Oct. 21, 1941. P. T. LINDHARD 2,259,702

PREHEATING APPARATUS

Filed July 16, 1940 3 Sheets-Sheet 1

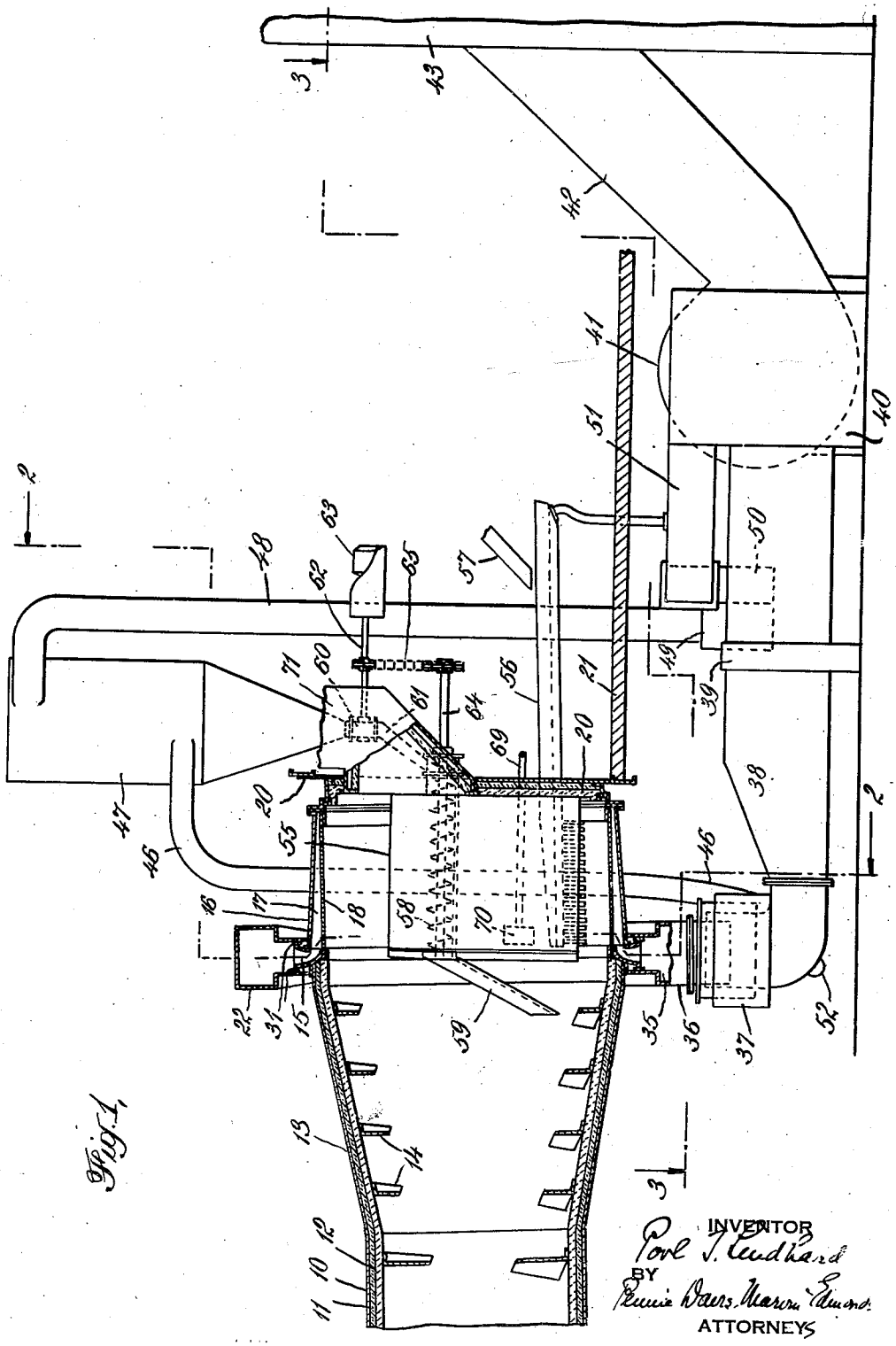


Fig. 1.

