April 3, 1962 G. W. WALLACE 3,027,652

METHODS AND MEANS FOR SIMULTANEOUSLY CLEANING AND DRYING FINELY DIVIDED MINERAL MATTER SUCH AS COAL AND THE LIKE

Filed Jan. 20, 1958 5 Sheets-Sheet 1

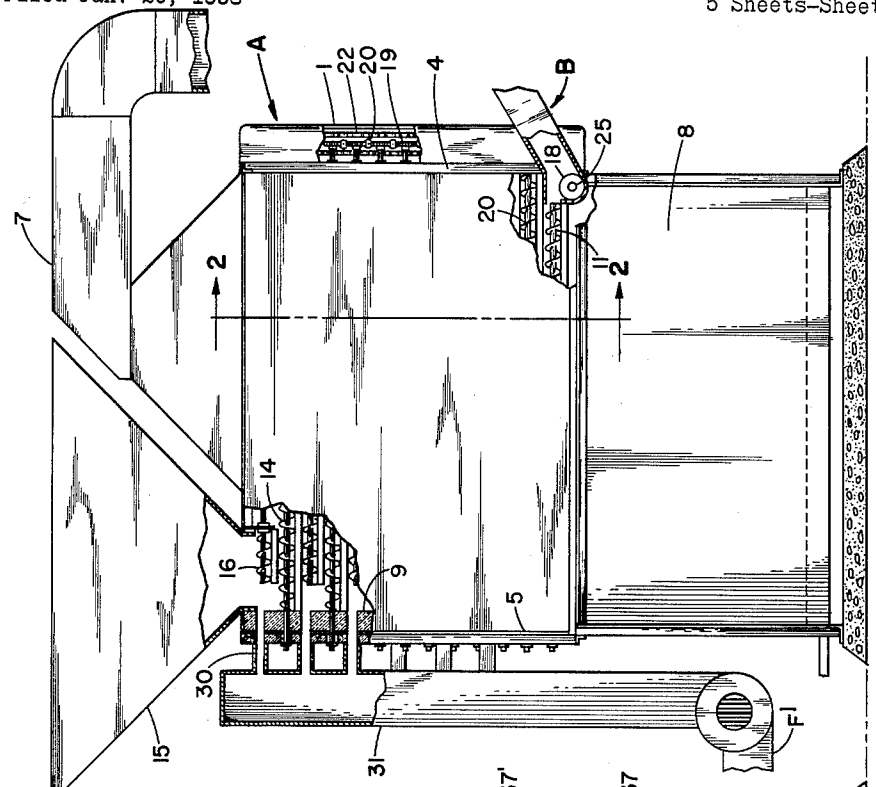


FIG. 1

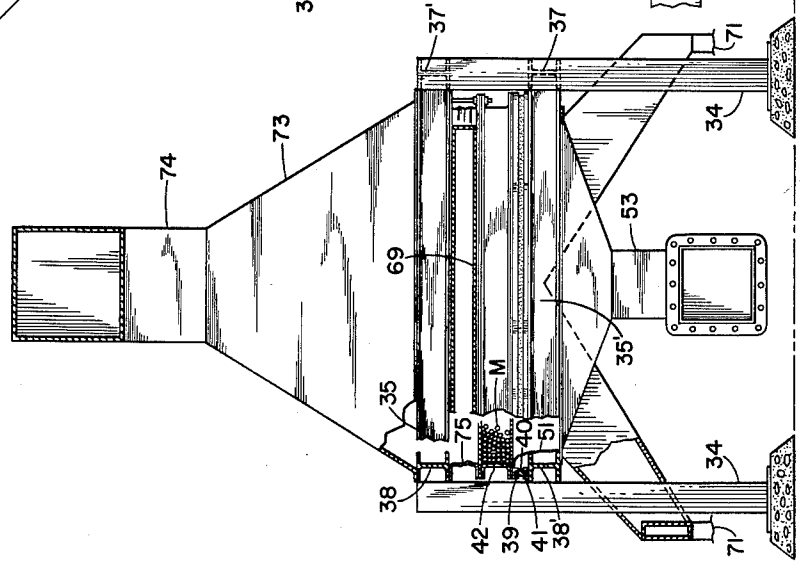


FIG. 7

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5 Sheets-Sheet 2

