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[54] DEVICE FOR CRUSHING HOT FURNACE DISCHARGE MATERIAL, PARTICULARLY HOT ALUMINA

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[57] ABSTRACT

A device for crushing hot alumina is arranged between the discharge aperture of a calcining furnace and the charging aperture of a cooler and comprises a primary crushing roller arranged in a vertical discharge channel between the ends thereof and a pneumatic crushing means connected to the lower end of said discharge channel, whereby the outlet of said pneumatic crushing means is connected with a separator which in turn is connected with said cooler.

12 Claims, 2 Drawing Figures

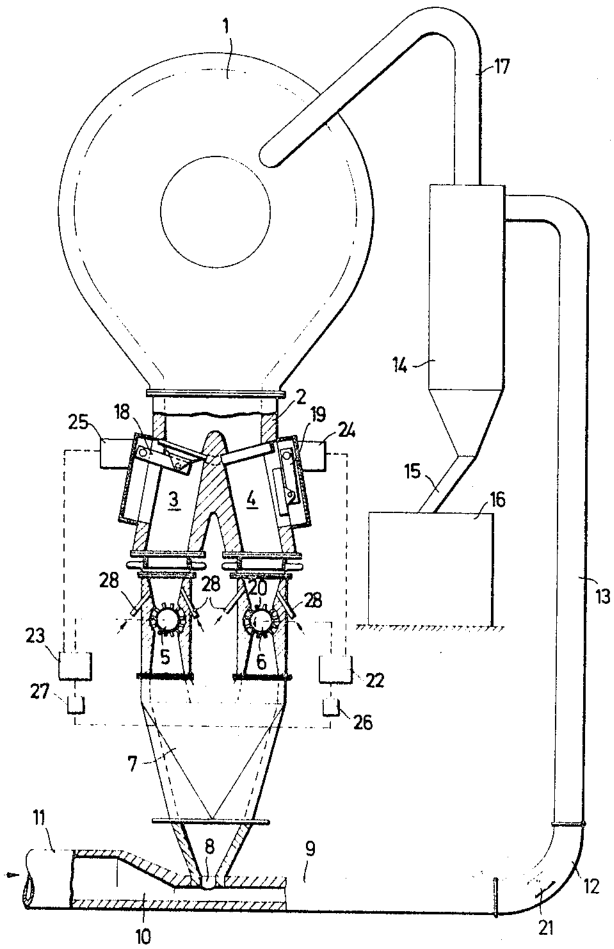
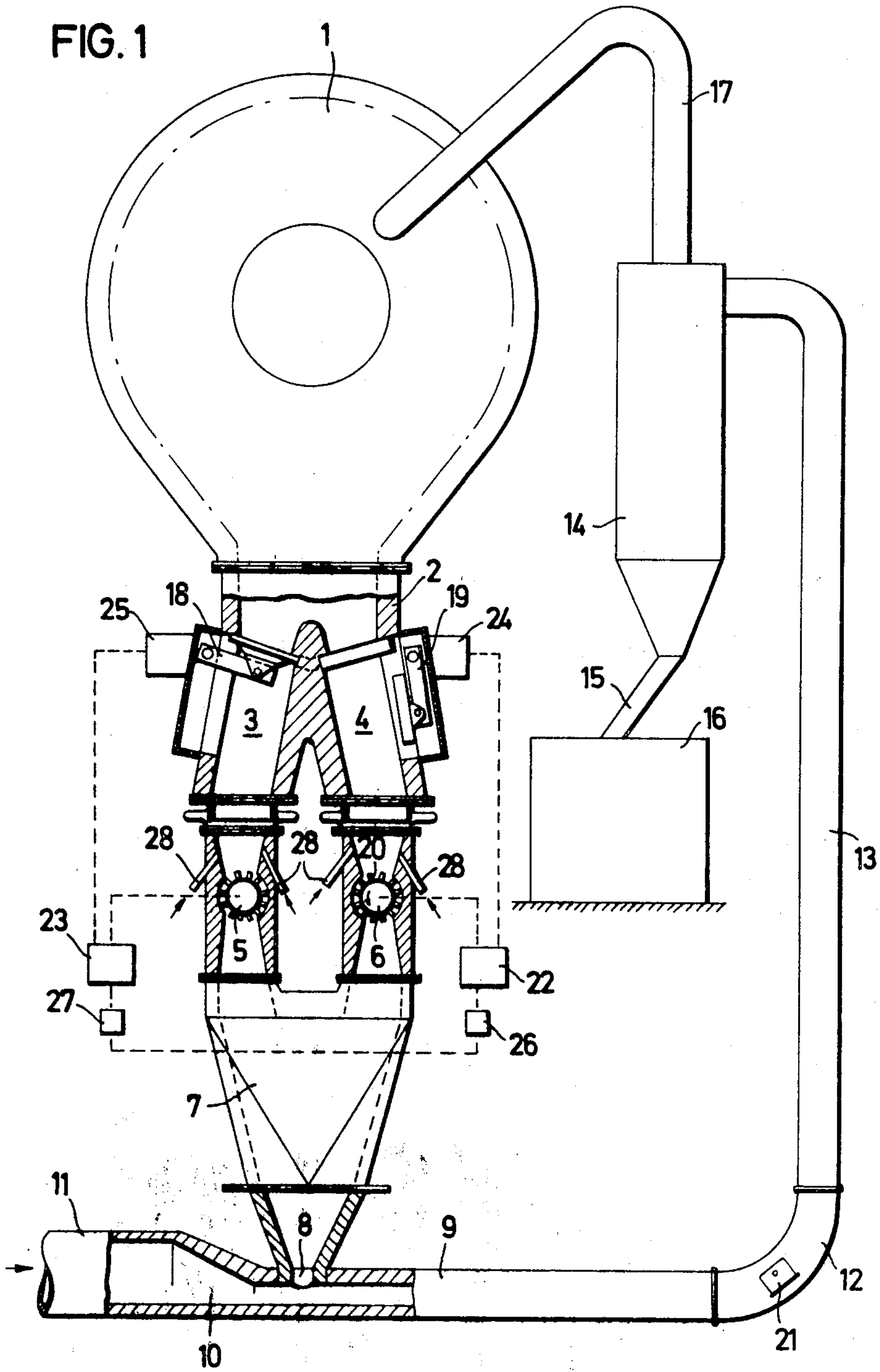