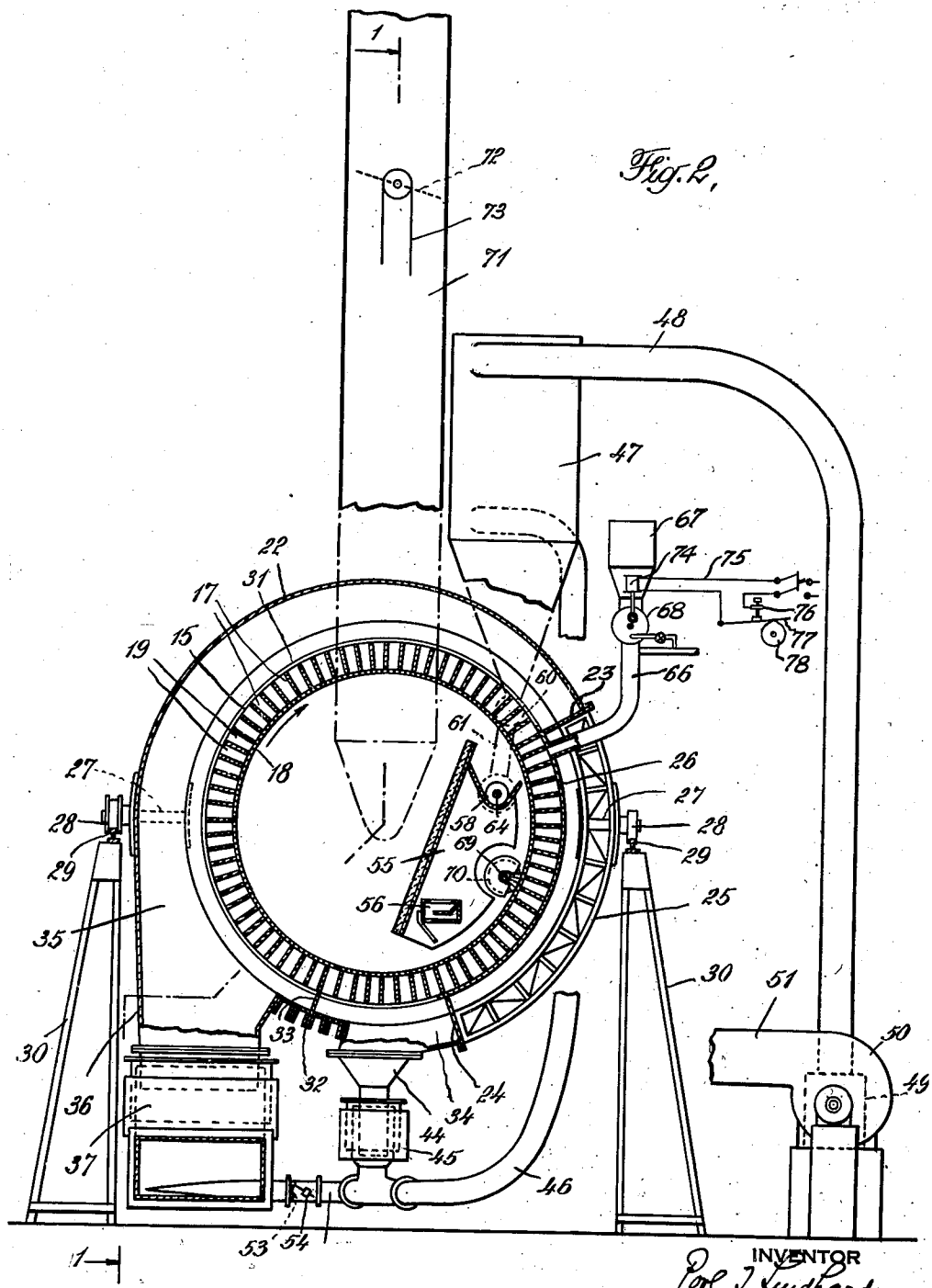
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Fig. 2.