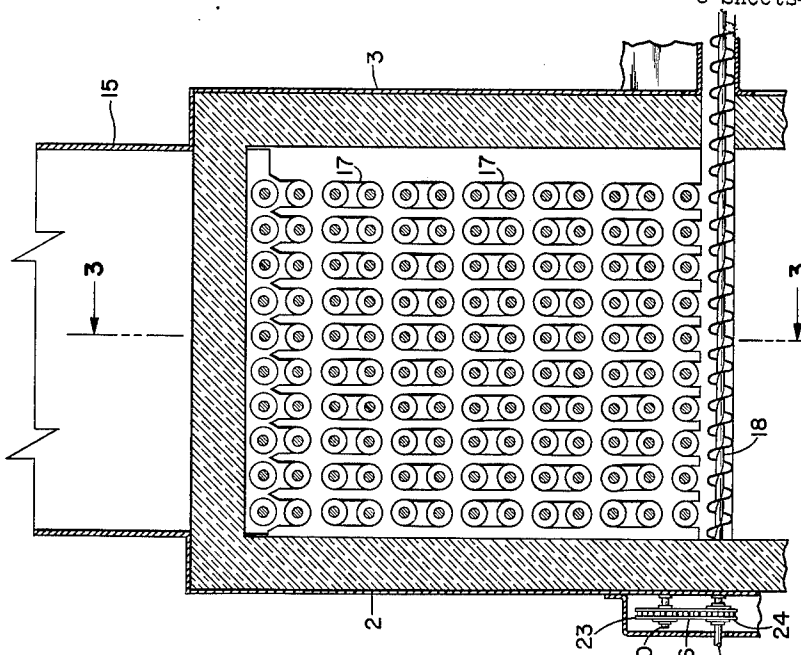


FIG. 2

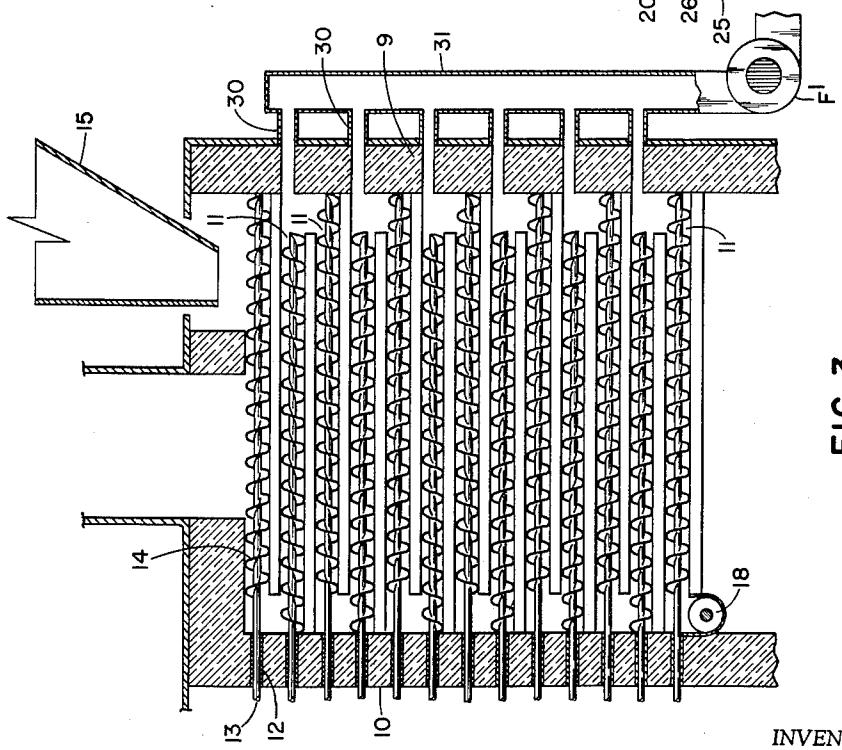


FIG. 3

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METHODS AND MEANS FOR SIMULTANEOUSLY CLEANING AND DRYING FINELY DIVIDED MINERAL MATTER SUCH AS COAL AND THE LIKE

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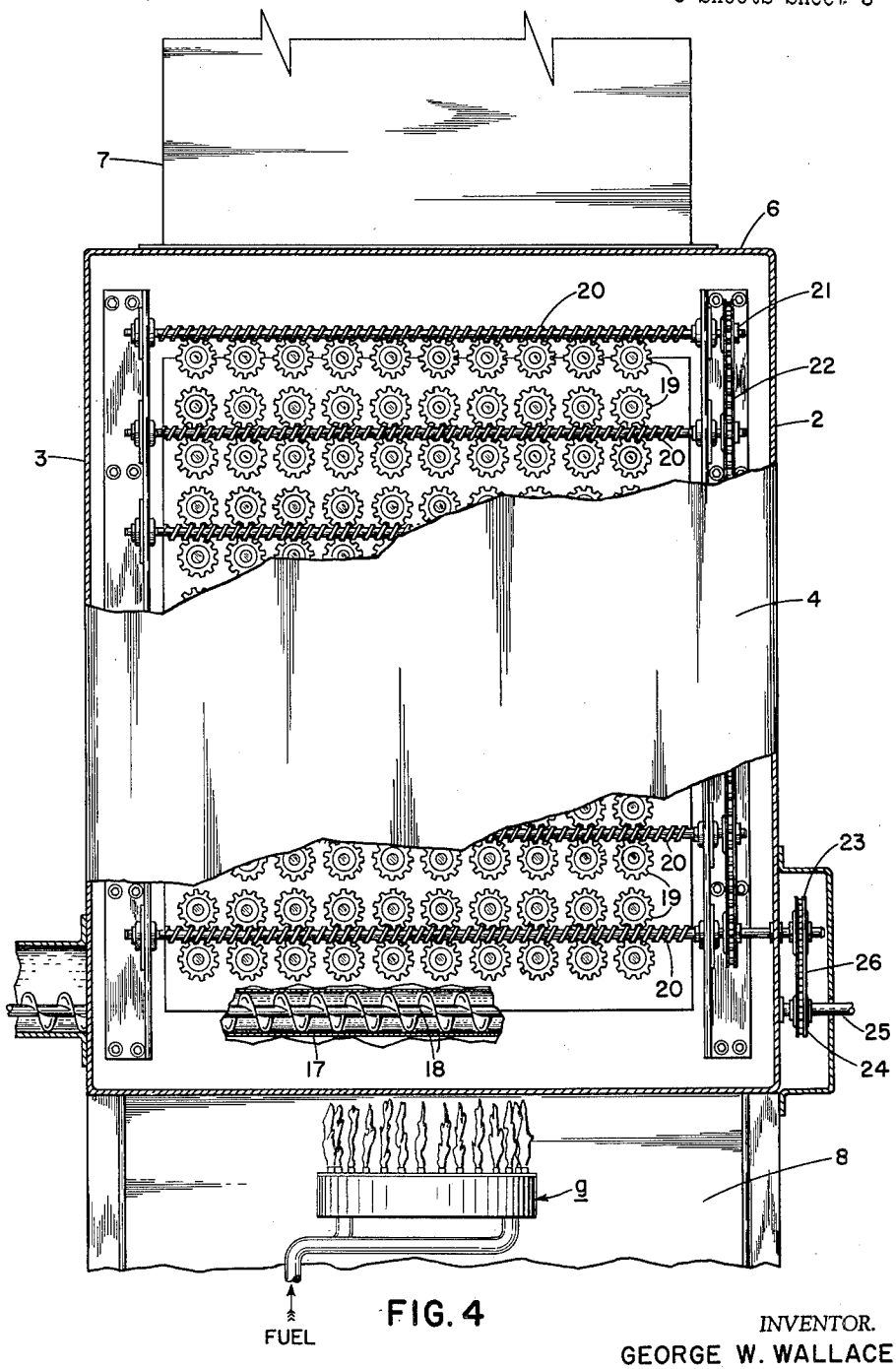