FIG. 1



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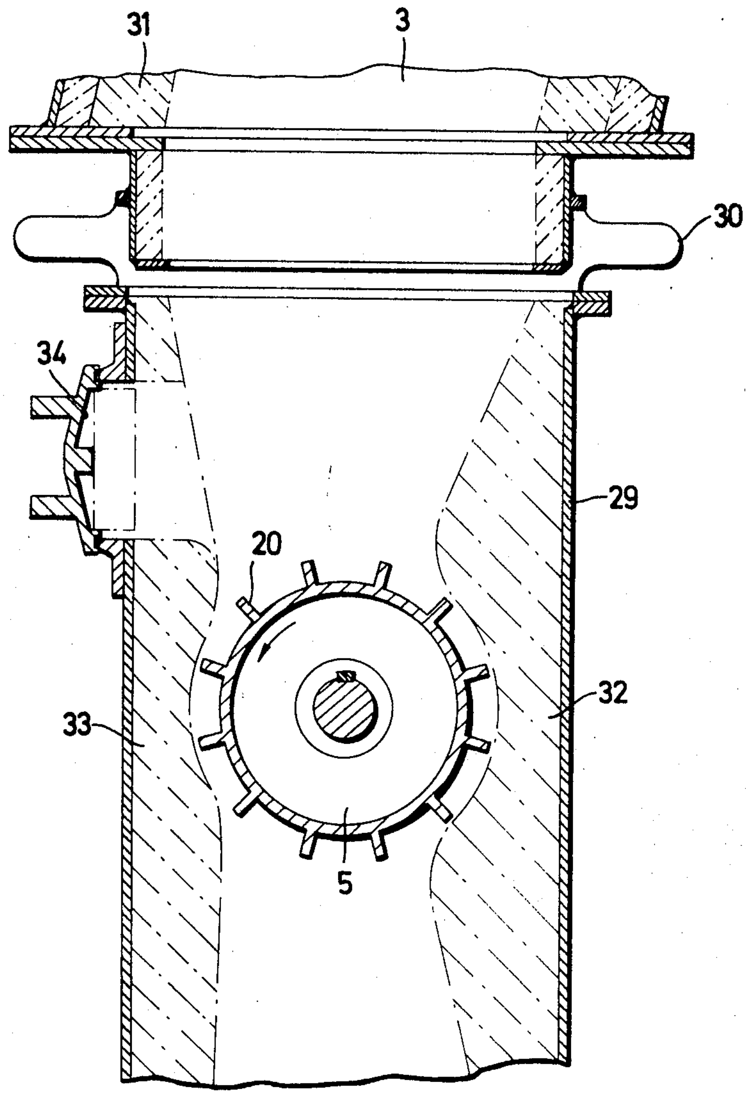

FIG. 2

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DEVICE FOR CRUSHING HOT FURNACE DISCHARGE MATERIAL, PARTICULARLY HOT ALUMINA

The invention relates to a device for the crushing of hot furnace discharge material, particularly hot alumina, which device is arranged between the material discharge aperture of a calcining furnace and the charging aperture of a cooling device.