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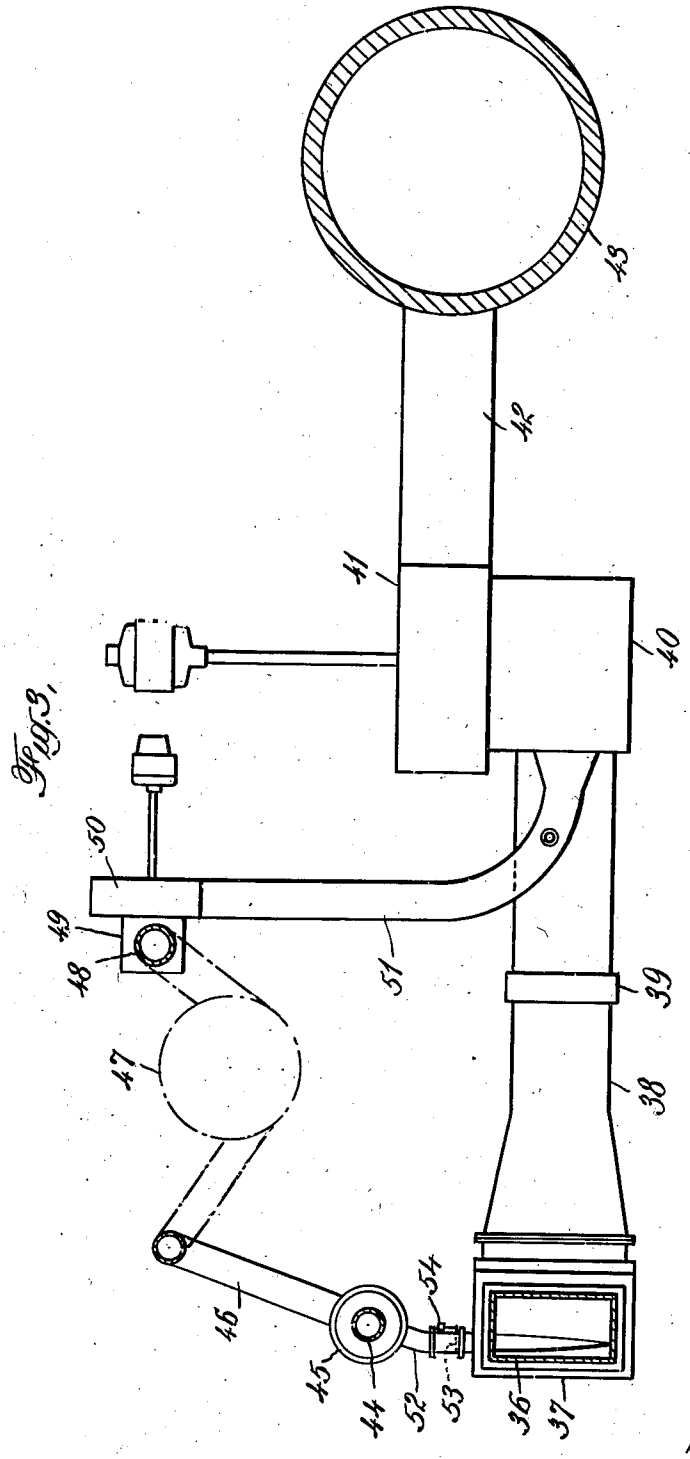


Fig. 3.

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UNITED STATES PATENT OFFICE

2,259,702

PREHEATING APPARATUS

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Application July 16, 1940, Serial No. 345,722

17 Claims. (Cl. 263—33)

This invention relates to apparatus for preheating materials by means of hot gases, such, for example, as the exhaust gases from a kiln in which the materials are later burned. More particularly, the invention has to do with a novel preheating apparatus in which the materials are continuously deposited upon a traveling pervious support and the hot gases passed through the layer of materials and support, the apparatus including means for recovering materials which escape through the support as the layer is formed thereon.

