

April 28, 1959

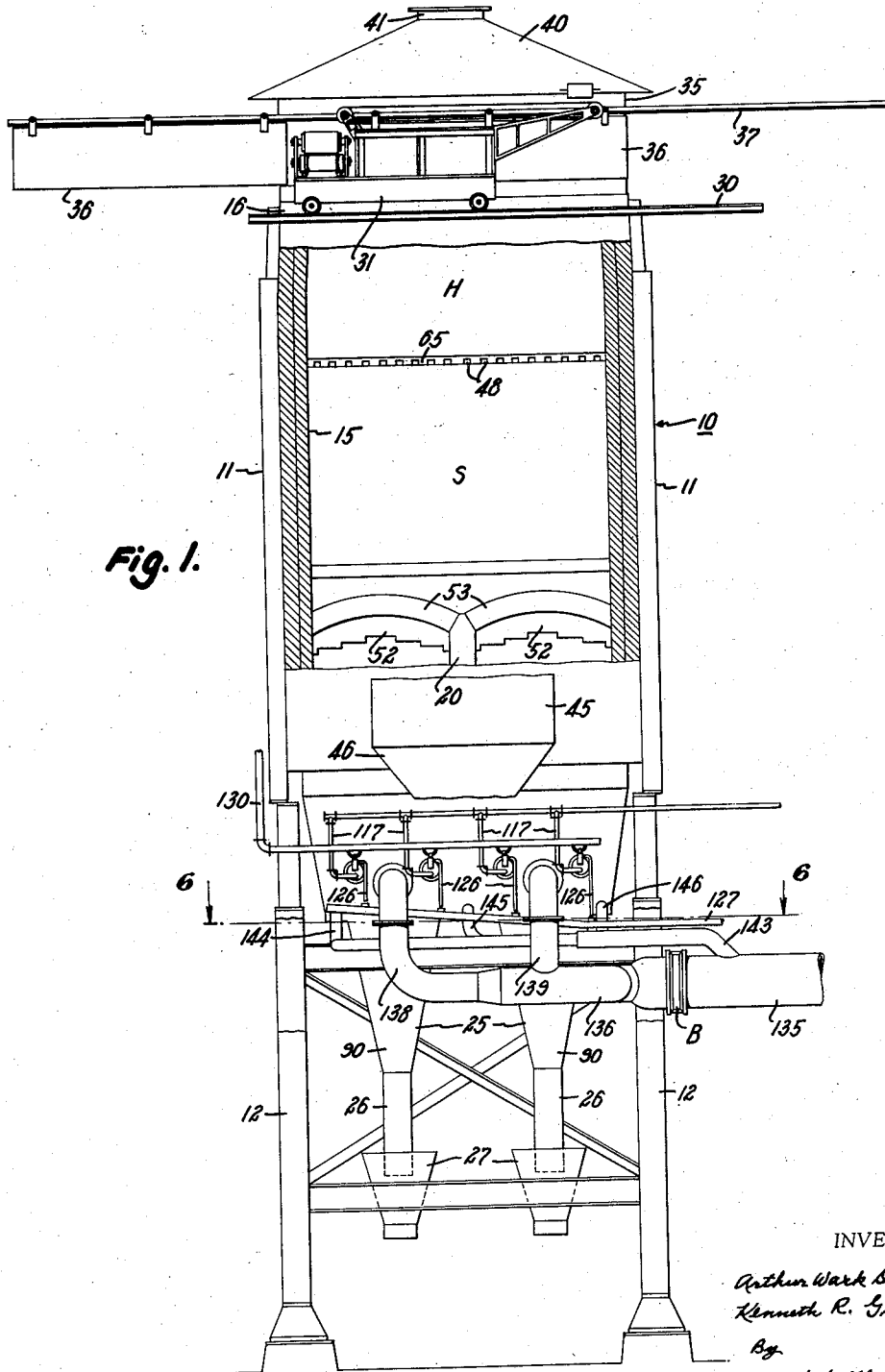
A. W. STORM ET AL

2,884,237

CHUNK BREAKER FOR RECTANGULAR FURNACE

Filed Oct. 20, 1955

4 Sheets-Sheet 1



INVENTORS

Arthur Wark Storm
Kenneth R. Groll,

By