During the calcination of alumina in a rotary furnace are produced frequently, owing to locally occurring sintering phenomena, more or less large nodules in the otherwise fine-grained material. These nodules, in view of their size and their relatively high weight, cannot pass through the customary employed vortex bed coolers or standpipe coolers. Particularly when employing vortex bed coolers the mentioned nodules are a disadvantage because they obstruct the passage of the material.

The U.S. Pat. No. 2,905,395 discloses a crushing device in which a transfer chamber is arranged directly after a rotary furnace between the discharge end of the furnace and the charging aperture of the following standpipe cooler. This crushing device comprises a screen arranged at an inclination and over which the entire furnace discharge is passed for the separation of the fine-grained material from the nodules. At the end of the screen layer is arranged a two roller crusher which has the purpose for crushing the nodules which are discharged by the furnace. This known device has the disadvantage that for the purpose of a sufficient crushing the gap between the two crushing rolls has to be small. This has, however, the result that the larger nodules are only poorly drawn into the gap so that either a greater gap has to be chosen, or one has to employ larger rolls. A larger gap results, however, in an insufficient crushing operation, while larger rolls are substantially more expensive. Since the material discharged by the furnace contains frequently fragments of the furnace wall which compared with the material nodules are very hard, it is necessary to support at least one of the rolls yieldably so that the rolls of the crushing device are protected against injury. Owing to the high temperature of the material discharged by the furnace, approximately 1,200° C, such a crushing device becomes very complicated and expensive.

Considering the above-mentioned disadvantages of the known device, the object of the invention is to arrange between the material discharge opening of a calcining furnace and the charging aperture of a cooling device a crushing device for the hot material coming from the furnace, particularly hot alumina, which device is distinguished by a material discharge channel in which is arranged a rotary primary crushing roll which is provided with substantially radial tappets and crushing elements and wherein the discharge channel below the mentioned primary crushing roll merges into a pneumatic crushing device. The advantage of this device is that the crushing operation takes place in two steps and that the primary crushing roll seizes large nodules more effectively than the known crushing device. Owing to the tappets and crushing elements which are arranged on the circumference of the roll, it is possible to employ a roll with a relatively small diameter. The combination of the mechanically acting primary crushing roll with a pneumatic crushing device results in an advantageous equalization of the material which

frequently is discharged by separated thrusts from the furnace. This is of importance for obtaining a good efficiency of vortex bed coolers or air-operated standpipe coolers. Since furthermore the entire amount of material discharged by the furnace is practically introduced in a fine-grained condition from the furnace into the cooling device a substantially more favorable heat exchange is obtained so that the heat consumption of the entire calcining process is favorable. Another advantage resides in the fact that any fragments of the furnace wall which may be contained in the material discharged by the furnace may pass the primary roll substantially unchanged and then may be separated from the furnace material in the pneumatic crushing device.

According to the invention, the pneumatic crushing device comprises a substantially horizontally extending guide tube into which—viewed in the flow direction of the gas—in advance of the merging point of the material discharge channel into the guide tube a driving nozzle for air or gas is inserted, while the guide tube in rear of the connection of the material discharge channel with the guide tube is provided with a sharp bend or elbow and that after this bend the conduit is connected with a separator whose material discharge tube is connected with a cooling device. The material discharged by the furnace and any small nodules and non-crushed nodule particles in the same are picked up by the air which passes at high speed from the driving nozzle and conveys the same through the guide tube. In view of the sharp bend of the driven air jet, the nodules and the non-crushed particles thereof and also fragments of the furnace wall are catapulted against the wall of the bend. When this happens, the nodules are broken up and continue as fine-grained material toward the separator. The fragments of the furnace wall, however, remain in the bend and are constantly moved by the gas stream back and forth and thereby are frictionally comminuted by abrasion. Very hard pieces may be removed from time to time through an inspection aperture which normally is closed by a plate. The necessary amounts of air for operating the pneumatic crushing device may be held relatively small owing to the employment of the drive nozzle so that in the subsequent cooling process the hot discharged air volumes do not have to be increased to any noticeable extent. On account of this feature the heat economy of the entire calcining method is very favorable.