Preheating apparatus of the type generally referred to may take various forms and in one such apparatus, disclosed in United States Patent No. 2,024,453, issued December 17, 1935, on an application of Vogel-Jorgensen, the material to be preheated is deposited on the surface of a pervious cylindrical support which is mounted within an extension of the shell of a rotary kiln and rotates with the kiln. The continuously deposited material forms a layer which is held in place on the support by the hot gases from the kiln passing through the layer and support, and after the material has been carried through the major portion of a revolution, it is discharged from the support by compressed air and is introduced into the kiln. Instead of being mounted within an extension of the shell of a kiln, the Vogel-Jorgensen preheater may be a separate piece of apparatus through which the exhaust gases from the kiln are directed and from which the preheated material passes directly to the kiln.

In either form of the preheater referred to, the materials are deposited in moistened condition upon the traveling pervious support or grate and it is impossible to distribute the material in an even layer upon the grate without a proportion of the material escaping through the openings therein. The spill is immediately picked up and carried away with the waste gases passing to the draft fan and since the fine material is dried almost instantly, it is beaten into dust by the fan and passes over and is lost through the stack. The escape of the material in this manner represents an operating loss and, in addition, may create a dust nuisance.

The present invention is, accordingly, directed to the provision of a preheating apparatus of the Vogel-Jorgensen type which includes means for collecting the spill through the grate near the place where the deposition of the material thereon occurs, the spill being carried off in a stream of the hot gases flowing through a duct leading to a separator where the solids are removed from the stream. These solids, which are dried and heated in their travel to the separator, are returned and added to the preheated material which has been removed from the grate and is being conveyed to the kiln and the gases from the separator are discharged into the main stack. The new preheater thus permits recovery of the spill from the grate and its addition to the preheated product, so that substantial operating economies are effected because of the elimination of waste and of the necessity of moistening the material and returning it with the supply to the grate.

For a better understanding of the invention, reference may be had to the accompanying drawings in which

Fig. 1 is a sectional view of one form of the new preheater shown in association with a rotary kiln, the view being taken on the line 1—1 of Fig. 2; and

Figs. 2 and 3 are sectional views on the lines 2—2 and 3—3, respectively, of Fig. 1.

The preheating apparatus of the invention in the form illustrated in the drawings is mounted at the feed end of a rotary kiln which includes a cylindrical section 10 having the usual insulating and firebrick linings 11 and 12, respectively. The kiln includes a conical section 13 provided with conveying flights 14 by which material delivered into the kiln is conveyed through the conical section and into the main kiln shell and at the end of the conical section is a collector ring 15 having a plurality of ports formed by radial partitions.

Beyond the collector ring is a frusto-conical extension 16 having its larger diameter adjacent the ring and longitudinal ribs 17 are secured to the inner surface of the extension. The ribs are aligned with the partitions in the ring 15, and a pervious support or grate 18 is mounted on the inner ends of the ribs. The ribs are so formed that the grate is cylindrical and the passages 19 of tapering cross-sectional area defined by the ribs, the extension, and the grate lead to the ports in the ring 15. The free end of the extension is closed by an end shield 20 supported on the operating platform 21, so that the exhaust gases from the kiln flow through the grate with the layer of material thereon and through the passages to the ports in the collector ring.

Encircling a portion of the ring 15 is a mantle 22, with the interior of which the ports communicate and this mantle extends through approximately three-quarters of the circumfer-

ence of the ring and its ends are closed by plates 23, 24. The ends of the mantle are connected by a curved lattice girder 25 and the ends of those passages 19 which lie between plates 23 and 24 are closed by a cover plate 26 which extends slightly beyond plates 23 and 24 and may be circumferentially adjusted.

The mantle is provided with gudgeons 27 on which are mounted wheels 28 resting on rails 29 on structural supports 30. The rails 29 are inclined and have the same pitch as the kiln and the mantle may thus float with the kiln as the latter expands and contracts. The mantle is provided with tightening rings 31 bearing against flanges on the opposite faces of the collector ring 15 near its periphery and the weight of the mantle normally keeps one ring 31 in proper contact with one of the flanges while the other ring is held resiliently against the other flange. If desired, counterweights may be attached to the gudgeons to insure the proper contact between the ring and flange.