Pierce, Scheffler & Parker
their ATTORNEYS

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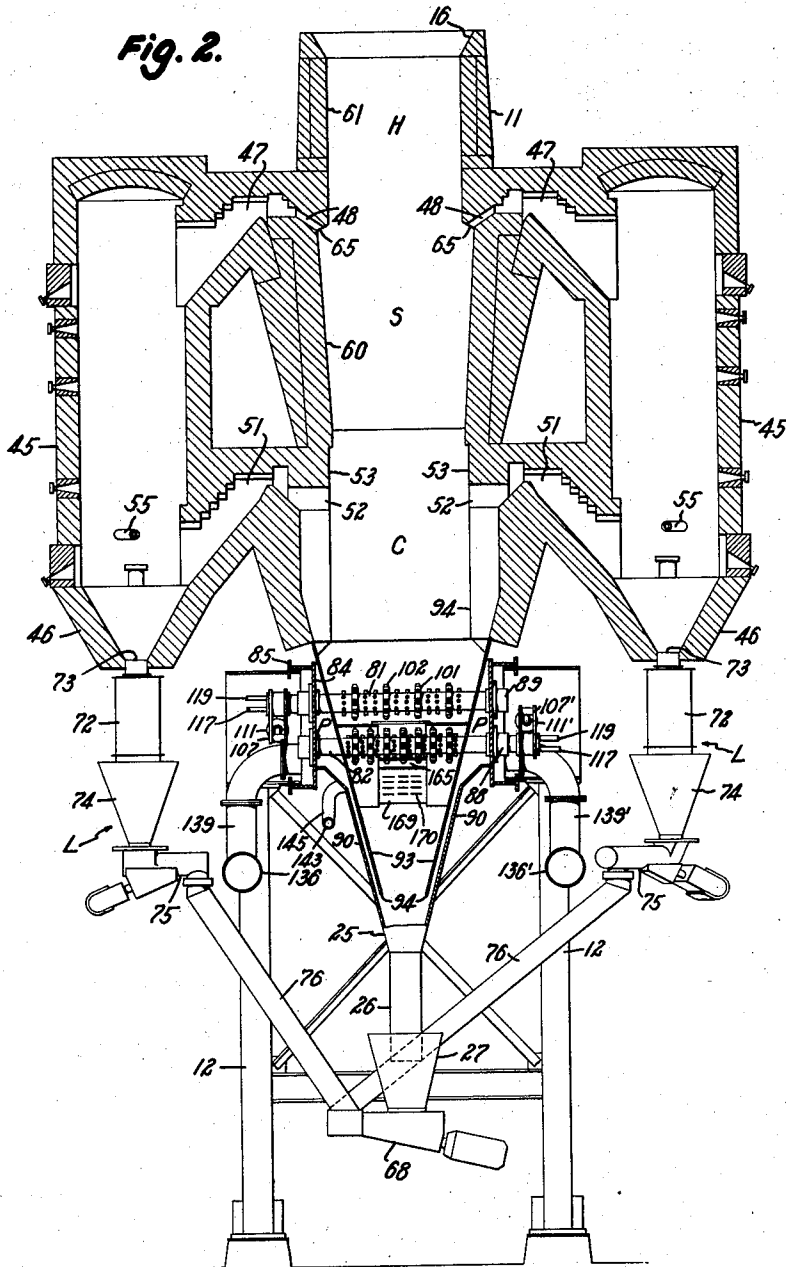
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CHUNK BREAKER FOR RECTANGULAR FURNACE

