Feb. 2, 1943. L. B. WEST 2,309,810

METHOD OF AND APPARATUS FOR TREATING MATERIAL

Filed Oct. 30, 1941 2 Sheets-Sheet 1

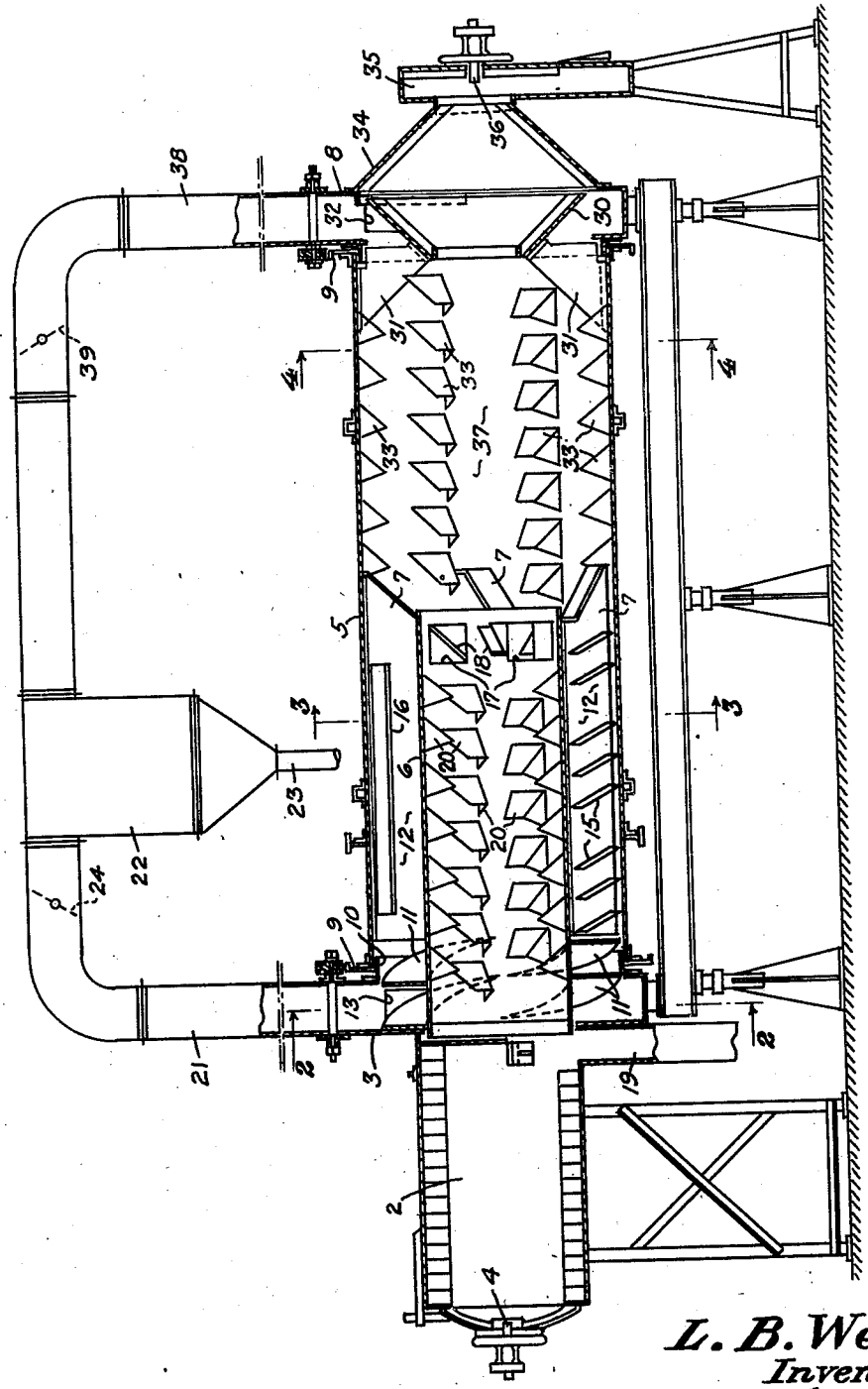

Fig. 1

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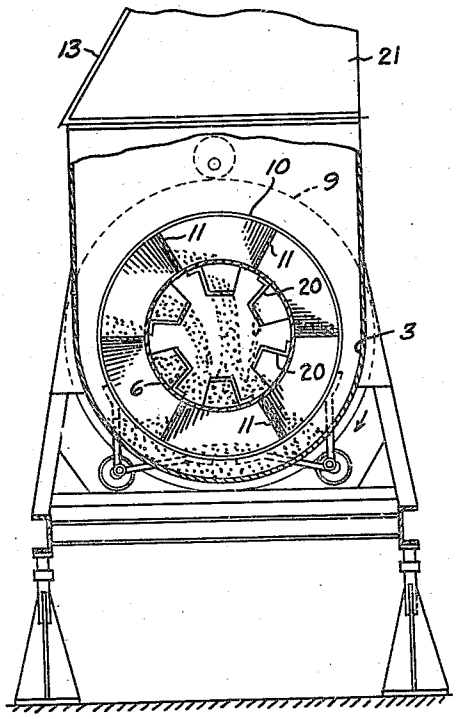

Fig. 2

