United States Patent [19]

Castanoli

[11] **3,927,715**

[45] **Dec. 23, 1975**

[54] MULTIPLE DECK DRYING APPARATUS

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[22] Filed: **Aug. 16, 1974**

[21] Appl. No.: **498,029**

[52] **U.S. Cl.** **165/120;** 198/102; 34/20; 34/171

[51] **Int. Cl.²** **F28F 7/00**

[58] **Field of Search** 62/63, 380; 165/120; 198/102, 168; 34/20, 171

[56] **References Cited**

UNITED STATES PATENTS

2,587,379	2/1952	Peterson	198/168
3,128,606	4/1964	Watson	62/63
3,161,485	12/1964	Buhrer	34/236
3,402,762	9/1968	Kreuter et al.	165/120

FOREIGN PATENTS OR APPLICATIONS

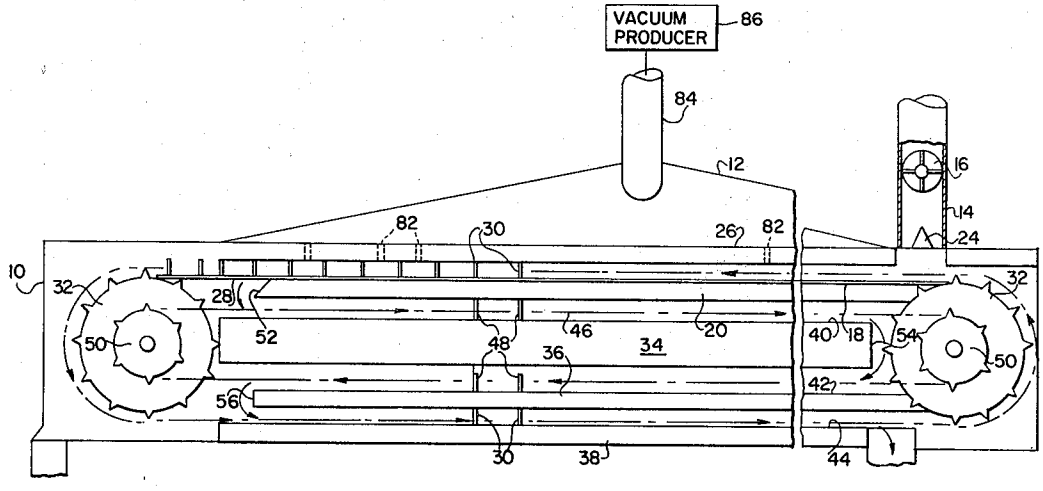
1,224,769	3/1971	United Kingdom	198/168

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Attorney, Agent, or Firm—Laurence, Stokes & Neilan

[57] **ABSTRACT**

Apparatus for treating a material by indirect heat exchange comprising a plurality of decks along which the material is passed by transversely extending scrapper blades the ends of which are attached to conveyor chains, the decks comprising the tops of enclosed heat exchange chambers containing a heat exchange fluid. The material passes from one deck to another with the decks being vertically spaced so that material drops from one deck onto the next lower deck. Vapor emanating from the material is exhausted under a vacuum. The apparatus has particular utility for the drying of wet coal since the coal is maintained out of direct contact with the heating fluid and thus coal dust does not exhaust to the atmosphere in the heating fluid.