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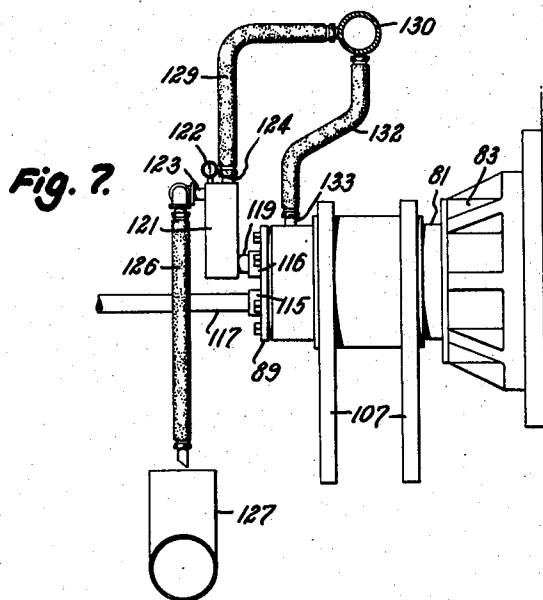
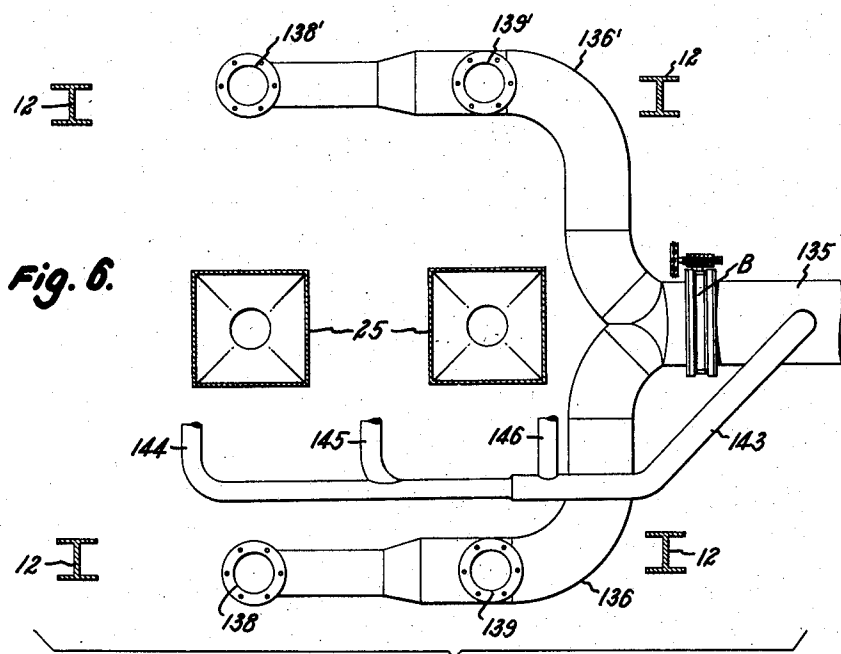
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CHUNK BREAKER FOR RECTANGULAR FURNACE

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2,884,237

CHUNK BREAKER FOR RECTANGULAR FURNACE

Arthur Wark Storm, Duluth, and Kenneth R. Groll, Aurora, Minn., assignors to Erie Mining Company, Hibbing, Minn., a corporation of Minnesota

Application October 20, 1955, Serial No. 541,589

7 Claims. (Cl. 263—29)

This invention relates to the art of indurating pellets (small balls), glomerules, briquets or similar small fluent bodies composed of at least loosely cohering particles of mineral solids such as ore fines or concentrates, whereby to confer upon such bodies a mechanical "strength" and ruggedness akin to that of naturally occurring ore or rock masses whilst minimizing aggregation of the pellets into "chunks" or large masses. The invention is concerned with the provision of an improved vertical shaft-type furnace for use in the process of indurating such bodies.

In this art it is conventional to form the vertical shaft-type furnace as a series of three communicating chambers of which the uppermost may be styled the "heating chamber" in that therein the "green" or unheated bodies are dried and heated to the maximum temperature attained in the process, the intermediate chamber or so-called "middle stove" may be styled the "soaking chamber" in that therein the already highly heated bodies are maintained at a relatively high temperature, while the lowermost may be styled the "cooling chamber." Associated with this three-chambered furnace is at least one combustion chamber wherein a stream of preheated oxidizing gas—air—diverted from the cooling chamber through the contents of which the gas had been forced under suitable pressure, is heated by burning a fuel in such preheated oxidizing gas, and wherefrom the resulting stream of heated gases—i.e. air and gaseous combustion products—are diverted to and into the bottom of the heating chamber for passage upwardly through that portion of the column of fluent bodies occupying said heating chamber.