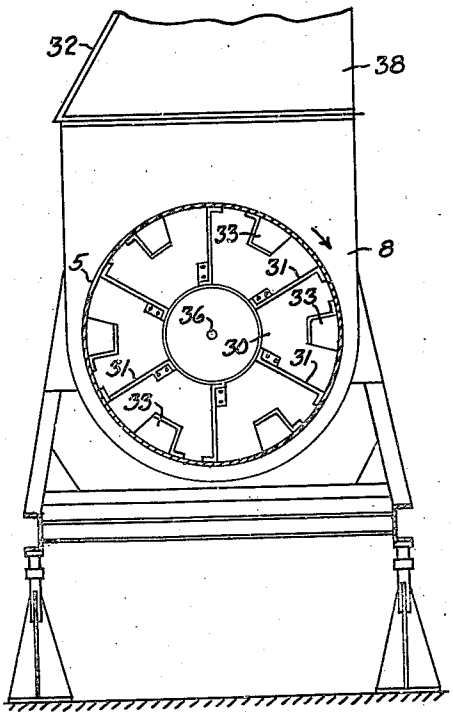

Fig. 4

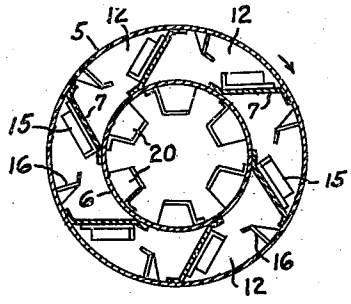

Fig. 3

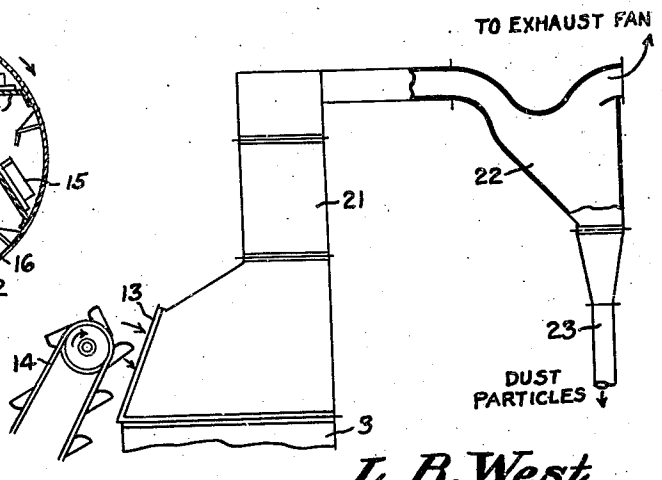

Fig. 5

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2,309,810

METHOD OF AND APPARATUS FOR TREATING MATERIAL

Lawrence B. West, Chattanooga, Tenn.