The portion of the guide tube in rear of the bend and leading to the separator is preferably positioned vertically and preferably has also a larger cross section as the horizontally disposed portion of the guide tube. This has the advantage that nodules and nodule particles, which owing to a stronger sintering effect have not been crushed during the first catapulting, drop back into the bend and remain there until they are completely comminuted by abrasion during their constant movement, so that in this manner these parts are also crushed or comminuted completely within a very short period of time.

Another object of the invention is to provide the walls of the material discharge channel above the primary crushing roll with one or more openings for the introduction of air for the purpose of loosening the material which comes from the furnace. This has the advantage that a caking of the material is avoided, whose temperature directly in rear of the calcining furnace is still within the range of the sintering temperature.

Still another object of the invention is that the tappets and crushing elements of the primary crushing roll are constructed as straight bars which substantially extend in the axial direction of the primary crushing roll. This construction of the tappets and crushing elements provides the primary crushing roll with an additional dosing effect which initiates in cooperation with the pneumatic crushing operation a practically completely uniform flow the material toward the cooling device, so that for the cooling operation the optimum operating condition may be adjusted.

In accordance with still another object of the invention, the walls of the material discharge channel extending in the axial direction of the primary crushing roll, are so curved that the same concentrically surround both sides of the primary crushing roller. This feature improves the dosing and crushing action of the primary crushing roll. Preferably, that portion of the wall of the material discharge channel which is located on the side of the upwardly directed rotary movement of the primary crushing roll surrounds the circumference of the primary crushing roll along a longer distance as the oppositely disposed wall portion of the material discharge channel. This construction has the result that on the side of the upwardly directed rotary movement of the primary crushing roll, on which no material is located which comes from the furnace, an improved sealing effect is obtained.

According to a preferred embodiment of the crushing device, the material discharge channel is separated into two branch channels in each of which is arranged a primary crushing roll. Each of these branch channels is provided above the primary crushing roll therein with a locking gate, and such a construction makes it possible—provided each primary crushing roll is so designed that it is able to accommodate the entire amount of material discharged by the furnace—to operate the device without interruption in the event of damage or in the event that very large brick fragments should block one of the two primary crushing rolls. In that event, one is able to make repairs on the inoperative primary crushing roll, while the other primary crushing roll continues to operate so that the furnace operation is not at all interrupted.

It is also an object of the invention to connect each primary crushing roll with a rotation monitor which closes automatically by means of an adjusting device the locking gate of the primary crushing roll which has been blocked, whereby also the drive of the respective primary crushing roll is disconnected. This feature avoids a damage to the corresponding primary crushing roll and its drive motor, respectively.

When the device of the invention is equipped with two primary crushing rolls, preferably each rotation monitor is additionally connected with a switching mechanism, which upon stoppage of one of the primary crushing rolls effects an operation of the other primary crushing roll. In this manner, a continuous and trouble-free furnace operation is assured.

With these and other objects in view, the invention will now be described with reference to a specific example illustrated in the drawings.

In the drawings:

FIG. 1 is an end view of the furnace discharge with a crushing device partly in vertical section, and

FIG. 2 illustrates on an enlarged scale one embodiment of a primary crushing device in section.

Referring to FIG. 1, a vertical material discharge channel 2 extends downwardly from the lower portion of the furnace hood 1 of a rotary furnace employed for the calcination of alumina. This discharge channel 2 is subdivided in two branch channels 3 and 4. In the branch channel 3 is arranged a primary crushing roll 5 and in the branch channel 4 is arranged a primary crushing roll 6. Below the primary crushing roll is arranged an intermediate channel piece 7 in which the two branch channels are again united to form a single channel. The lower discharge aperture 8 of this intermediate channel member 7 is in communication with a horizontally disposed guide tube 9 through which air or gas flows with high speed. Looking in the direction of the flow of the gas or air, there is arranged ahead of the discharge aperture 8 a drive nozzle 10 through which air is introduced from a feed tube 11 which is accelerated to a speed above 20 m/per sec. Viewed in the flow direction of the driven air jet, there is arranged in rear of the discharge aperture 8, which transversely enters the guide tube 9, a bend 12 which deflects the driven air jet laden with material from the discharge channel 7 about 90° upwardly and into a vertical conveyor tube 13, which is preferably internally larger than the horizontal portion 9, and whose upper end is connected with the upper end of a cyclone 14 in which the fine-grained material is separated from the driven air and by means of a discharge tube 15 is conducted into a cooling device 16. The heated driven air which is discharged by the upper end of the cyclone, in addition to that portion which is withdrawn from the cooling device, is conducted as secondary air into the furnace by a pipe 17.