It heretofore had been proposed to construct the intermediate and lowermost chambers in the form of inverted truncated pyramids (or, cones) so disposed and of such size and configurations that the bottom part of the intermediate chamber was smaller than and communicated directly with the upper (larger) end of the cooling chamber, whilst the lower end of the generally straight-sided heating chamber was smaller than and communicated directly with the upper (larger) end of the intermediate chamber, whereby to provide relatively large open spaces or plenum chambers at the junctures of the lowermost and uppermost chambers with the intermediate chamber. Such relatively large plenum chambers were thought to be essential for the ready egress and ingress, respectively, of the current of initially cold air being moved counter-currently through the charge column of the furnace—into and through said combustion chamber and thence into said column again. U.S. Patent No. 2,646,900 generally illustrates the prior art indurating furnace above described.

It has been found that it is neither necessary nor desirable that substantially all of the current of cooling gas be diverted out of the charge column to and through the combustion chamber, it being preferable that a substantial portion, from one-third to three-fifths, only, of the total current be diverted to the combustion chamber whilst the residual portion of the total current passes, undiverted, through that part of the charge column which occupies the intermediate chamber. Very substantial reduction in

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the amount of gas diverted to the combustion chamber minimizes any necessity for large plenum chambers.

It is an inherent necessity of the successful carrying out of this indurating process that the charge column move downwardly through the heating and intermediate chambers of the shaft-type furnace (a) uninterruptedly, and (b) "as a whole," i.e., that the column gravitate at a regulated rate and that the peripheral portions of the column descend at the same (or, substantially the same) rate as does the "core" or axially central portion of the column.

Gross aggregations (i.e., "chunks") of initially discrete pellets in the column—formed either as a result of localized over-heating or as a result of consolidation of "green" pellets through inadvertent condensation of water thereon and thereamongst—are bound to interfere with the uniform descent of the column; such chunks may and sometimes do assume such size as to "bridge" across the pyramidally (or conically) tapered part of the cooling chamber and thereby substantially stop further downward movement of the overlying column.

It is, therefore, an important object of the present invention to provide, within the furnace and in the path of the descending charge column, means for mechanically reducing the size of, e.g., breaking or crushing, any gross aggregations or chunks which may be present in the column.

It has been found that a substantial inward taper of those walls of the furnace which are in contact with the hottest sections of the charge column (i.e., the walls of the heating and intermediate chambers and the walls of the upper part of the cooling chamber) provides supporting surfaces for the peripheral portions of the charge column on which surfaces the peripheral portions of the column tend to "hang" or cling.

It is, therefore, an object of the invention to so shape the walls of those portions of the furnace which are immediately adjacent the hottest sections or zones of the charge column as to prevent hanging of the column on said walls.

According to the present invention the regular, uniform and uninterrupted descent of the charge column is effected by providing novel chunk-breaking means—hereinafter more particularly described—in the lower part of the cooling chamber, and by so shaping the walls of the heating and intermediate chambers and the walls of that part of the cooling chamber which extends above the level of the chunk-breaking means that a straight, or substantially straight, unobstructed path is provided for the charge column, from the stockline thereof down to the zone of influence of the chunk-breaking means.

The heating and intermediate chambers of the furnace of the present invention taken together constitute a thermally insulated, substantially straight-walled, shaft which in cross-section is a rectangle substantially longer than it is wide, e.g. twice as long as it is wide. The upper part of the cooling chamber similarly is thermally insulated and is co-extensive in dimensions with the contiguous lower end of the intermediate chamber. In its lower part, the cooling chamber divides into two substantially equal channels, each substantially square in cross-section and being in the form of an inverted elongated pyramid which may or may not be thermally insulated.

A pair of thermally insulated combustion chambers are disposed opposite the intermediate chamber of the furnace, each being adjacent a long side of the shaft. At its lower end, each combustion chamber communicates with the interior of the shaft by way of a thermally insulated gas passage terminating in arched openings in the walls of the cooling chamber channels at substantially the level of the top of the septum wall which separates said channels. At its upper end, each combustion chamber com-

municates with the interior of the shaft by way of a thermally insulated gas passage terminating in a plurality of spaced ports across the "long side" of the shaft and let into the walls of the latter at the level of the bottom of the heating chamber.