Application October 30, 1941, Serial No. 417,193

24 Claims. (Cl. 34—13)

This invention relates to the drying of mineral aggregate or like material under variable heat conditions, and a process therefor, which will be more efficient and less costly to operate than those heretofore proposed.

Referring to the accompanying drawings forming a part of this specification and in which like parts are designated by like numerals—

Fig. 1 is a vertical longitudinal sectional view of an apparatus made in accordance with this invention;

Fig. 2 is a transverse sectional view taken as on the line 2—2 of Fig. 1 and looking in the direction of the arrows;

Fig. 3 is a transverse sectional view taken as on the line 3—3 of Fig. 1 and looking in the direction of the arrows;

Fig. 4 is a transverse sectional view taken as on the line 4—4 of Fig. 1 and looking in the direction of the arrows; and

Fig. 5 is a diagrammatic representation of a feeding means for the material being treated, as well as an exhaust means for the gases utilized.

This invention constitutes an improvement over that disclosed in U. S. Letters Patent No. 1,641,108 granted August 30, 1927, to Lawrence B. West and entitled Apparatus for drying and heating material, and No. 1,871,934 granted August 16, 1932, to Lawrence B. West and Marion P. Wall entitled Process of and apparatus for drying material, both patents disclosing therein a double-shell drier.

In the art of drying mineral aggregates for asphalt paving and other purposes, it is a well known fact that some characters of aggregate material, especially those having a large clay content, will dry better in a single-shell drier, whereas other materials will dry more readily, and especially more economically, in a double-shell drier. Therefore, a combination of a double-shell and a single-shell drier in accordance with this disclosure will meet all of the requirements in the drying of all kinds of mineral aggregate, thereby lowering the initial and operating costs.

Further, this combination of driers will permit the feeding of one kind or grade of aggregate material into one end of the apparatus, and another kind or grade into the opposite end of the apparatus, the two kinds of aggregate being conveyed in streams of opposite directional flow within the apparatus to an area where the one kind will meet or join the other kind, the mixture of the two kinds thereafter being conveyed, in a stream disposed within one of the first mentioned streams, to the discharge end of the apparatus. During such conveyance of the material, hot gases and/or cooling air are passed over the material to obtain the desired results, this invention thereby lending itself admirably to either the production of hot-mixed or cold-mixed asphalt.

It is also a decided advantage in drying mineral aggregates, in the operation of an asphalt plant, to be able to operate economically at a lower capacity and also to operate at an extremely high capacity. When a low capacity is desired the material is fed only into one end of the apparatus, but by feeding the material into both ends, the apparatus will be operating at 100% capacity.

Referring to the drawings, a stationary furnace 2 is indicated attached to the breeching 3 and provided with a source of heat such as an oil burner 4. The drier comprises a horizontal cylindrical outer casing 5 mounted for rotation about its axis, and containing an inner coaxial cylindrical casing or drum 6 secured thereto as by the oblique partitions 7, as was the case disclosed in said patents. The outer drum 5 is disposed between the breeching 3 and a similar breeching 8 at opposite ends of the drum, sealing rings such as 9 being provided for preventing any material loss of hot gases to the atmosphere, the sealing rings cooperating with annular rings or collars such as 10 carried by the breeching and providing means for the passage of material and gases between the breeching and said drum.

The inner end of the inner drum 6 is disposed at approximately the middle of the outer drum, but the opposite end of the inner drum extends beyond the end of the outer drum and through the breeching 3. The extending end of the inner drum carries external screws such as 11 by means of which material is forced from the lower region of said breeching into the compartments 12 formed by the partitions 7 between the inner and outer drums, such material being fed into the breeching through the aperture 13 therein by any suitable means such as a conveyor 14.