The lower wall of the mantle is provided with slots 32 in one or the other of which is inserted a partition 33, while the others are closed by removable filler pieces. The partition plate extends close to the outer face of the collector ring and thus divides the interior of the mantle into a small compartment 34 and a large compartment 35. The large compartment is provided with an outlet 36 which extends into a water seal, generally designated 37, and is connected by a flue 38 containing a damper 39 with the plenum box 40 of a draft fan 41. The outlet from the fan is connected by a flue 42 to a stack 43.

The compartment 34 has an outlet 44 connected through a water seal 45 to a pipe 46 which leads to a separator 47 of the cyclone type. A pipe 48 leads from the upper end of the separator to the plenum box 49 of an auxiliary fan 50, the outlet of which is connected by a flue 51 to the plenum box 40 of the main fan. A by-pass 52 connects the flue 38 with the pipe 46 and in this by-pass is an automatic damper 53 provided with an adjustable counterweight 54 to control the flow of gas from compartment 35 into pipe 46.

Mounted on the end shield 20 of the kiln and extending into the interior of the grate is a loading chamber 55 serving as a protection for the inner end of a distributor 56 which projects through an opening in the end shield into the interior of the grate. The distributor may be of any desired type and that illustrated is of the construction disclosed in the co-pending application of Vogel-Jorgensen Serial No. 192,257, filed February 24, 1938. The distributor receives the moistened material to be preheated through a chute 57 and delivers it upon the inner surface of the grate in a layer extending across the latter. Within the loading chamber is a screw conveyor 58 which leads at its forward end to a chute 59 discharging into the conical section of the kiln. The other end of the conveyor extends out through the end shield and solid material separated in the cyclone is discharged through an air lock 60 and chute 61 into the conveyor. The movable member of the air lock is mounted on a shaft 62 driven by a motor 63 and shaft 64 of the screw conveyor is driven from shaft 62 by a chain 65.

The layer of material discharged upon the grate by the distributor is carried around with the grate as the latter rotates, being held in place by the hot gases flowing through the layer and grate into the passages 19 and thence through the ports in ring 15 into the mantle. As each such port passes beyond the end plate 23 of the mantle, the outer end of the port is closed by the cover plate 26. The flow of gases through that port and its associated passage thereupon ceases and the material begins to fall off the grate and into the trough of conveyor 58. Just beyond the plate 23 there is an opening in the cover plate 26 to which leads a pipe 66 connected to an air vessel 67 charged with compressed air. A valve 68 in the pipe controls the flow of air from the vessel to the opening in plate 26 and means are provided for opening the valve whenever a port comes in registry with the opening. The valve and the means for opening it may be of the type shown and described in detail in my copending application, Serial No. 344,225, filed July 6, 1940. It is sufficient for the present purpose to note that the valve 68 is operated by a pilot valve 74. The pilot valve is operated by a solenoid supplied with current through a circuit 75 which includes a switch 76 having a movable member 77 which is operated by a cam disc 78 rotated in synchronism with the kiln and at such a rate that switch 76 is closed whenever one of the ports is in registry with the opening in cover plate 26. Air admitted into the port upon opening of the valve flows through the passage with which the port is in communication and through that portion of the grate overlying the passage. The air blast discharges the remainder of the material to the conveyor.

Extending through the end shield in position to be protected by the loading chamber is a shaft 69 on which is mounted a rotary brush 70 and the brush can be manipulated from outside the apparatus to remove from the grate any particles adhering thereto.

The end shield is provided with an auxiliary stack 71 leading to the atmosphere and containing a damper 72 which can be controlled from the loading platform by a chain 73.

In the operation of the apparatus, a proportion of the material deposited upon the grate by the distributor passes through the openings in the grate and into the passages which lie immediately beneath the distributor. The outer ends of those passages are closed by plate 26 and as each such passage passes the plate 24, it is immediately subjected to a strong suction produced by the auxiliary fan 50. The action of the fan causes a strong gas current to penetrate the layer and grate and enter the passages referred to, and the current carries with it the material which has passed through the grate and discharges the material through the ports in ring 15 to which the passages lead and into compartment 34 of the mantle. The entrained material flows through the mantle and through pipe 46 to the separator where the solids collect in the lower end of the separator and are discharged through the air lock into the conveyor 58 where they are mixed with the material that has been removed from the grate. The gas stream entering the separator then passes out through the auxiliary fan and through the main fan into the stack. The separated material is dried in its passage through pipe 46 and the separator, so that the material can be added as described to that which has been preheated and can be delivered therewith directly into the kiln.