The novel chunk-breaking means of the present invention are disposed, transversely of the furnace, across the upper ends of the pyramidal terminal portions of the cooling chamber channels, and are associated with novel means for introducing the cooling air current into the furnace, and into the charge column therein, in the zone of the influence of said chunk-breaking means. Said chunk-breaking means consists principally in two spaced, superposed banks or arrays of horizontally disposed rotatable breaker shafts the peripheral surfaces of which are provided with protuberances adapted, when the shafts are rotated, so to act upon any chunks or aggregations of pellets which may be present in that stratum of the charge column immediately above them as to reduce the size of such chunks, by abrasion, sawing action, grinding action or equivalent disintegrative treatment, to that of pieces sufficiently small to be unable to obstruct the even, uninterrupted, gravitational descent of the pellets column through the remainder of the shaft.

Spatially associated with said chunk-breaking means are the aforesaid means for admitting a current of initially "cold" air into the column of pellets, the same including louvered and slotted members extending across the cooling chamber, from one "long side" to the other, and "bustle" air introducing means along the opposed outer and inner walls of the pyramidal portions of the cooling chamber channels, the combination being adapted to introduce cooling air uniformly throughout the cross-section of the charge column adjacent to the chunk-breaking means.

The furnace is provided with suitable pellets-feeding means, pellets-discharging means and the conventional appurtenances of shaft-type indurating furnaces.

The invention will now be described with greater particularity and with reference to the accompanying drawings, in which

Fig. 1 is a front elevational view, partly in section and with certain parts removed, of a shaft-type indurating furnace embodying principles of the invention;

Fig. 2 is a side elevational view, partly in section, of the furnace shown in Fig. 1;

Fig. 3 is an enlarged front elevational view, in section, of a preferred form of chunk-breaking means in association with a preferred form of air inlet means;

Fig. 4 is an enlarged fragmentary side elevational view, partly in section, of the combination shown in Fig. 3;

Fig. 5 is a front elevational view of a portion of the furnace shown in Fig. 1 showing means for rotating the shafts of the chunk-breaking means;

Fig. 6 is a sectional view of the furnace at line 6—6 of Fig. 1, showing the disposition of air conduits with respect to the bottom portions of the cooling chamber of the furnace and

Fig. 7 is a detailed view illustrating an arrangement of coolant conduits in association with one shaft member of the chunk-breaking means.

It will be seen from a consideration of the drawings, that the invention is embodied in a shaft-type furnace, designated generally 10, of rectangular cross-section. The furnace comprises a shell 11, formed of metal plates, which is supported by substantially vertical leg members 12, 12. Shell 11 is provided with a refractory lining 15 extending from the mouth 16 of the furnace downwardly to define the walls of the heating chamber "H," the intermediate soaking chamber "S" and at least the upper part of the cooling chamber. The cooling chamber "C" comprises a vertical extension of intermediate chamber "S," which in its lower part divides into two, substantially equal, inverted elongated pyramids 25, 25, which ter-

minate in tubular discharge ducts 26, 26, of substantially square cross-section, debouching into closed hoppers 27, 27.

Adjacent one long side of the furnace 10 there is positioned a horizontal track means 30, suitably supported on framing structure (not shown), on which a wheeled loading mechanism, designated generally 31, is adapted to move back and forth over the mouth of the furnace for delivering a supply of "green" (i.e., unheated) pellets evenly onto the stockline of a column of pellets substantially filling the shaft of the furnace. This loading mechanism—which forms no part of the present invention—may be, and preferably is, that described and claimed in co-pending application Serial No. 437,948 filed June 21, 1954, now U.S. Patent No. 2,834,484, in the names of Fred D. De Vaney and Donald Beggs, and assigned to the same assignee as is the present application.

Above the mouth 16 of the furnace there is disposed a housing, designated generally 35, three sides of which are stationary and the fourth side of which—adjacent loading mechanism 31—is composed of a plurality of co-acting doors 36, 36 supported on and horizontally translatable along a horizontal door rail 37 in accordance with movement of loading mechanism 31 whereby at all positions of the latter the extent of opening into housing 35 may be minimized. Housing 35 is surmounted by a hood 40 having a centrally disposed opening 41 adapted to be connected to the intake side of an exhaust blower (not shown) for positive displacement of steam, dust and gases from the interior of the housing.