Inclined flights such as 15 on the partitions 7 move the material progressively toward the inner end of the inner drum, and flights such as 16 within each compartment cause the material to be cascaded or showered across the compartments so as to come into more intimate contact with the hot drying gases, during the rotation of the apparatus. When the material reaches the inner end of said compartments it drops

through valves or openings 17 formed in the wall of the inner drum and is started by the inclined flights 18 in a reverse directional movement within the inner drum toward the discharge chute 19, a great plurality of buckets or cups 20 attached to the inner surface of the inner drum assisting in this reverse movement and causing a cross-shower of the material within the inner drum as clearly indicated in Fig. 2. Therefore it will be understood from the description so far that material fed into the breeching 3 is caused to move to the right as seen in Fig. 1 within the compartments 12 by the flights 15, but after reaching the valves 17 of the inner drum, the material passes through said valves and is caused by the buckets 20 to be moved within the inner drum to the left as seen in said Fig. 1.

Hot gases created by the burner 4 are caused by a suitable exhaust fan to travel from the furnace 2 through the inner drum to the extreme inner end thereof, and thence in the opposite direction through the compartments 12, between the inner and outer drums, to the breeching 3 and out through the flue 21 to a dust collector or classifier 22, and thence to atmosphere through the exhaust fan, any dust particles carried by the gas flow being caught or trapped in the collector 22 and recovered from the discharge 23 thereof, a suitable valve 24 being provided in the flue 21 to regulate the amount of air and gas passing through the device.

Up to this point the apparatus is substantially a duplicate of that disclosed in said patents.

The end of the outer drum adjacent the breeching 8 carries a cone such as 30 axially thereof, which cone is so directed as to positively impel material into the drum, said cone secured to the drum as by the spacing plates 31 for rotation with the drum. The wall of the breeching at the juncture with the drum is suitably cut away in order that the material admitted through the opening 32 (as by a duplicate of the conveyor 14) may reach the interior of said drum where the material is picked up by the plurality of buckets or cups such as 33 and moved to the left as seen in Fig. 1, to meet the material travelling in the reverse direction through the compartments 12. The opposite wall of the breeching 8 is cut away in substantial registry with the end of the cone 30, and covering this cut-away portion of said wall is a second cone 34 substantially axial with the cone 30, the smaller end of the cone (furnace) 34 communicating with a housing 35 containing a source of heat such as the oil burner 36.

Thus it will be understood that the hot gas created by the burner 36, and induced by the exhaust fan through flue 21 communicating with the breeching 3, will pass into the single-shell portion 37 of the apparatus, coming into contact with the material admitted through the breeching 8 and cascaded across the single-drum chamber by the buckets 33, and escape from the apparatus through the compartments 12, breeching 3, and flue 21, thereby drying said material as well as, if desired, any material admitted through breeching 3 and passing through said compartments 12 as heretofore described. The material from breeching 8 ultimately reaches the compartments 12 but, due to the flights 15 therein, will be forced to and through the valves 17 of the inner drum 6 and be conveyed to the discharge 19 by the buckets 20 as heretofore described.

By providing the flue 38 connected to the breeching 8 (and a substantial duplicate of flue 21) and by providing the damper 39 therein, the entire apparatus is made adaptable for various uses. In other words either or both of the furnaces may be used to generate the hot gas. For example, with burner 36 lighted and valve 39 closed, the current of hot gas will flow from furnace 34 through the drier to and through the flue 21 thereby heating the material in either or both the compartments 37 and 12, in which case it may be found desirable to open unlighted furnace 2 so that cooling air may be drawn therethrough and through the inner drum 6 to mix with the hot gases in compartments 12. On the other hand the burner 4 may be used alone for the source of hot gas which is extracted through flue 21 and/or 38 as desired. Still further burner 4 may be utilized as the source of hot gas, and unlighted furnace 34 opened and valve 39 closed, whereby cooling air will be drawn through the furnace 34 and chamber 37 to mix with the hot gas escaping from the apparatus through compartments 12 and flue 21.

From the foregoing description it will be seen that by this invention there is provided a combination single-shell and double-shell drier which meets all the conditions and requirements that may be encountered in drying mineral aggregates, especially for asphalt road-building purposes, and which combines the advantages of both types of drier into a dual drier at a saving in initial and operating costs. Most materials dry more economically in the double-shell drier (5 and 6) such as stone, gravel, and reasonably clean sand. Other materials, such as sand with a high clay content, are difficult to process through the economical double-shell drier, and therefore this apparatus has been devised which will process both classes of materials either singly or together, to the best advantage.