5 Claims, 2 Drawing Figures



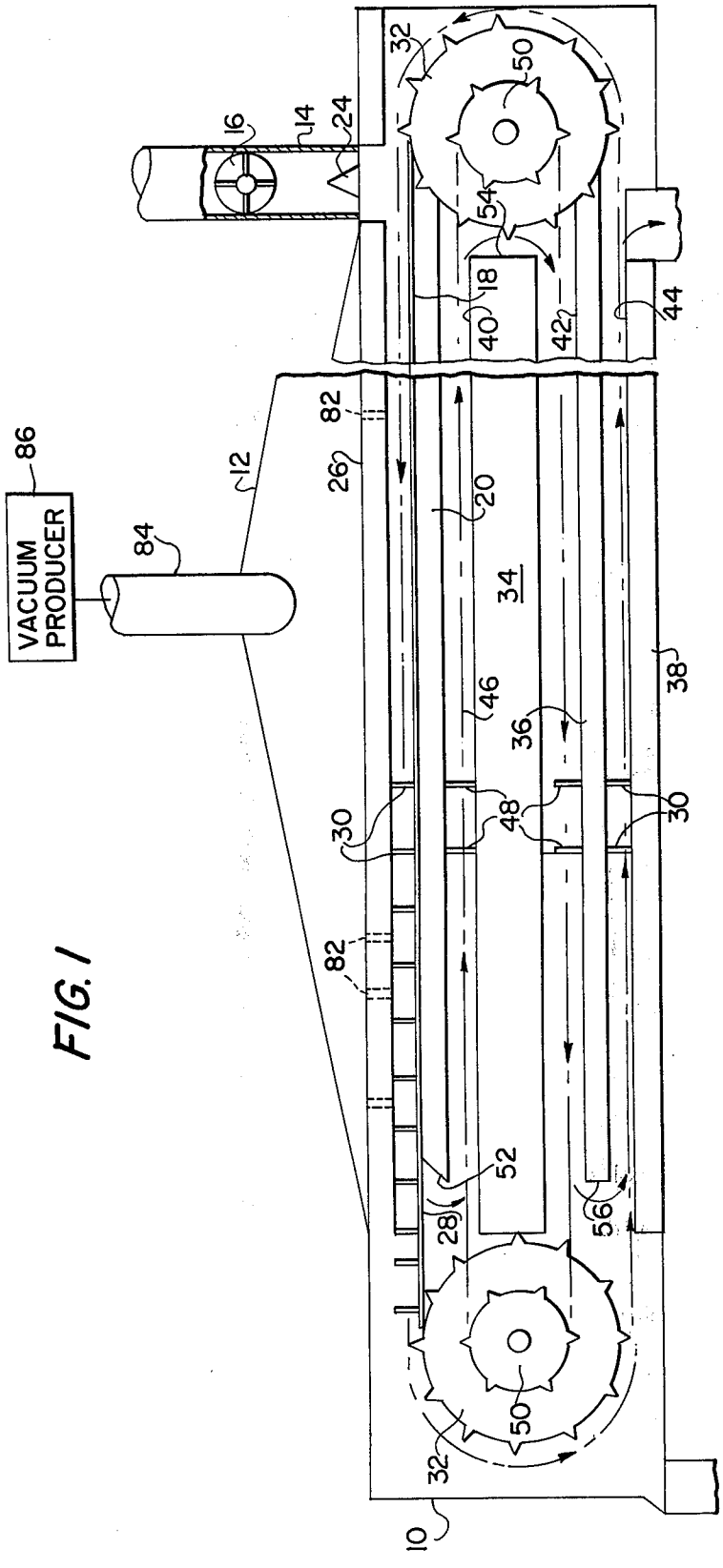

VACUUM PRODUCER
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FIG. 1

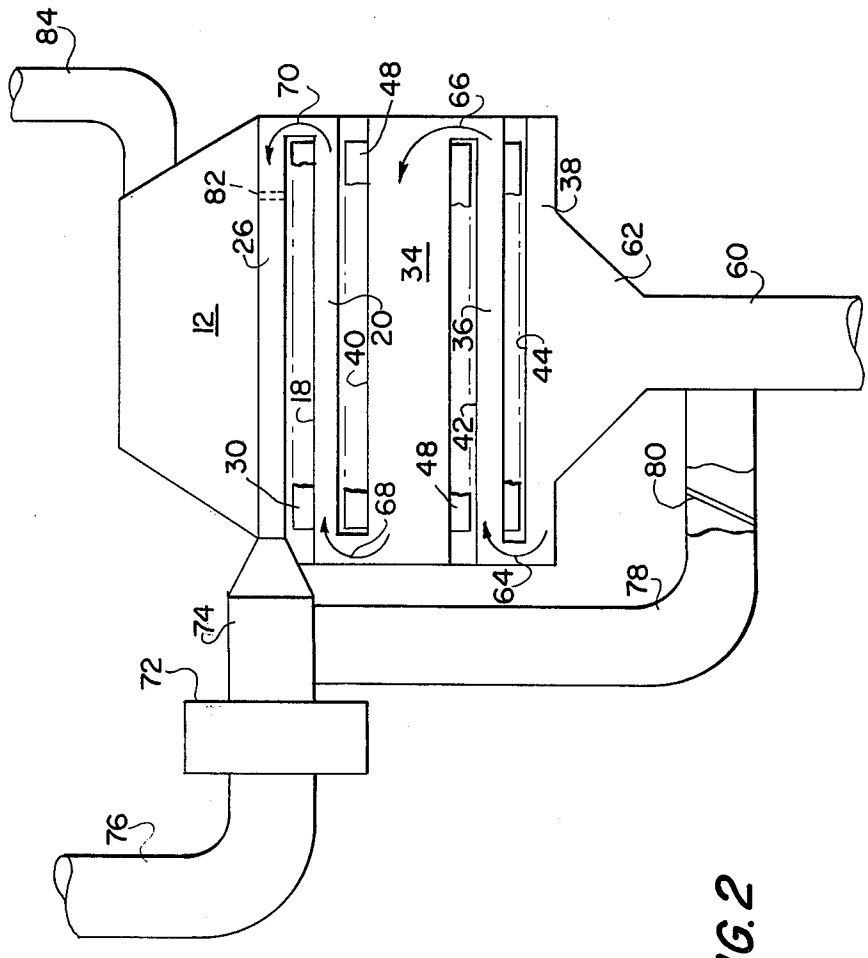

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FIG. 2

MULTIPLE DECK DRYING APPARATUS

The present invention relates to material treating apparatus and more particularly to a multiple pass drying apparatus wherein the material to be dried moves in series from one pass to another. Each pass comprises a deck which is the top of an enclosed heat exchange chamber, and conveying means for transporting the material along the upper surface of the deck in indirect heat exchange with a heat exchange fluid in the enclosed chamber. The apparatus is preferably maintained under vacuum so that when the material is being dried, the drying may be carried out at lower temperatures.

While the apparatus of the invention has many applications, for example, in food processing, desalination of water to obtain pure wate, and/or salt or bittern of any gravity for further treatment to produce magnesium chloride etc., and for drying of various particulate materials; the apparatus finds particular utility in the drying of wet coal. For illustration purposes, coal will in general be referred to as the material being dried throughout this description although it will be understood that this is merely for purpose of illustration.

As is well known, it is frequently necessary to dry wet coal. Heretofore, prior art apparatus for this purpose have usually employed direct contact of the wet coal with a heating medium such as furnace gases or heated air. While this provides for intimate heat exchange, it is subject to the drawback that coal dust may be taken up by the heating gas and discharged to the atmosphere, even in installations in which dust collectors are employed. The dust laden steam and air emission may travel for miles and is a serious source of pollution.

When employing the apparatus of the subject invention, the coal or other material to be dried is not in direct contact with the gaseous heating medium. Therefore, atmospheric pollution is eliminated as is the need for dust collectors and the like. In addition, there is no contamination of the material being dried by the heat exchange fluid, which is essential in many applications. Since the drying is carried out under vacuum, the rate of moisture evaporation is far greater than at atmospheric pressure and in addition the chance of fire or scorching of the material being dried is minimized. In accordance with the invention, drying of coal takes place at temperatures considerably below the customarily 1000°F. of prior art processes.