FIG. 4

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METHODS AND MEANS FOR SIMULTANEOUSLY CLEANING AND DRYING FINELY DIVIDED MINERAL MATTER SUCH AS COAL AND THE LIKE

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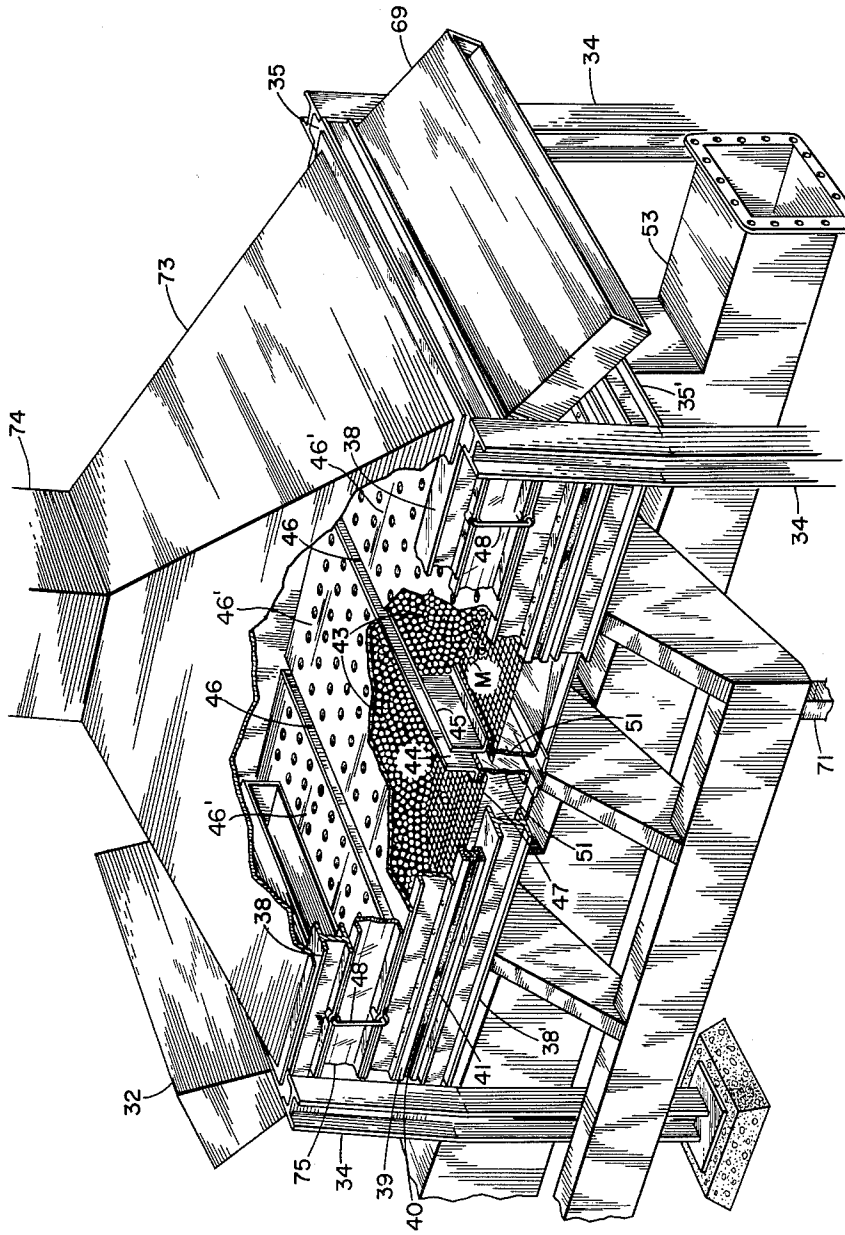


FIG. 5

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METHODS AND MEANS FOR SIMULTANEOUSLY CLEANING AND DRYING FINELY DIVIDED MINERAL MATTER SUCH AS COAL AND THE LIKE