This apparatus is provided with dual means of feeding and conveying. The difficult material, with the clay content, should be processed through the single-shell drier from breeching 8, and the other materials should be processed through the double-shell drier from breeching 3, both classes of materials ultimately entering the inner drum 6 and reaching the discharge 19, and when both classes of materials are being processed simultaneously they may be controlled as to proper proportions through the conveyors 14 to meet the specifications of paving. Furthermore, when the demand is for very large production, both single and double-shell portions of the apparatus can be put into service to reach a maximum capacity. On lower capacity it is more economical to operate only the double-shell portion of the apparatus (if the character of material will permit) due to the conservation of heat within the inner drum by the blanket effect of the moist or wet material passing through compartments 12 from breeching 3; or to operate the single-shell portion of the apparatus for material with high clay content.

Requirements often are for asphalt paving mitxures which are processed cold, using naphtha or some other temporary solvent other than heat, the purpose being to prolong the setting or hardening time so that the mixture can be stored or transported over long distances. The mineral aggregates for this cold process must be thoroughly dried and then cooled to approximate summer atmospheric temperature before the asphalt with the solvent is added.

It will therefore be seen that this dual drier offers all of the advantages of the double-shell drier disclosed in said patents, and provides the major advantage of a single-shell drier namely, the processing of materials with a high clay content to better advantage than would be attained with a double-shell drier. That is to say, the single shell drier in combination with the double-shell drier produces a higher efficiency in that the capacity of the apparatus is greatly increased and the production cost is greatly lowered by virtue of the saving in the heat of the waste gases from the single-shell drier which are put to use in heating material passing through the compartments 12 of the double-shell drier.

With respect to hot materials processed through the double-shell drier, the following brief summary is given. The wet cold sand or other mineral aggregate is fed by conveyor 14 into breeching 3 from which the screws 11 pass the maerial into the compartments 12 during the rotation of the drier, and the flights 15 on the partitions 7 progressively move the material lengthwise of said compartments until the material reaches and passes through the valves 17 into the inner drum 6, the material in compartments 12 receiving a preheating direct from the hot gases passing through said compartments as well as from the heat radiated from the metal wall of the inner drum. Within the inner drum the material is progressively moved by the buckets 20 in the reverse direction to the furnace end of said drum and the discharge chute 19, said material in this movement receiving the maximum amount of heat directly from the hot gases flowing counter thereto, or in other words the material is superheated in its passage through the inner drum, the exhaust fan inducing flow of the hot gases. In this process the furnace 34 is unlighted and closed, and valve 39 in flue 38 is closed, but valve 24 in flue 21 is open to a degree commensurate with the desired time and temperature of drying.

With respect to processing difficult materials, with clay content, through the single-shell drier, the following brief summary will be given. Material from a conveyor is conveyed into the breeching 8 and into the single-shell chamber 37 where it is picked up, cross-showered, and progressively moved by the buckets or cups 33 to and into the inner drum 6 and/or the compartments 12 from which latter the material passes through the ports 17 into said inner drum where the buckets 20 progressively move the material to the discharge chute 19. Within this inner drum, the said material is mixed with the aggregates admitted through breeching 3 and from the compartments 12. In this processing heat from furnace 2 acts upon all of the material by virtue of the dampers 24 and 39 being open in flues 21 and 38 respectively, the degree of opening of these dampers being in accordance with the control and proper distribution of the air and hot gas current desired with relation to the materials being processed. Thus it will be understood that a valuable feature of this invention resides in the fact that the material which is being processed through the single-shell chamber 37 can, by a careful adjustment of air current by damper 39, be processed at a lower fuel cost than through the ordinary type single-shell drier. Also, the only partially cooled hot gases from the single-shell drier can be passed through the compartments 12 of the double-shell drier, thereby utilizing the hot gases therein that otherwise would escape.