It will of course be appreciated that the apparatus is equally useful in cooling a material rather than heating the material.

Another object of the present invention is to provide an improved procedure for drying wet coal which substantially eliminates atmospheric pollution by coal dust and which substantially prevents fires and explosions while drying the coal.

Still another object of the invention is to provide a novel system for conveying wet material through a multiple deck treatment apparatus.

The above and other objects, features, and advantages of the invention will in part be obvious and will in part be pointed out as this description proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view of a presently preferred embodiment of the invention taken primarily in longitudinal, vertical cross-section.

FIG. **2** is a transverse vertical cross-section view of the apparatus of FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a presently preferred materal treating apparatus of the invention is shown which includes an air tight casing **10** having a pitched roof **12.** Wet coal or other material to be treated enters an upper end of the casing **10** through an inlet duct **14** in which there is a star valve or other suitable metering device **16.** The coal falls onto the right hand end of an upper metal deck **18** which constitutes the top of an enclosed heat exchange chamber **20.** A partitioning device **24** may be utilized to split the incoming stream of coal and distribute it more evenly onto deck **18.** There is an upper enclosed heat exchange chamber **26** which is spaced above the heat exchange chamber **20** and the coal on deck **18.**

The coal is transported along deck **18** in a right to left direction by the upper pass of a first endless conveyor which comprises two endless chains **28** disposed adjacent the opposite longitudinal walls of casing **10.** A plurality of metal scrapper blades **30** are attached to each of chains **28.** The chains **28** are trained around two sprockets **32** at each end.

Beneath heat exchange chamber **20** there are three additional heat exchange chambers **34, 36,** and **38** each having decks **40, 42,** and **44** respectively. Each of the chambers and the four decks extend across substantially the full width of the casing **10.** The lower pass of the first conveyor is between the heat exchange chambers **36** and **38** so that the scrapper blades **30** are in contact with the lowest deck **44** on the lower pass of the conveyor where the blades are moving from left to right.