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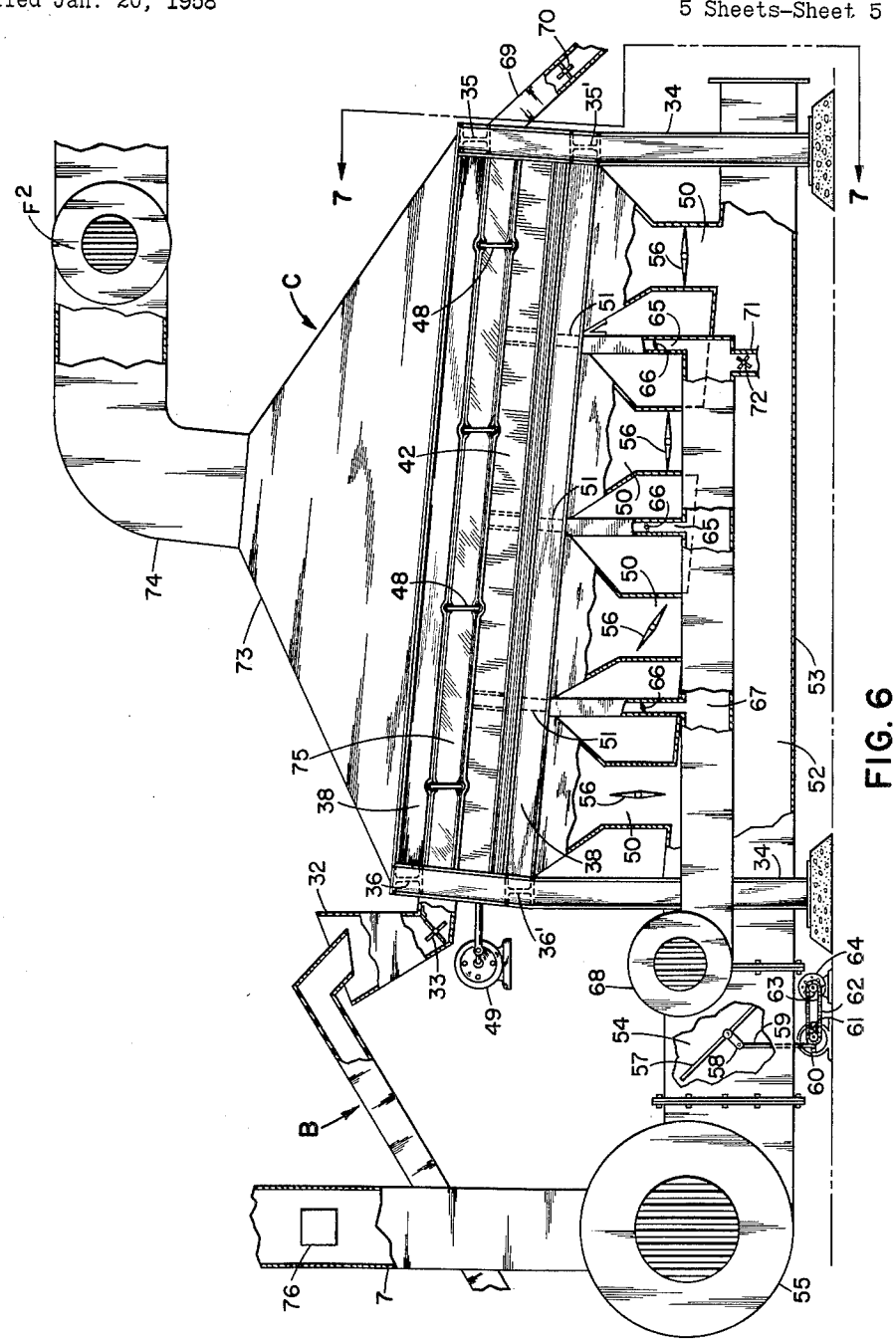


FIG. 6

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3,027,652

METHODS AND MEANS FOR SIMULTANEOUSLY CLEANING AND DRYING FINELY DIVIDED MINERAL MATTER SUCH AS COAL AND THE LIKE

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Filed Jan. 20, 1958, Ser. No. 709,928

8 Claims. (Cl. 34—17)

This invention relates to certain new and useful improvements in drying and cleaning wet coal, and more particularly, to means and methods for drying and recovering finely divided coal which cannot be cleaned on a conventional air cleaning table.

Fine coal containing 10% water does not readily respond to air cleaning by conventional methods. In fact, with even less water content, it is very difficult to remove any appreciable quantity of the ash-forming constituents of fine coal. Consequently, the coal slurry as it comes from a coal washer or exists in ponds and from slurry dumps used for storage has, thus far, had little or no recoverable commercial value, notwithstanding the fact that many industrial installations use powdered coal as a fuel. Countless thousands of tons of very fine coal, therefore, are, of necessity, wasted, because such material has a very high ash content and has much too high a water content to be recovered by conventional methods.

It is, therefore, the primary object of the present invention to provide methods and means for drying and cleaning fine coal as it comes from coal washers and the like in the form of a slurry or fluid mass having high water content.

It is another object of the present invention to provide methods and means for recovering economically valuable fuel from coal-fines in wash effluent, slurry ponds and waste dumps in which such slurries have been deposited.

It is a further object of the present invention to provide methods and means of the type stated which is relatively simple in construction and operation, being thus capable of installation and use at relatively low cost.

With the above and other objects in view, my invention resides in the novel features of form, construction, arrangement, and combination of parts presently described and pointed out in the claims.

In the accompanying drawings (five sheets)—

FIGURE 1 is a side elevational view, partly broken away and in section, of the primary heater and dryer forming a part of the present invention;

FIGURE 2 is a vertical sectional view of the primary heater and dryer taken along line 2—2 of FIGURE 1;

FIGURE 3 is a transverse sectional view of the primary heater and dryer taken along line 3—3 of FIGURE 2;

FIGURE 4 is an end elevational view, partly broken away and in section, of the primary heater and dryer;

FIGURE 5 is a perspective view, partly broken away and in section, of the secondary dryer and cleaner;

FIGURE 6 is a longitudinal sectional view of the secondary dryer and cleaner forming a part of the present invention; and

FIGURE 7 is a transverse sectional view of the secondary dryer and cleaner taken along line 7—7 of FIGURE 6.