For drying and then cooling mineral aggregates for producing cold mixtures, the following synopsis will be given. This contemplates the use of naptha or other light distillates instead of heat for keeping the mixture in workable condition for longer periods of time than where asphalt is added directly to the heated material for immediate paving purposes. In this drying and cooling process unlighted furnace 2 is opened, and burner 36 is lighted, whereby the hot gases will be caused to travel by the induced air current through the single-shell chamber 37, through the compartments 12, and out through the flue 21, cooling air being drawn through the open unlighted furnace 2, through the inner drum 6 and mixing with the hot gases in compartments 12. Thus the materials are heated in compartments 12 and/or 37 and subjected to cooling action in their passage through the inner drum to the discharge 19, the valves 24 and 39 being regulated to obtain the results desired. The material can be admitted through either or both of breechings 3 and 8.

It is obvious that those skilled in the art may vary the details of construction comprising the apparatus, as well as vary the steps of the method, without departing from the spirit of this invention, and therefore it is desired not to be limited to the exact foregoing disclosure except as may be required by the claims.

What is claimed is:

1. A method of treating material which comprises conveying the material in streams of opposite directional flow to an area where the material of both streams mix and thereafter conveying the mixed material in a stream disposed within one of the first mentioned streams, subjecting the material while being conveyed in the first mentioned streams to a current of hot gas, and subjecting the mixed material while being conveyed to a current of cooling air.

2. A method of treating material which comprises conveying the material in separate streams of opposite directional flow to an area where the material of both streams mix and thereafter conveying the mixed material in a stream disposed within one of the first mentioned streams, subjecting the material while being conveyed in the first mentioned streams to a current of hot gas having uni-directional flow, and subjecting the mixed material while being conveyed to a current of cooling air moving counter to the flow of the mixed material.

3. A method of treating material which comprises conveying the material in streams of opposite directional flow to an area where the material of both streams mix, one of said streams being substantially annular, and thereafter conveying the mixed material in a stream disposed within the annular one of the first mentioned streams, and subjecting the material while being conveyed in each of the first mentioned streams to heat from a current of hot gas moving counter to the directional flow of the mixed material.

4. A method of treating material which comprises conveying the material in streams of opposite directional flow to an area where the material of both streams mix and thereafter conveying the mixed material in a stream disposed within one of the first mentioned streams, subjecting the material while being conveyed in the first mentioned streams to a current of hot gas, subjecting the mixed material while being con-

veyed to a current of cooling air, and uniting the current of cooling air with the current of hot gas substantially at the area where the materials mix.

5. A method of treating material which comprises conveying the material in streams of opposite directional flow to an area where the material of both streams mix and thereafter conveying the mixed material in a stream separated from and disposed within one of the first mentioned streams, and passing a current of gas, having a temperature different than the temperature of the material, in contact with the material.

6. A method of treating material which comprises conveying two different kinds of material in streams of opposite directional flow, subjecting the material of both streams to a current of hot gas, mixing the heated material of one stream with the heated material of the other stream, conveying the mixed materials in a stream disposed within one of the first mentioned streams, and subjecting the stream of mixed materials to a counter current of cooling air.

7. A method of treating material which comprises conveying two different kinds of material in substantially coaxial streams of opposite directional flow, subjecting the material of both streams to a single current of hot gas, mixing the heated material of one stream with the heated material of the other stream, conveying the mixed materials in a stream disposed within one of the first mentioned streams, and subjecting the stream of mixed materials to a counter current of cooling air.

8. A method of treating material which comprises conveying two different kinds of material in streams of opposite directional flow, one of said streams being substantially cylindrical, subjecting the material of both streams to a current of hot gas, mixing the heated material of one stream with the heated material of the other stream, conveying the mixed materials in a stream disposed within the cylindrical stream, and subjecting the stream of mixed materials to a counter current of cooling air.

9. A method of treating material which comprises conveying two different kinds of material in separate streams of opposite directional flow, subjecting the material of both streams to a current of hot gas, mixing the heated material of one stream with the heated material of the other stream, conveying the mixed materials in a stream disposed within but separated from one of the first mentioned streams, and subjecting the stream of mixed materials to a counter current of cooling air.

