparatus for continuously drying combustible solids having high inherent moisture at a controlled rate as claimed in claim 1, wherein the outlet from the chamber comprises a plurality of laterally spaced ports, spaced receiving platforms positioned one beneath each port upon which dried solids may fall and assume an angle of repose, and means to cause predetermined quantities of solids to drop over the edges of the platforms.

6. Apparatus for continuously drying combustible...
solids having high inherent moisture comprising, a chamber having an inlet for solids at the top and an outlet for solids at the bottom, heat exchanging means within the chamber, an upwardly directed conduit having an inlet for solids to be dried at the bottom at a level below the outlet from the chamber and an outlet for solids at the top communicating with the inlet of the chamber to complete a continuous airtight passageway through the conduit and chamber, means to elevate solids through the conduit to the top thereof, and means on the conduit at a level below the outlet from the chamber forming an outlet for hot vapor generated by passage of moisture-laden solids through the apparatus so that the interior of the airtight passageway through the conduit and chamber will be filled with hot vapor before vapor can escape and the solids will be surrounded by a hot vapor-filled air-free atmosphere while passing through the apparatus.

7. Apparatus for continuously drying combustible solids having high inherent moisture as claimed in claim 20

6, wherein there are means for controlling the discharge of dried solids from the chamber outlet.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,031,773

May 1, 1962

Wesley Earl Dunkle, deceased, by
Gladys Elizabeth Dunkle, executrix

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 1 to 3, for "Wesley Earl Dunkle, deceased, late of Anchorage, Alaska, by Gladys Elizabeth Dunkle, administrator, of Anchorage, Alaska," read -- Wesley Earl Dunkle, deceased, late of Anchorage, Alaska, by Gladys Elizabeth Dunkle, executrix, of Anchorage, Alaska; Gladys Elizabeth Dunkle, sole trustee of the estate of said Wesley Earl Dunkle, deceased, --; line 14, for "administrator" read -- sole trustee --; in the heading to the printed specification, lines 3 to 5, for "Wesley Earl Dunkle, deceased, late of Anchorage, Alaska, by Gladys Elizabeth Dunkle, administrator, Anchorage, Alaska (806 17th St., N. W., Washington, D. C.), read -- Wesley Earl Dunkle, deceased, late of Anchorage, Alaska, by Gladys Elizabeth Dunkle, executrix, Anchorage, Alaska (806 17th St., N. W., Washington, D. C.); Gladys Elizabeth Dunkle, sole trustee of the estate of said Wesley Earl Dunkle, deceased, --.

Signed and sealed this 19th day of February 1963.

(SEAL)
Attest: DAVID L. LADD
ESTON G. JOHNSON Commissioner of Patents
Attesting Officer