The position of the partition 33, separating the two compartments of the mantle, may be varied as desired so as to give the gas current time to

sweep free the passages in which the spill has collected before the ports of those passages are connected to the large compartment of the mantle. Since the gas current sweeping out the spill must have a substantial velocity in order to convey the material upward to the cyclone and the volume of the gas passing through that portion of the grate lying between end plate **24** and partition **32** may be insufficient to attain this velocity, the counterweight **54** on damper **53** and by-pass **52** is so adjusted that gas is automatically drawn from compartment **35** through the by-pass in order that the desired velocity through pipe **46** may be obtained. The gas entering pipe **46** from the by-pass is drier than that entering the pipe from the compartment **34** and the addition of such dry gas helps to prevent possible condensation in the cyclone. The proper division of gas flow through the two compartments of the mantle may also be obtained by driving the auxiliary fan **50** by means of an adjustable speed motor.

The new preheater operates more economically than prior similar apparatus in that the spill through the grate is recovered and the heat taken up by the spill as it is carried out in the gas stream is recovered since the spill is added to the preheated material and not returned to the moistening apparatus. The collection and return of the spill in this manner also avoids possible interference with the preliminary moistening operation in which the material is prepared for preheating and eliminates dust nuisance.

In the specific embodiment of the invention described, the grate is mounted within an extension of the kiln and the material is deposited upon the inner surface thereof. It will be apparent that the principles of the invention may also be employed to advantage in constructions in which the preheater is a piece of apparatus separate from the kiln or in which the material is deposited on the outer surface of the grate.

I claim:

1. Apparatus for preheating material by hot gases, which comprises a traveling grate, means for depositing the material in a layer on the grate, means for passing hot gases through the layer in two streams, the first of which flows through the layer near the place of deposition thereof and the other of which flows through the remainder of the layer, the gases in the first stream carrying along material that has passed through the grate, means for separating the material from the gases in the first stream, means for removing the preheated material from the grate, and means for combining the separated material with that removed from the grate.

2. Apparatus for preheating material by hot gases, which comprises a traveling grate, means for depositing the material in a layer on the grate, means for passing hot gases through the layer in two streams, the first of which flows through the layer near the place of deposition thereof and the other of which flows through the remainder of the layer, the gases in the first stream carrying along material that has passed through the grate, means for adding part of the second stream to the first after the streams have passed through the layer, means for separating the material from the gases in the first stream, and means for combining the separated material with that removed from the grate.

3. Apparatus for preheating material by hot gases, which comprises a rotary support, a cylindrical grate on the support, means defining a series of passages extending lengthwise of the grate along one face thereof, means for depositing the material in a layer on the opposite face of the grate, means for passing hot gases through the layer and grate, the gases flowing off through the passages and carrying with them material that has passed through the grate and into the passages, means for separating the material from the gases by which it is carried off, means for removing the preheated material from the grate, and means for combining the separated material with that removed from the grate.

4. Apparatus for preheating material by hot gases, which comprises a rotary support, a cylindrical grate on the support, means defining a series of passages extending lengthwise of the grate along one face thereof, means for depositing the material in a layer on the opposite face of the grate, means for passing hot gases through the layer and grate, the gases flowing off through the passages, means for confining the gases issuing from passages in two streams, one containing gases issuing from passages near the place of deposition of the material and the other containing the gases issuing from the remaining passages, the gases in the first stream carrying with them material which has passed through the grate, means for separating the material from the first gas stream, means for removing the preheated material from the grate, and means for combining the separated material with that which has been removed from the grate.

5. Apparatus for preheating material by hot gases, which comprises a rotary support, a cylindrical grate on the support, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, means for depositing the material on the opposite face of the grate, means for passing hot gases through the layer and grate into the passages, the gases escaping through the passage outlets and those flowing through passages near the place of deposition of the material carrying with them material that has passed through the grate and entered the passages, means dividing the gases issuing from the passage outlets into two streams, one stream containing material picked up in the passages, means for separating the entrained material from the gas stream, means for removing preheated material from the grate, and means for combining the separated material with that removed from the grate.