10. A method of treating material which comprises conveying two different kinds of material in streams of opposite directional flow, processing the material of both streams by passing in contact with the material a current of gas having a temperature different than the temperature of the material, mixing the processed material of one stream with the processed material of the other stream, and conveying the mixed materials in a stream disposed within one of the first mentioned streams, the movement of the stream of mixed materials being counter to the flow of the current of gas.

11. A method of treating material which comprises conveying material of one kind in a cylindrical stream in one direction and then in the reverse direction within said stream, the material while moving in the first direction subjected to a current of hot gas, and said material while moving in the other direction subjected to a current of cooling air, the currents of gas and air being counter to the flow of material, and the current of gas passing through the area of change of directional flow of the material, conveying material of a different kind in the said reverse direction and mixing it with the first mentioned material while subjected to the current of cooling air, and subjecting the material of the different kind to the current of hot gas prior to its mixture with the other material.

12. A method of treating material which comprises conveying material of one kind in a cylindrical stream in one direction and then in the reverse direction within but separated from said stream, the material while moving in the first direction subjected to a current of hot gas, and said material while moving in the other direction subjected to a current of cooling air, the currents of gas and air being counter to the flow of material, and the currents of gas and air mixing together and passing through the area of change of directional flow of the material, conveying material of a different kind in the said reverse direction and mixing it with the first mentioned material while subjected to the current of cooling air, and subjecting the material of the different kind to the current of hot gas prior to its mixture with the other material.

13. A method of treating material which comprises conveying material of one kind in a cylindrical stream in one direction and then in the reverse direction within said stream, the material while moving in the first direction subjected to a current of hot gas, and said material while moving in the other direction subjected to a current of cooling air, the currents of gas and air being counter to the flow of material, and the current of gas passing through the area of change of directional flow of the material, conveying material of a different kind in the said reverse direction and mixing it with the first mentioned material at the area of change of directional flow of the latter, and subjecting the material of the different kind to the current of hot gas prior to its mixture with the other material.

14. In an apparatus of the character described the combination of an outer drier casing; a superheater extending from approximately the middle to beyond the end of said casing and spaced therein; a flue adapted to admit hot gas to one end of the superheater; a stationary breeching disposed about the extending end of said superheater and communicating with the space between said superheater and said casing; means to feed material into each end of said casing; means, extending from each said feeding means to said space, to convey material from both ends of said casing to the space between said superheater and said casing; means to convey the material to the interior of said superheater from said space, for mixing in said superheater; means to deliver the mixed material from said superheater; and means to rotate said superheater and said casing.

15. In an apparatus of the character described the combination of an outer casing; an inner casing extending from approximately the middle to beyond the end of said outer casing and spaced therein; a stationary breeching disposed about the extending end of said inner casing and communicating with the space between said

inner and outer casings; means to feed material into each end of the outer casing; means, extending from each said feeding means to said space, to convey material from both ends of said outer casing to the space between said inner and outer casings; means to convey the material to the interior of said inner casing from said space, for mixing in said inner casing; means to deliver the mixed material from said inner casing; means to rotate said inner and outer casings; and means to pass a current of gas, having a temperature different than the temperature of the material, in contact with the materials while so conveyed.

16. In an apparatus of the character described the combination of an outer drier casing; a superheater extending from approximately the middle to beyond the end of said casing and spaced therein; a flue adapted to admit hot gas to one end of the superheater; a stationary breeching disposed about the extending end of said superheater and communicating with the space between said superheater and said casing; means to feed material into each end of said casing; means comprising spaced elements carried by said casing and extending from each said feeding means to said space, to convey material from both ends of said casing to the space between said superheater and said casing; means disposed at the inner end of said superheater to convey the material to the interior of said superheater from said space, for mixing in said superheater; means to deliver the mixed material from said superheater; and means to rotate said superheater and said casing.