The crushing device of the invention operates in the following manner: Since the primary crushing rolls 5 and 6 are so designed that each roll is able to accommodate the entire amount of material discharged by the furnace, one of the two locking gates 18, 19 arranged in the branch channels 3, 4 is closed. The locking gates 18, 19 are arranged in said branch channels 3 and 4 above the primary crushing rolls therein. In the present instance, the branch channel 3 is closed by the locking gate 18. The fine-grained material together with the material nodules therein and which is discharged by the furnace is conducted by the branch channel 4 to the crushing roll 6. The tappets and crushing elements 20 on the circumference of this crushing roll draw the fine-grained material and nodules into the roll and those nodules which are thicker than the height of the crushing elements are crushed. The primary crushing roll 6 delivers the material to the common channel piece 7 and from the lower end thereof the material is conducted through the aperture 8 transversely into the horizontal guide tube 9.

The feed pipe 11 supplies air to the guide tube 9 and this air by means of the drive nozzle 10 is accelerated to a speed of approximately 25 m/per sec. The driven air jet pulls the material coming from the furnace and discharged by the aperture 8 along with it. The length of the guide tube 9 between the aperture 8 and the bend 12 has to be determined to be of such a distance that the material coming from the furnace will be given the highest possible acceleration so that a sufficient kinetic energy is available for the crushing operation. The fine-grained portion of the material, which comprises the largest portion of the material coming from the furnace, will pass the bend 12 without encountering any difficulties and is conveyed by the driven air into the cyclone 14. The nodules and nodule particles, which are not sufficiently crushed by the primary crushing roll are, however, catapulted against the curved wall in the bend 12 and when this happens they are practically completely converted into fine-grained material particles, which are at once seized by the driven air and are pulled upwardly in the conveyor tube 13. Those nodules, however, which are sintered together to a higher degree and which do not disintegrate upon the first impact, are moved continuously back and forth by the driven air stream over the lower portion of the wall of the bend 12 and in this manner they are completely ground within a very short time. At the same time, the bend 12 will also cause a grinding of the fragments of the brick lining which may be contained in the material coming from the furnace. Any pieces, however, which are difficult to crush or ground may be removed from time to time through a normally closed inspection aperture 21 provided in the bend 12.

In order to assure an operation of the furnace without disturbances, the embodiment of the crushing device illustrated in FIG. 1 and provided with two primary crushing rolls 5 and 6, is also provided with rotation monitors 22 and 23, one for each of said primary crushing rolls. These rotation monitors are connected by a suitable circuit with adjusting devices 24 and 25, which operate the locking gates 18 and 19. In addition, the rotation monitors are each connected with a switching mechanism 26 and 27 which connect the rotation monitors 22 and 23 with each other. The arrangement is such that, for instance, when one of the primary crushing rolls 6 should suddenly stop, for instance, by encountering a brick lining fragment of excessive size, then the rotation monitor 22 closes by means of the adjusting device 24 the locking gate 19. At the same time, the switching mechanisms 26 and 27 cause the primary crushing roll 5 to be set in operation and by means of the adjusting device 25 the locking gate 18 in the branch channel 3 is opened so that no interruption of the furnace operation occurs.

A preferred arrangement for controlling the rotation of the crushing rolls is to provide a drive motor for each of said rolls. The drive motor can be directly connected to the roll or connected through a clutch. For stopping the roll, the motor may be disconnected such as by turning off its power, or it may be disconnected by disengagement of the clutch. These conventional driving devices will be fully apparent to those versed in the art.

Pipelines 28 are connected with the spaces above the primary crushing rolls in the material discharge channels 3 and 4 and blow just sufficient air into the channels 3 and 4 that the material in these channels is aerated and loosened up. In this manner a caking of the material coming from the furnace is prevented even though the temperature of this material may still be in the range of the sintering temperature.