On either side of furnace 11 there is disposed a refractory-lined combustion chamber, designated generally 45, having a hopper-shaped bottom 46. Each combustion chamber 45 communicates, adjacent its upper end, with the interior of the furnace 11 by means of a refractory-lined upper gas passage 47 which terminates in a plurality of downwardly directed gas inlet ports 48, 48 which are spaced, in a generally horizontal row, along the adjacent "long side" of the furnace at a level coincident with the junction of the heating and soaking chambers "H" and "S." Each combustion chamber 45 also communicates, adjacent its lower end, with the interior of the furnace 11 by means of a refractory-lined lower gas passage 51 which terminates in a pair of gas outlet openings 52, 52 formed in lining 15 by a pair of masonry arches 53, 53, supported in part by pilasters 20, 20 which extend outwardly for a convenient distance, e.g. 15 inches, from the long side walls of the chamber. At 55 is indicated an opening, in the wall of each combustion chamber 45, for a fluid fuel burner (not shown). The combustion chambers are provided with the manhole openings, viewing orifices and the like conventionally employed in high-temperature combustion chamber installations.

It is to be noted that the opposed walls 60, 60 forming the "long sides" of soaking chamber "S" taper outwardly, from bottom to top, at a very slight angle, say, approximately 3 degrees from the vertical, whereby their upper ends are outset with respect to the lower ends of the generally vertical "long side" walls 61 of heating chamber "H" to provide—in cooperation with a charge of pellets filling the furnace shaft—an elongated plenum space 65 into which ports 48, 48 may discharge. The end walls of the heating chamber "H" may have, as indicated in Fig. 1, a slight batter, whilst its "long side" walls are substantially vertical. It will be seen, then, that the heating, "soaking" and cooling chambers including the upper portion of cooling chamber "C" provide uninterrupted gravitational passage for a column of pellets from the mouth of the furnace to the zone of influence of the chunk-breaking means hereinafter to be described.

Beneath each closed hopper 27 there is located a pellets-discharging mechanism, designated generally 68, adapted positively to induce withdrawal of pellets from

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the furnace at a controlled, variable rate appropriate for maintaining substantially constant the height of the stockline of a column of pellets filling the furnace irrespective of variations in the rate at which "green" pellets may be delivered to such stockline. Hopper 27 and mechanism 68 are substantially gas-tight.

Each combustion chamber 45 is provided with means—styled herein as a "dust leg" and designated generally "L"—for collecting and removing settled-out dust from the combustion chamber and for delivering it into pellets-discharging mechanism 68. The same comprises, in cooperative sequence, a first dust conduit 72 communicating with the interior of the hopper bottom 46 of the combustion chamber through an apex opening 73 in the latter, a dust hopper 74, a vibratory discharge device 75, and a second dust conduit 76 communicating with pellets-discharging mechanism 68. Dust legs "L," "L" function to collect and divert to the final product of the furnace any of the dust which is produced during the heat-treatment of the pellets and transported by the countercurrent stream of air into the combustion chambers.

In preferred form, the chunk-breaking means comprises an upper horizontal row of three symmetrically spaced, horizontally disposed, parallel, rotatable, hollow, breaker shaft members 81, 81 extending across the furnace and through the opposed "long side" walls thereof, and, spaced therebeneath, a lower horizontal row of four symmetrically spaced, horizontally disposed, parallel, rotatable, hollow, breaker shaft members 82, 82 similarly spanning the furnace and having their long axes parallel with the long axes of the breaker shaft members constituting said upper row. The ends of each of breaker shaft members 81, 81 are journaled, exteriorly of the furnace, in a pair of bearing members 83, 83 secured to a pair of vertically disposed bearing plates 84, 84 welded or bolted to framing members 85, 85 carried by the supporting leg members 12, 12. Similarly, the ends of each of breaker shaft members 82, 82 are journaled in a pair of bearing members 88, 88 likewise secured to the bearing plates 84, 84. As shown more particularly in Fig. 7, the ends of hollow breaker shaft members 81 and 82 are closed by means of replaceable closure members 89.