Broadly speaking, the present invention resides in the system of initially subjecting the coal-slurry to indirect drying by conveying it through chambers or conduits in a primary dryer and heater which generates heat by burning any conventional fuel, such as gas, oil, or coal. The heat thus generated is directed against the walls of the chambers or conduits through which the slurry is being continuously moved with constant agitation while being subjected to some degree of negative pressure created by an exhaust fan which is connected to such

chambers or conduits and discharges the steam-laden exhaust air to atmosphere through a conventional cyclone or similar device. The partially dried coal, which is reduced in the primary dryer and heater to the consistency of a wet pulverulent mass more in the nature of a heavy paste rather than a fluid slurry, is then subjected to direct drying by transferring it to a secondary dryer and cleaner in which it is passed over an inclined vibratory screen in the form of a thin bed. The hot gases of combustion generated in the primary heater and dryer are blown directly through this bed from the underside while being caused to pulsate so that the bed of coal will actually be floated forwardly along the inclined screen toward the lower or discharge end thereof with a vibratory movement which will cause the siliceous particles and ash-forming constituents to migrate downwardly to the bottom surface of the bed. Interspersed along the inclined screen at suitable intervals are transverse gaps or so-called "draws" which are independently supplied with pulsating air which is blown upwardly through the draws at substantially the same pressure as the hot gases of combustion, whereby the siliceous particles and ash-forming constituents, which have reached the bottom surface of the bed, being relatively heavy, will drop downwardly and be removed. Actually, the upward pressure of the hot gases of combustion is just barely sufficient to lift the coal against the force of gravity and for fine coal a pressure of 1½ to 1¾ inches (water manometer) is adequate. For coal which is comparatively coarse-grained, pressures up to 5 or 6 inches may be used.

Since the vibratory movement of the bed causes continual downward migration of the siliceous particles and ash-forming constituents, a number of such draws may be employed with the result that the coal passing outwardly over the lower or discharge end of the screen will be in the form of a fully dry powdered fuel having an ash content below 8½%, and, thus, will be a highly salable commercial product.

Referring now in more detail and by reference characters to the drawings, which illustrate a preferred embodiment of the present invention, A designates the primary heater and dryer comprising a preferably rectilinear chamber 1 formed of four upright walls 2, 3, 4, 5, and a top wall 6 provided with a flue-pipe 7. At its lower end, the chamber 1 is provided with a conventional combustion chamber 8 equipped with any suitable type of conventional burner *g*. Mounted vertically within the chamber 1 are spaced parallel tube sheets 9, 10, for supporting a plurality of vertically spaced banks of horizontal tubes 11 which are mounted at their ends therein. As will be seen by reference to FIGURE 2, the tubes 11 in each horizontal bank are vertically aligned with a corresponding tube 11 in the banks above and below so that the tubes 11 are arranged, so to speak, in vertical banks as well as horizontal banks.

At one end (i.e. the left end as viewed in FIG. 3), each tube 11 is provided with a rotary seal 12 for operatively accommodating a shaft 13 which extends therethrough and forms part of a conveyor-screw 14, which, in turn, extends axially from end-to-end through each tube 11. The tubes 11 in the uppermost horizontal bank open upwardly into the bottom of a feed hopper 15 which receives the incoming coal-slurry and is provided with a series of short conveyor-screws 16 which move the incoming coal-slurry into the uppermost tubes 11. The tubes 11 in each vertical bank are, furthermore, vertically connected at alternate ends, as shown in FIGURES 2 and 3, by elliptical headers 17, so that the coal-slurry which is fed into the uppermost tube 11 will flow progressively downwardly from one tube 11 to the next tube 11 directly below until it reaches the lower-

most tube 11, from which it will be discharged into a large transverse screw-conveyor 18, which accepts the partially dried coal-slurry from all the tubes 11 in the lowermost horizontal bank and moves it out of the primary dryer and heater A to a transfer conveyor B.

All of the conveyor-screws 14, 16, are drivingly interconnected by worm-gears 19 and worm-shafts 20, which are, in turn, provided at their ends with sprockets 21 and a drive chain 22 is operatively trained over the sprockets 21. The lower worm-shaft 20 is provided on its end with a sprocket 23 which is operatively connected to a sprocket 24 on a main-shaft 25 by a roller chain 26, and the shaft 25 may be driven by a suitable prime mover (not shown).

It will, of course, be understood that this worm-gear driving system, as shown in FIGURE 4, must be of extremely heavy and rugged construction as is common in coal-processing equipment, since the loads are very great and the driving forces which must be transmitted are correspondingly large. It will also be noted, by reference to FIGURE 4, that, by interposing the worm-shafts 20 between upper and lower sets of worm-gears 19, the screw-conveyors 14 in adjacent horizontal banks will be caused to rotate in opposite directions as is necessary to convey the coal-slurry successively from one horizontal bank of tubes 11 to the next horizontal bank of tubes 11 directly below.

The headers 17 at the right hand side of the tube 11 (reference being made to FIGURE 3) open into horizontal off-take tubes 30, which, in turn, communicate with a suction-header 31 connected to the intake side of an exhaust fan F^1, which, in turn, discharges to atmosphere through a conventional cyclone (not shown). Consequently, all water vapor or steam removed from the coal-slurry by the indirect drying process within the primary dryer and heater will be discharged from the system and the moderate degree of suction or negative pressure imposed by the exhaust fan (i.e. pressure less than normal atmospheric pressure) will accelerate evaporation in the tubes 11. Finally, it must be pointed out in this connection that the continuous agitation or turning over of the coal-slurry as it passes through the tubes 11 results in a high rate of heat transfer through the walls of the tubes 11 to the coal-slurry, so that a very material amount of drying takes place in a most efficient manner.

The transfer conveyor B may be of any suitable or conventional type and extends angularly upwardly from the discharge end of the screw-conveyor 18 and discharges into an intake hopper 32 of a secondary dryer and cleaner C which is similar in construction to, but an improvement upon, the coal-cleaner described in United States Letters Patent No. 2,512,422 issued June 20, 1950, to applicant and others as co-inventors. The hopper 32 is provided, at its lower end, with a star-wheel feeder 33 which may be constructed in any one of several well known forms for supplying a continuous stream of partially dried coal-slurry to the intake end of the secondary dryer and cleaner C, as shown in FIGURE 6.