17. In an apparatus of the character described the combination of an outer casing; an inner casing extending from approximately the middle to beyond the end of said outer casing and spaced therein; a stationary breeching disposed about the extending end of said inner casing and communicating with the space between said inner and outer casings; means to feed material into each end of the outer casing; means comprising spaced elements carried by said outer casing and extending from each said feeding means to said space, to convey material from both ends of said outer casing to the space between said inner and outer casings; means disposed at the inner end of said inner casing to convey the material to the interior of said inner casing from said space, for mixing in said inner casing; means to deliver the mixed material from said inner casing; means to rotate said inner and outer casings; and means to pass a current of gas, having a temperature different than the temperature of the material, in contact with the materials while so conveyed.

18. A rotating mixer comprising inner and outer drums spaced by a plurality of partitions providing passageways between the drums, the inner drum extending from one end to approximately the middle of the outer drum; means to convey material from both ends of the outer drum to the innermost ends of said passageways where the conveyed materials unite; means to deliver the united materials to within the inner drum; means to mix the united materials in the inner drum and to convey the mixed materials to the outermost end of said inner drum; and means to pass a current of gas, having a temperature different than the temperature of the material, in contact with the materials while so conveyed.

19. A rotating mixer comprising inner and outer drums spaced by a plurality of partitions providing passageways between the drums, the inner drum extending from one end to approximately the middle of the outer drum; means to feed material into each end of the outer drum; means, extending from each said feeding means to said pasageways, to convey material from both ends of the outer drum to the innermost ends of said passageways where the conveyed materials unite; means to deliver the united materials to within the inner drum; means to mix the united materials in the inner drum and to convey the mixed materials to the outermost end of said inner drum; and means for processing the materials with a current of gas having a temperature different than the temperature of the materials being conveyed, said processing means comprising an exhaust flue, as well as a controllable source of gas, communicating with each end of said outer drum.

20. In a drier of the character described the combination of two concentrically spaced cylindrical drums, one drum extending inwardly from one end of the other drum to approximately the middle of the said other drum, the innermost end of the inner drum being freely open to the interior space of the outer drum, means for feeding material to be dried into each end of the drier; means to convey the material within the drier in opposing directions, from each said feeding means to the space between said drums at the innermost end of the inner drum where the oppositely moving materials meet; a furnace disposed at either end of the drier for selectively processing the material while being so conveyed; and a discharge for the processed materials.

21. In an apparatus of the character described the combination of an outer drier casing; a superheater substantially concentrically spaced therein, said superheater being substantially half as long as said casing and having one end terminating approximately at the middle of said casing; a flue adapted to admit hot gas to one end of the superheater; means to feed material into each end of said casing; means to convey the fed material from both ends of said casing into the space between said superheater and said casing; means to convey the material to the interior of said superheater from said space, for mixing in said superheater; and a discharge for the mixed material from said superheater.

22. A method of treating material in a mixer which comprises charging material of one kind into one end of the mixer, charging material of a different kind into the opposite end of the mixer, conveying both materials in opposed streams inwardly from the respective ends of the mixer to an area of meeting of said materials, conveying the united materials from said area to one end of the mixer for discharge therefrom, the united materials moving in a stream disposed within the stream of one of the materials, and passing a current of gas in contact with the materials while so conveyed.

23. A method of treating material which comprises conveying the material in streams of opposite directional flow to an area where the material of both streams mix, and thereafter conveying the mixed material in a stream disposed within one of the first mentioned streams, and subjecting the material while being conveyed in each of the first mentioned streams to contact with a current of gas having a tempera-

ture different than the temperature of the material, the current of gas during contact with the material being in a direction counter to the movement of each material stream.

24. A method of treating material which comprises conveying the material in streams of opposite directional flow to an area where the material of both streams mix, and thereafter conveying the mixed material in a stream disposed within one of the first mentioned streams, and subjecting the material while being conveyed in each of the first mentioned streams, as well as in the stream of mixed material, to contact with a current of gas having a temperature different than the temperature of the material, the current of gas during contact with the material being in a direction counter to the movement of each material stream.

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