Adjacent the lower ends of bearing plates 84, 84 and welded (or otherwise secured) in gas-tight manner there-to are opposed side plate members 90, 90 of the pyramidal lower portion 25 of cooling chamber channel "C" which side plate members have their lateral edges continuously welded to the adjacent edges of complementary end plate members 91, 91 to define the pyramidal lower portion 25 of said channel. Interiorly, opposed shield plate members 93, 93 depend from the lower ends of long side walls 94, 94 of the cooling chamber. Said shield plate members are spaced from, and parallel to the lower portions of, side plate members 90, 90 and terminate adjacent the bottom of cooling chamber "C"; in cooperation with side plate members 90, 90 they define a pair of relatively narrow open-ended elongated open spaces or plenum chambers, indicated in Fig. 4 by the reference "P," on opposite sides of the pyramidal portions 25, 25 and in communication with the interiors of the latter. Breaker shaft members 81, 82 extend through openings 95, 96 in said shield plate members, and the openings are sealed by sealing members 97, 98, respectively.

As shown in Figs. 2, 3 and 4, those portions of the peripheral surfaces of breaker shaft members 81 and 82 which are disposed between opposed shield plate members 93, 93 are studded with protuberances adapted—when the breaker shaft members are rotated—to engage and break up any chunks or gross aggregations of fused-together pellets which may be present in the pellets column gravitating within the zone of influence of the chunk-breaking means. Preferably, each of breaker shaft members 81 and 82 is provided with a series of spaced, raised circumferential rings 101, 101, to which are secured a plurality of studs 102, 102 formed of hard and wear-

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resistant alloy. On either side of ring 101 is at least one circumferential row of knobs 104, formed of similar wear-resistant alloy, secured directly to the breaker shafts 81, 81. As shown, the lower row of breaker shaft members 82, 82 may be provided with a proportionately greater number of stud-carrying rings 101 than are the breaker shaft members 81, 81 of the upper row: they may, as shown, be provided with knobs 104 fixed directly to the lower breaker shaft members 82, 82, or such knobs may be omitted from the latter, as desired.

Rotation of breaker shaft members 81, 81 is effected in the following manner: To one end of each breaker shaft member 81 is secured a crank arm 107 which is pivotally connected (as shown more particularly in Fig. 4) to a drive rod 108. Drive rod 108, in turn, is pivotally connected to the outer end of piston shaft 110 which is secured to an actuating piston (not shown) reciprocable within hydraulic cylinder 111. Preferably, the stroke is so adjusted that the breaker shaft members 81, 81 rotate through an arc of about 30°, and the total time of one complete cycle of rotational movement (through such arc) is preferably adjusted to about 1.5 minutes, but of course may be varied in accordance with varying operational requirements.

Rotation of the breaker shaft members 82, 82 of the lower row is effected by a combination of crank arms 107', drive rod 108', hydraulic cylinder 111' and piston 110' similar to that above described. As shown in Fig. 5, the mechanism operating the lower row of breaker shaft members is positioned on the opposite side of the furnace and is associated with those ends of breaker shaft members 82, 82 which are remote from those ends of breaker shaft members 81, 81 to which the above-described mechanism operating breaker shaft members 81, 81 is connected.

Cooling water or other fluid coolant preferably is circulated through each of the breaker shaft members of the upper and lower rows. For this purpose, closure member 89 is provided with two openings 115 and 116, through the former of which a water inlet pipe 117 extends for a substantial distance within the hollow breaker shaft member, while a water outlet pipe 119 is threadedly secured in opening 116. Inlet pipe 117 is operatively associated with a suitable source (not shown) of cooling water. At its outer end outlet pipe 119 is operatively associated with a thermostat box 121 which is provided at its upper end with a thermostatic control member 122 and with an outlet 123 for water and a second outlet 124 for steam. Outlet 123 is associated with a flexible tube 126 for leading off heated coolant water to drain 127, whilst outlet 124 is associated with a similar flexible tube 129 for conducting steam from box 121 to and into steam discharge conduit 130. A similar flexible tube 132 communicates between a vent member 133 provided in the upper arc of breaker shaft member 81 and said steam discharge conduit 130. As will be understood, thermostatic control member 122 is adapted to function to vary the rate at which cooling water is delivered to the interior of breaker shaft member 81, and may if desired additionally function to actuate a suitable alarm system in the event of failure in the cooling water supply. Preferably, sufficient cooling water is circulated through breaker shaft member 81 to maintain the latter at a temperature of the order of that of boiling water. Breaker shaft members 82, 82 are similarly equipped for cooling.