The secondary dryer and cleaner C comprises a supporting framework including vertical legs 34 which are rigidly connected by pairs of transverse rails 35, 35', 36, 36', and pairs of longitudinal rails 37, 37', 38, 38', all fabricated of heavy structural steel members, such as I-beams. The upper faces or flanges of the rails 35, 36, 37, 38, project inwardly and are provided with an upwardly opening continuous U-shaped channel 39 which retentively receives the lower portion of a large rectangular collar 40 formed of dense high-temperature sponge rubber or similar resilient synthetic elastomer. The collar 40 projects a substantial distance upwardly above the channel 39 and along its upper peripheral margin rests in a downwardly opening U-shaped channel 41 which extends continuously around the periphery of a rectangular frame 42 sized to fit loosely within the area bounded by the rails 35, 36, 37, 38. The frame 42 is of substantial depth in the vertical direction and is transversely subdivided into a series of longitudinally spaced compartments 43 by pairs of vertically disposed cross plates 44, 45, which are spaced from each other by narrow gaps 46 and are flush along their upper and lower margins, respectively, with the upper and lower margins of the frame 42. Each of the compartments 43 is covered across its top with a perforated screen 46' formed of a sheet metal plate provided with equi-spaced apertures preferably having a diametral size ranging from .020 inch to .050 inch and being so spaced that from 20% to 40% of the screen area is open-area. These dimensions and areas, of course, are not critical and can be varied depending upon the grain size of the coal being processed. The screens 46 are tightly secured around their entire peripheries to the frame 42 and the respective cross-plates 44, 45, so as to cover the compartments 43 completely and support a bed of partially dry coal introduced from the hopper 32 by the star-wheel feeder 33.

Similarly, each of the compartments 43 is covered across its bottom with a rectangular underdeck formed of coarse mesh woven wire cloth 47 (i.e. 3/3" to 1/2" openings) tightly secured around its entire periphery to the frame 42 and respective cross-plates 44 or 45 as the case may be. The enclosed space within each compartment 43 is filled with china marbles *m* or some other similar type of packing, such as Raschig rings, broken tile, or the like.

The frame 42 is additionally suspended by a plurality of swing-links 48 which are rockably connected at their upper ends to the longitudinal rails 37', 38'. Thus, through the cushioning effect of the rubber collar 40 and the swing links 48, the frame 42 is free to vibrate in the manner of a vibratory screen and is accordingly connected to a motor driven vibrator 49 which may be of any conventional design.

Rigidly suspended from the lower rails 37, 38 beneath each compartment 43 are funnel-shaped pressure chambers 50 which are flexibly connected around the peripheries of the underdecks 47 by means of shaker-sleeves 51 formed of either heavy canvas or asbestos cloth. In this connection, it will be noted that these sleeves lie well inside the rubber collar 40 and serve to protect the latter from the maximum temperature of the hot gases of combustion, although as will presently be noted these temperatures are not particularly high and do not exceed the tolerable limits for many forms of natural or synthetic rubber and many available resilient synthetic elastomers. The pressure chambers 50 open downwardly into a plenum chamber 52 connected by a duct 53 to a pulsator chamber 54, which is, in turn, connected through a large blower 55 to the flue pipe 7, so that the hot gases of combustion will be fed to the plenum chamber 52 and forced under pulsating pressure through the bed of coal on the screens 46. Individual adjustment of the pressure supplied to each of the successive regions of screens 46 may also be obtained by manipulation of conventional dampers 56.

Rockably mounted within the pulsator chamber 54 is a pulsator flap 57 which periodically throttles the flow of pressured gases into pressure chambers 50 and, hence, causes a pulsation in the stream of such gases flowing through the bed of coal in the screens 46. Preferably the flap 57 is adjustable as to percentage of open to closed condition per cycle.

The pulsating flap 57 is rocked to and fro by a rock-arm 58, link 59, adjustable eccentric 60, sprocket 61, chain 62, motor sprocket 63, and motor 64. The adjustable eccentric 60 may be of any conventional design, being merely employed to permit adjustment of the stroke of the link 59 and, thereby, change the periodicity of the flap 57.

Also rigidly supported from the longitudinal rails 37, 38, between each of the adjacent chambers 50 and be-

neath the slot-like gaps 46 are narrow vertical chambers or draws 65 which extend transversely all the way across the frame 42. Each of the draws 65 is provided with its own pulsating flap 66 constructed similarly to the previously described pulsating flap 57. At the lower end, each draw 65 opens into an air duct 67 which is supplied by a motor-driven blower 68 drawing air in from the ambient atmosphere. The pressure established by the blower 68 is substantially the same as that established by the blower 55. Since the siliceous material and ash-forming constituents which migrate to the under surface of the vibrating coal-bed have a specific gravity well in excess of 160 whereas burnable coal is much lighter, such materials will drop down through the draws 65. The coal-bed, on the other hand, is relatively light and will "float," so to speak, on the upwardly flowing gases and air. Thus, the coal will pass uninterruptedly across the gaps 46 and ultimately drop down into a discharge chute 69 from which it is discharged by a star-wheel feeder 70, the latter serving to retain pressure within the secondary dryer and cleaner C. The siliceous material and ash-forming constituents, meanwhile, drop slowly down into the duct 67 and will work forward, under the force of the air-flow therein, to the discharge chute 71 from which said siliceous material and ash-forming constituents are also discharged by a star-wheel feeder 72.

Suitably mounted over and forming the top wall of the secondary dryer and cleaner C is a hood 73, the walls of which converge upwardly into a duct 74 connected to an exhaust fan F^2, which, in turn, discharges to atmosphere through a conventional cyclone (not shown). The lower peripheral margins of the hood 73 are connected to the frame 42 by a shaker-sleeve 75 formed of heavy canvas or asbestos cloth to prevent air leakage between the frame 42 and the hood 73.