FIG. 2 illustrates on an enlarged scale and in section one of the primary crushing rolls, namely roll 5. The primary crushing roll 5 is advantageously arranged in a particularly-shaped channel portion 29, which by a flexible connection 30 is connected with the upper part of the material discharge channel, namely in this particular instance, with the branch channel 3. The brick lining 31 of this material discharge channel, in the range of the channel portion 29, is so shaped that the lining surrounds a portion of the circumference of the primary crushing roll concentrically. This portion of the brick lining is advantageously so shaped that the wall portion 32 on the side of the upwardly directed rotary movement of the primary crushing roll is surrounded to a greater extent than the oppositely disposed wall portion 33. In this manner the wall portion 32 is more inclined above the primary crushing roll and effects a good seal of the pneumatic crushing device with respect to the furnace space. The other opposite wall portion 33, has above the primary crushing roll a closeable inspection aperture 34 which permits the removal of any blocking particles which may collect above the range of the primary crushing roll so that any disturbance in the operation can be eliminated.

The primary crushing roll in the disclosed example is provided on its circumference with radial tappets and crushing elements 20 which are constructed as straight bars which extend substantially in axial direction of the primary crushing roll. These bars effect a very good dosing and a sufficient primary crushing of very large nodules which would be crushed with more difficulty in the pneumatic crushing device. In place of these long straight bars, one could also employ prongs or shorter bars which are offset with respect to one another.

What we claim is:

1. Device for crushing of hot furnace discharge material, particularly hot alumina, arranged between the discharge aperture of a calcining furnace and the charging aperture of a cooler, comprising means forming a vertical material discharge channel, a rotary primary crushing roll arranged in said discharge channel between the ends thereof, a pneumatic crushing means arranged below said primary crushing roll and connected to the lower end of said vertical discharge channel which discharges the material which was crushed by said primary crushing roll, and means connecting said pneumatic crushing means with said cooler.

2. Device according to claim 1, in which said pneumatic crushing means includes a horizontally disposed guide tube into one end of which extends a drive nozzle for introducing air lengthwise into said guide tube, said discharge channel being transversely connected with said guide tube at a point where the air from said nozzle enters, said guide tube at a distance spaced from the point where the discharge channel is connected to it being provided with a bend leading upwardly to the inlet of a separator, and a discharge pipe for said separator leading to said cooler.

3. Device according to claim 1, in which the wall of said discharge channel above said primary crushing roll is provided with at least one aperture for the feed of air into said channel for loosening the material coming from the furnace.

4. Device according to claim 1, in which the circumference of said primary crushing roll is provided with material crushing tappets in the form of bars extending lengthwise of said primary crushing roll.

5. Device according to claim 1, in which said primary crushing roll is of a size so as to fill the cross sectional area of said discharge channel.

6. Device according to claim 5, in which wall portions of the discharge channel surround concentrically opposite circumferential portions of said primary crushing roll.

7. Device according to claim 5, in which wall portions of the discharge channel surround concentrically opposite circumferential portions of said primary

crushing roll, and the wall portion at the downwardly rotating portion of said primary crushing roll surrounds said crushing roll along a longer circumferential portion of said primary crushing roll than on the opposite side of said roll.

8. Device according to claim 1, in which said material discharge channel is subdivided into two branch channels and that in each one of said branch channel is disposed a primary crushing roll.

9. Device according to claim 1, in which said material discharge channel is subdivided into two branch channels and that in each one of said branch channel is disposed a primary crushing roll, and a locking gate is positioned in each of said branch channels disposed above said primary crushing roll.

10. A device according to claim 9, including an rotation monitor connected with each one of said primary crushing rolls, a drive motor for each of said rolls, an adjusting means for each one of said rotation monitors, the latter together with said adjusting means upon stoppage of one of said primary crushing rolls causing a closure of the locking gate associated with said stopped primary crushing roll and a disconnection of the respective drive motor.

11. A device according to claim 9, including a rotation monitor connected with each one of said primary crushing rolls, a drive motor for each said rolls, an adjusting means for each one of said rotation monitors, the latter together with said adjusting means upon stoppage of one of said primary crushing rolls causing a closure of the locking gate associated with said stopped primary crushing roll and a disconnection of the respective drive motor, and an additional switching means for each rotation monitor, said switching means upon stoppage of one of said primary crushing rolls causing an operation of the other one of said primary crushing roll and an opening of the locking gate connected therewith.

12. Device according to claim 2, in which the upwardly extending portion of said guide tube has a greater cross sectional area than said horizontally disposed guide tube.

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