6. Apparatus for preheating material by gases which comprises a cylindrical grate mounted for rotation, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, means for depositing the material on the opposite face of the grate, means for passing hot gases through the layer and grate into the passages, the gases escaping through the outlets, a mantle in communication with said outlets, a partition subdividing the mantle into two compartments, the first of which communicates with the outlets of passages lying near the place of deposition of the material on the grate, means for separating from the gas stream issuing from said first compartment material which has passed through the grate and entered the passages, means for removing preheated material from the grate, and means for combining the separated and preheated materials.

7. Apparatus for preheating material by gases which comprises a cylindrical grate mounted for

rotation, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, means for depositing the material on the opposite face of the grate, means for passing hot gases through the layer and grate into the passages, the gases escaping through the outlets, a mantle in communication with said outlets, a partition subdividing the mantle into two compartments, the first of which communicates with the outlets of passages lying near the place of deposition of the material on the grate, means for separating from the gas stream issuing from said first compartment material which has passed through the grate and entered the passages, means for removing preheated material from the grate, means for combining the separated and preheated materials, and means for adding a portion of the gas stream flowing through the second compartment to that flowing through the first.

8. Apparatus for preheating material by gases which comprises a cylindrical grate mounted for rotation, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, means for depositing the material on the opposite face of the grate, a mantle in communication with said outlets, a partition subdividing the mantle into two compartments, the first of which communicates with the outlets of passages lying near the place of deposition of the material on the grate, means for drawing hot gases through the layer and grate and into the passages leading to the two compartments, means for separating from the gas stream issuing from the first compartment material which has passed through the grate and entered the passages, means for removing preheated material from the grate, and means for combining the separated and preheated materials.

9. Apparatus for preheating material by gases which comprises a cylindrical grate mounted for rotation, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, means for depositing the material on the opposite face of the grate, a mantle in communication with said outlets, a partition subdividing the mantle into two compartments, the first of which communicates with the outlets of passages lying near the place of deposition of the material on the grate, a fan connected to each compartment for drawing hot gases through the layer and grate and through the passages and compartment, a separator through which the gases issuing from the first compartment are passed, the separator removing from the gas stream material which has passed through the grate, means for removing the preheated material from the grate, and means for combining the separated and preheated materials.

10. Apparatus for preheating material by gases which comprises a cylindrical grate mounted for rotation, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, means for depositing the material on the opposite face of the grate, a mantle in communication with said outlets, a partition subdividing the mantle into two compartments, the first of which communicates with the outlets of passages lying near the place of deposition of the material on the grate, a fan connected to each compartment for drawing hot gases through the layer and grate and through the passages and compartment, a separator through which the gases issuing from the first compartment are passed, the separator removing from the gas stream material which has passed through the grate, means for adding gases flowing through the second compartment to those flowing through the first compartment and to the separator, means for removing preheated material from the grate, and means for combining the separated and preheated materials.

11. Apparatus for preheating materials by gases which comprises a cylindrical grate mounted for rotation, means dividing a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, a distributor for depositing the material on the opposite face of the grate, means spaced along the grate from the distributor for removing preheated material from the grate, a mantle extending around the grate from the distributor to the place of removal of the material, the mantle communicating with the outlets of passages with which the mantle lies in registry, a cover plate closing the outlets of passages between the material removal means and the distributor, a partition subdividing the mantle into two compartments, the first lying near the distributor and the second extending therefrom to the removal means, a pair of fans each connected to one of the compartments, the fans acting to draw hot gases through the layer and grate and through the passages and the compartments communicating therewith, the gas stream passing through the first compartment carrying with it material which has passed through the grate, a separator for removing entrained material from the gas stream issuing from the first compartment, and means for combining the separated material with that removed from the grate.