The hot gases of combustion coming from the primary dryer and heater A are somewhat cooled by heat losses in traveling through the flue-pipe 7 to the blower 55 and, to whatever extent necessary, may be adjusted by bleeding in cold air from the outside through a conventional damper 76, so that the temperature of these hot gases of combustion will be substantially above 212° F., but below 450° F., the latter temperature being the kindling point of coal. The same considerations enter into the temperature generated in the primary dryer and heater. The temperature therein must be controlled by any suitable means to avoid burning, charring, or coking the coal in the slurry. This, however, is not a serious problem, since the slurry is extremely wet and will not exceed 212° F. so long as any significant amount of water is present.

Furthermore, the conveyor-screws 14 are rotated rather rapidly (i.e. 150 to 200 r.p.m.). Hence the coal slurry will be turned over several thousand times during passage through the primary heater and dryer A.

Although the present invention has been described in connection with the drying of fine coal, it has been found equally well suited to drying other slurries, such as fluorspar and other metal ores.

It should be understood that changes and modifications in the form, construction, arrangement, and combination of the several parts of the methods and means for simultaneously cleaning and drying finely divided mineral matter such as coal and the like may be made and substituted for those herein shown and described without departing from the nature and principle of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Apparatus for simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said apparatus comprising a primary heater and dryer having a chamber provided with combustion means for generating heat therein, a flue opening into said chamber in spaced relation to the combustion means for removing the hot gases of combustion, a plurality of tubes extending across said chamber between said combustion means and the flue, said tubes being endwise interconnected to form a circuitous path which opens at one end externally of the chamber to receive an input of wet mineral matter and being open at its other end externally of the chamber to discharge the mineral matter after it has passed through the tubes, the interior of the tubes and the circuitous path formed thereby being isolated from the chamber so that the mineral matter is heated indirectly through the walls of the tubes, conveyer means operatively mounted in the tubes for forcing the mineral matter through the tubes from the intake end to the discharge end, a blower operatively connected on its suction side to the interior of the tube for drawing normal atmospheric air into the interior of the tube through the intake opening and drawing such air through the tubes in concurrent flow with the mineral matter so as to partially dry same, a secondary dryer operatively associated with the primary dryer, conveyer means operatively interposed between the discharge end of the tubes and the secondary dryer for transferring the partially dried mineral matter to the secondary dryer, said secondary dryer including a foraminous member, means for spreading said partially dried mineral matter in the form of a thin bed on said foraminous member, means for conducting the hot gases of combustion from said primary dryer to said foraminous member for simultaneously heating and agitating said member, and vibratory actuating means for separating the impurities from the mineral matter.

2. Apparatus for simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said apparatus comprising a primary heater and dryer having a chamber provided with combustion means for generating heat therein, a flue opening into said chamber in spaced relation to the combustion means for removing the hot gases of combustion, a plurality of tubes extending across said chamber between said combustion means and the flue, said tubes being endwise interconnected to form a circuitous path which opens at one end externally of the chamber to receive an input of wet mineral matter and being open at its other end externally of the chamber to discharge the mineral matter after it has passed through the tubes, the interior of the tubes and the circuitous path formed thereby being isolated from the chamber so that the mineral matter is heated indirectly through the walls of the tubes, conveyer means operatively mounted in the tubes for forcing the mineral matter through the tubes from the intake end to the discharge end, a blower operatively connected on its suction side to the interior of the tube for drawing normal atmospheric air into the interior of the tube through the intake opening and drawing such air through the tubes in concurrent flow with the mineral matter so as to partially dry same, a secondary dryer operatively associated with the primary dryer, conveyer means operatively interposed between the discharge end of the tubes and the secondary dryer for transferring the partially dried mineral matter to the secondary dryer, said secondary dryer including a foraminous member, means for spreading said partially dried mineral matter in the form of a thin bed on said foraminous member, vibratory actuating means operatively connected to said foraminous member for vibrating said foraminous member, a duct connected at one end to the flue and at the other end to the secondary dryer beneath the foraminous member, whereby to conduct the hot gases of combustion from the primary dryer to the underside of said foraminous member so that the hot gases of combustion will pass through the foraminous member and through said bed for heating said bed as the foraminous member vibrates so as to further dry the mineral matter and at the same time cause the lighter constituents in the bed to work to the top and the heavier constituents to work to the bottom, and a plurality of spaced transversely extending openings in the foraminous member for separating the denser constituents from the mineral matter.

3. Apparatus for simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said apparatus comprising a primary heater and dryer having a chamber provided with combustion means for generating heat therein, a flue opening into said chamber in spaced relation to the combustion means for removing the hot gases of combustion, a plurality of tubes extending across said chamber between said combustion means and the flue, said tubes being endwise interconnected to form a circuitous path which opens at one end externally of the chamber to receive an input of wet mineral matter and being open at its other end externally of the chamber to discharge the mineral matter after it has passed through the tubes, the interior of the tubes and the circuitous path formed thereby being isolated from the chamber so that the mineral matter is heated indirectly through the walls of the tubes, conveyer means operatively mounted in the tubes for forcing the mineral matter through the tubes from the intake end to the discharge end, a blower operatively connected on its suction side to the interior of the tube for drawing normal atmospheric air into the interior of the tube through the intake opening and drawing such air through the tubes in concurrent flow with the mineral matter so as to partially dry same, a secondary dryer operatively associated with the primary dryer, conveyer means operatively interposed between the discharge end of the tubes and the secondary dryer for transferring the partially dried mineral matter to the secondary dryer, said secondary dryer including an inclined foraminous member, means for spreading said partially dried mineral matter in the form of a thin bed on the inclined foraminous member, a vibratory actuator operatively connected to said foraminous member for vibrating said foraminous member, a duct connected at one end to the flue and at the other end to the secondary dryer beneath the foraminous member, whereby to conduct the hot gases of combustion from the primary dryer to the underside of said foraminous member so that the hot gases of combustion will pass through the foraminous member and through said bed for heating said bed as the foraminous member vibrates, said foraminous member being provided at spaced intervals along its length with narrow elongated openings extending transversely thereacross, each of said openings being provided with a duct communicating therewith and extending downwardly therefrom, and means operatively associated with said ducts for drawing air from outside the secondary dryer and forcing said air upwardly through the ducts and the elongated openings under sufficient pressure to support the upper portion of the bed while allowing the denser materials on the under face of the bed to drop downwardly through the openings.