A second smaller conveyor comprised of a pair of endless chains **46** and scrapper blades **48** is trained about a pair of small sprockets **50** at each end of the conveyor. As best seen in FIG. **1,** the smaller conveyor is driven in the opposite direction to the larger conveyor and the upper pass of the small conveyor moves from left to right along the surface of deck **40.** The lower pass of this conveyor moves from right to left across the surface of deck **42.**

The path of the coal or other material being treated is thus from right to left along upper deck **18** to the end of this deck where it falls down the foreshortened inclined end **52** of chamber **20** onto the left end of deck **40.** The upper pass of the smaller conveyor then transports the coal from left to right to the opposite end of the apparatus where the coal now falls down past end **54** of heat exchange chamber **34** onto deck **42.** The lower pass of the small conveyor then transports the coal along deck **42** to the left until the coal falls past the end **56** of heat exchange chamber **36** onto the bottom deck **44.** The lower pass of the first conveyor now pushes the nearly dried coal along deck **44** to the right hand end of the apparatus where the dried coal falls out through a discharge duct **58** to storage or if desired to another material treating unit identical to that described above for further drying, if necessary.

It will of course be understood that conventional drive means for the two conveyors are provided. Such means are not illustrated since these details are not important to the present invention and would unnecessarily complicate the drawings. Preferably the two conveyors are driven at the same linear speed which can readily be accomplished by appropriately selecting the

sizes of the sprockets, the number of teeth, and the rpms of the sprockets.

Preferably, one conveyor is driven by a motor at one end and the other conveyor is driven by a motor at the other end in order to simplify the drive arrangement.

Referring to FIG. **2**, furnace gas or other suitable heat exchange medium in a duct **60** enters the apparatus through inlet **62** into the lower heat exchange chamber **38.** At one side of the apparatus, there is a connecting duct **64** so that after the heat exchange medium has flown through the lower chamber **38** and cooled somewhat it enters the next higher heat exchange chamber, chamber **36.** From chamber **36,** the heat exchange medium goes through connecting duct **66** into heat exchange chamber **34.** After transversing this chamber, the heat exchange medium flows through connecting duct **68** into heat exchange chamber **20** and then through connecting duct **70** into the upper heat exchange chamber **26.** An exhaust fan **72** or the like draws the cooled heat exchange medium from upper chamber **26** out through discharge **74** into exhaust line **76.** The heat exchange medium thus flows through the apparatus in the illustrated embodiment countercurrent to the flow of the coal or other material to be treated.

As shown in FIG. **2**, there is a by-pass conduit **78** so that incoming furnace gas in line **60** may be by-passed by opening valve **80** directly to the discharge duct **74.**

Vapors, for example, water vapors, emanating from the coal is drawn off into one of a plurality of vertically extending vapor exhaust conduits **82** at one or both sides of the casing **10.** The upper ends of exhaust conduits **82** open into the portion of the casing **10** above the upper heat exchange chamber **26** and below the roof **12.** From this region, the vapors are withdrawn through a vapor discharge conduit **84** by suitable vacuum means (not shown). For example, the vacuum in this region may be in the order of **20** inches of mercury. From the foregoing description, it is apparent that at no time is there direct contact between the coal and the heat exchange medium, and there is minimal movement of the coal and consequently minimal agitation of coal dust.

Although a presently preferred embodiment of the invention has been shown and described with particularity, it will be appreciated that many changes and modifications may readily suggest themselves to those of ordinary skill in the art upon being apprised of the present invention. It is intended to cover all such changes and modifications as fall within the scope and spirit of the appended claims.

I claim:

1. Apparatus for subjecting a material to indirect heat exchange comprising an enclosed casing, means defining a plurality of closed chambers containing a heat exchange medium disposed in said casing and spaced in a vertical direction from each other, each of said chambers being defined in part by an upper impervious deck along which the material being treated moves, said decks preventing direct contact between the material thereon and the heat exchange medium in said chambers, endless conveyor means having an upper pass disposed adjacent to a deck of one of said chambers and having a lower pass disposed between and adjacent the upper deck of another of said chambers and a lower impervious bottom of the superadjacent chamber, said endless conveyor means including a plurality of transversely extending blades spaced therealong, said blades being positioned to move the material along said decks, means for introducing a material to be treated onto one end of the uppermost deck, means to transfer material from a deck onto the next lower deck, means to discharge treated material from the lower deck, and means for maintaining a vacuum in said casing to exhaust vapor emanating from said material.

2. Apparatus according to claim **1,** further comprising connecting means interconnecting said chambers to enable heat exchange medium to flow from one chamber to another in sequence.

3. Apparatus according to claim **2,** wherein said chambers and said decks extend substantially the full width of said casing.

4. Apparatus according to claim **1,** wherein there are at least four decks, and wherein said endless conveyor means comprise a pair of endless conveyors each having two passes associated with different decks.

5. Apparatus according to claim **4,** wherein said two conveyors comprise a large conveyor and a smaller conveyor, said large conveyor having its upper pass over the uppermost deck and having its lower pass over the lowermost deck, said smaller conveyor having its upper pass over the deck beneath the uppermost deck and its lower pass over the next deck below, said smaller conveyor being disposed between the upper and lower passes of said large conveyor, and means to drive said conveyors in opposite directions.

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