12. In a rotary kiln having an extension at the inlet end thereof, the combination of a cylindrical grate mounted within the extension, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, a distributor for depositing a layer of material on the opposite face of the grate, means for passing hot gases through the layer and grate into the passages to escape through the outlets, the gases carrying along material that has passed through the grate, means for separating the entrained material from the gases, means for removing the preheated material from the grate, and means for combining the separated material with the preheated material.

13. In a rotary kiln having an extension at the inlet end thereof, the combination of a cylindrical grate mounted within the extension, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, a distributor for depositing a layer of material on the opposite face of the grate, means for passing hot gases through the layer and grate into the passages to escape through the outlets, the gases flowing through passages near the place of deposition of the material carrying with them material that has passed through the grate and entered the passages, a mantle receiving the gases issuing from the passage outlets, a partition within the mantle dividing the mantle into two compartments, through one of which passes gases carrying material picked up in the passages,

means for separating the entrained material from the gas stream, means for removing preheated material from the grate, and means for combining the separated and preheated materials.

14. In a rotary kiln having an extension at the inlet end thereof, the combination of a cylindrical grate mounted within the extension, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, a distributor for depositing a layer of material on the opposite face of the grate, a mantle containing a pair of compartments communicating with the passage outlets, the first compartment lying near the place of deposition of the material on the grate, separate means connected to the compartments for drawing hot gases through the layer and grate and through the passages and compartments, the gas stream flowing through the first compartment carrying with it material which has passed through the grate, means for separating the entrained material from said gas stream, means for removing preheated material from the grate, and means for combining the separated material with the preheated material.

15. In a rotary kiln having an extension at the inlet end thereof, the combination of a cylindrical grate mounted within the extension, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, a distributor for depositing a layer of material on the opposite face of the grate, means spaced along the grate from the distributor for removing preheated material, a mantle extending around the grate from the distributor to the removal means, the mantle containing a pair of compartments, the first of which lies near the distributor, a fan connected to each compartment for drawing hot gases through the layer and grate and through the passages and into said compartment, the gas stream flowing through the first compartment containing material which has passed through the grate and into the passages, a cover plate closing the outlets of the passages lying between the removal means and the distributor, a separator for removing from the gas stream issuing from the first compartment material entrained therewith, and means for combining the separated and preheated materials.

16. In a rotary kiln having an extension at the inlet end thereof, the combination of a cylindrical grate mounted within the extension, means defining a series of passages extending lengthwise of the grate along one face thereof, the passages having outlets at one end of the grate, a distributor for depositing a layer of material on the opposite face of the grate, means spaced along the grate from the distributor for removing preheated material, a mantle extending around the grate from the distributor to the removal means, the mantle containing a pair of compartments, the first of which lies near the distributor, a fan connected to each compartment for drawing hot gases through the layer and grate and through the passages and into said compartment, the gas stream flowing through the first compartment containing material which has passed through the grate and into the passages, a cover plate closing the outlets of the passages lying between the removal means and the distributor, a separator for removing from the gas stream issuing from the first compartment material entrained therewith, means for withdrawing a part of the gas stream issuing from the second compartment and adding it to the stream flowing from the first compartment to the separator, means for delivering into the kiln the preheated material removed from the grate, and means for adding the separated material with the preheated material being delivered into the kiln.

17. In a rotary kiln having a cylindrical extension at the feed end, a plurality of ribs extending lengthwise of said extension and partly defining passages, a cylindrical grate mounted on the inner ends of said ribs, a ring between the kiln shell and extension and formed with a plurality of ports connecting with said passages, the ring having outlets in its peripheral surface, a distributor for depositing a layer of material on the inner surface of the grate, a mantle extending around the ring and formed with two compartments, the first of which is in communication with the outlets of the ring lying near the distributor, means spaced along the grate from the distributor for removing preheated material from the grate, the mantle extending from the distributor to the removal means, a cover plate closing the outlets in the ring lying between the removal means and the distributor, a fan connected to each compartment and drawing hot gases from the kiln through the layer and grate and through the passages and compartment, the gas stream flowing through the first compartment carrying with it material which has passed through the grate and into the passages, a separator for removing the entrained material from the gas stream, means for conveying the preheated material removed from the grate into the kiln, and means for combining the separated material with that being conveyed.

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