4. Apparatus for simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said apparatus comprising a primary heater and dryer having a chamber provided with combustion means for generating heat therein, a flue opening into said chamber in spaced relation to the combustion means for removing the hot gases of combustion, a plurality of tubes extending across said chamber between said combustion means and the flue, said tubes being endwise interconnected to form a circuitous path which opens at one end externally of the chamber to receive an input of wet mineral matter and being open at its other end externally of the chamber to discharge the mineral matter after it has passed through the tubes, the interior of the tubes and the circuitous path formed thereby being isolated from the chamber so that the mineral matter is heated indirectly through the walls of the tubes, conveyer means operatively mounted in the tubes for forcing the mineral matter through the tubes from the intake end to the discharge end, a blower operatively connected on its suction side to the interior of the tube for drawing normal atmospheric air into the interior of the tube through the intake opening and drawing such air through the tubes in concurrent flow with the mineral matter so as to partially dry same, a secondary dryer operatively associated with the primary dryer, conveyer means operatively interposed between the discharge end of the tubes and the secondary dryer for transferring the partially dried mineral matter to the secondary dryer, said secondary dryer including an inclined foraminous member, means for spreading said partially dried mineral matter in the form of a thin bed on said foraminous member, a vibratory actuator for vibrating said foraminous member whereby to cause said bed to advance progressively therealong, a duct connected at one end to the flue and at the other end to the secondary dryer beneath the foraminous member, whereby to conduct the hot gases of combustion from the primary dryer to the underside of said foraminous member so that the hot gases of combustion will pass through the foraminous member and through said bed for heating said bed as the foraminous member vibrates, said foraminous member being provided at spaced intervals along its length with narrow elongated openings extending transversely thereacross, each of said openings being provided with a duct communicating therewith and extending downwardly therefrom, and means operatively associated with said ducts for drawing air from outside the secondary dryer and forcing said air upwardly through the ducts and the elongated openings under sufficient pressure to support the upper portion of the bed while allowing the denser materials on the under face of the bed to drop downwardly through the openings.

5. A method of simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said method comprising partially drying said wet mineral matter by forcibly conveying it through confined spaces in an attenuated circuitous path while exposing it to a concurrent stream of air and at the same time heating it indirectly by means external to the confined spaces, forming said partially dried material into a thin bed, simultaneously heating and mechanically agitating said bed so as to allow denser materials to migrate to the bottom of the bed forcing a regulated stream of heated gas upwardly through the bed so as to allow the lighter materials to be suspended slightly above the denser materials in a continuous sheet, and removing said denser materials from the bottom of the bed without interrupting the continuity of the upper levels of the bed.

6. A method of simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said method comprising partially drying said wet mineral matter by forcibly conveying it through confined spaces in an attenuated circuitous path while exposing it to a concurrent stream of air and at the same time heating it indirectly by means external to the confined spaces, thereby producing a damp mixture in which particles of the mineral matter and particles of the impurities are separately agglomerated, forming said damp mixture into a thin bed, simultaneously heating and mechanically agitating said bed so as to allow denser materials to migrate to the bottom of the bed forcing a regulated stream of heated gas upwardly through the bed so as to allow the lighter materials to be suspended slightly above the denser materials in a continuous sheet, and removing said denser materials from the bottom of the bed at spaced intervals therealong without interrupting the continuity of the upper levels of the bed.

7. A method of simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said method comprising partially drying said wet mineral matter by forcibly conveying it through confined spaces in an attenuated circuitous path while exposing it to a concurrent stream of air and at the same time heating it indirectly by means external to the confined spaces, thereby producing a damp mixture in which particles of the mineral matter and particles of the impurities are separately agglomerated, forming said damp mixture into a thin inclined bed, simultaneously heating and mechani-

cally agitating said bed so as to advance the bed progressively and allow denser materials to migrate to the bottom of the bed forcing a regulated stream of heated gas upwardly through the bed so as to allow the lighter materials to be suspended slightly above the denser materials in a continuous sheet, and removing said denser materials from the bottom of the bed at spaced intervals therealong without interrupting the continuity of the upper levels of the bed.

8. A method of simultaneously cleaning and drying finely divided wet mineral matter having impurities therein, said method comprising partially drying said wet mineral matter by forcibly conveying it through confined spaces in an attenuated circuitous path while exposing it to a concurrent stream of air and at the same time heating it indirectly by means external to the confined spaces, thereby producing a damp mixture in which particles of the mineral matter and particles of the impurities are separately agglomerated, forming said damp mixture into a thin inclined bed, simultaneously heating and mechanically agitating said bed so as to advance the bed progressively and allow denser materials to migrate to the bottom of the bed, forcing a regulated stream of heated gas upwardly through the bed so as to allow the lighter materials to be suspended slightly above the denser materials in a continuous sheet, causing the continuous sheet of lighter materials to pass progressively into a discharge chute, and removing the denser materials from the bottom of the bed at spaced intervals therealong without interrupting the continuity of the upper levels of the bed.

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1,079,905	Seagrave	Nov. 25, 1913
1,595,088	Gudger	Aug. 10, 1926
1,802,476	Peterson	Apr. 28, 1931
1,868,512	Ahlmann	July 26, 1932
2,014,249	Fletcher	Sept. 10, 1935
2,512,422	Fletcher et al.	June 20, 1950