Air, under pressure, for cooling the heat-treated pellets is introduced into the pellets column of the furnace, at the level of the zone of influence of the chunk-breaking means, in the following manners. An air main 135, operatively associated with a source (not shown) of air under pressure, divides into two similar manifolds 136, 136', each of which communicates between main 135 and two similar air ducts 138, 139, each of which latter serves a pyramidal lower portion 25 of cooling chamber "C."

A supplemental air duct 143 communicates between main 135 and three air distributing pipes 144, 145 and 146 which terminate at the end walls of cooling chamber "C" at the upper extremities of end plate members 91, 91. Between the point of branching off of supplemental air duct 143 and the point of bifurcation of main 135 there is disposed in the latter a butterfly valve, identified at "B" in Fig. 6, for maintaining a predetermined desired pressure differential (e.g. 3-4" water) between the air in 143 and the air in 136, 136'. Pipes 144 and 146 deliver cooling air into the interiors of elongated hopper bustle air channels 147 and 148, respectively, which extend along the upper edges of end plate members 91, 91, being co-extensive with the same, and which discharge relatively thin "sheets" of cooling air into the adjacent pellets column through downwardly directed slot-like openings, 149 and 150, respectively, along substantially their entire length. Air distributing pipe 145 delivers cooling air into the interior of a central duct member 153 which extends across the cooling chamber at the junction of the bases of the pyramidal lower parts of cooling chamber "C." Central duct member 153 is defined by shield plate members 93, 93, sloping side wall plates 154, 154, top wall plate 155 and a bottom plate 156 the side edges 157, 157 of which flare downwardly and terminate in the opposed inner walls of the pyramidal lower portions 25, 25 of cooling chamber "C." The lower edges of side wall plates 154, 154, are spaced above the flared side edges of the bottom plate to provide elongated passages, 158, 158 for the discharge of cooling air into the adjacent pellets column.

Air ducts 138 and 139 are in communication with plenum chambers "P," "P" through suitable openings, indicated in broken lines in Fig. 3, and deliver cooling air into said plenum chambers. These latter, in turn, are in communication with each other—across the cooling chamber—by means of three spaced open-ended discharge duct members of which the outer two, 161, 161, are similar and the intermediate one, 162, of which is disposed above and contiguous with duct member 153. Discharge duct members 161, 162, 161 are disposed substantially in the plane of, and between the lower row of breaker shaft members 82, 82, and vertically beneath the upper row of breaker shaft members 81, 81. As regards their upper parts, discharge duct members 161, 162, 161 are identical and said upper part is characterized as follows: The side walls are composed of downwardly outwardly sloping spaced louver members 165, 165 so disposed as to define perforate side walls which taper outwardly from top to bottom, which side walls are surmounted by an imperforate plate member 166. The lower part of each of discharge duct members 161, 161 is an open-bottomed trough composed of two similar plate members 169, 169 provided with rows of spaced horizontal slots 170, 170. Cooling air is discharged, at several elevations (for better distribution), from between the spaced louver members 165, 165 of discharge duct members 161, 162, 161 and through slots 170, 170 and slot-like openings 171, 171 of the rough-like lower parts of discharge duct members 161, 161 into the pellets column immediately adjacent the zone of influence of the chunk breaker mechanism, where the pellets column is loosened by the latter, and functions to cool the chunk breaker mechanism as well as the intimately contacted pellets. As was noted above, cooling air is also introduced, at substantially the same level, into the hopper portions of the cooling chamber channel through the openings 150 and 158. Some small fractional part of the total cooling air also discharges from the plenum chambers "P," "P" at the lower edges of plates 93, 93 into the pellets, exerting its cooling effect at the latter level.

In carrying out the indurating operation in the furnace of the present invention, as the charge column gravitates through the heating chamber, the "middle stove" and cool-

ing chamber in sequence, and into the zone of influence of the chunk-breaking means, the breaker shaft members are slowly rotated so as to "saw" or grind against any "chunks" resident in the contacted stratum of the column, breaking the same into small pieces readily accommodated by the subsequently encountered parts of the furnace. Coincidentally, cooling air is introduced uniformly into the same stratum of the column, for upward passage through the cooling chamber.

It is to be understood that the invention is applicable to shaft-type furnaces of rectangular cross-section regardless of the ratio of the long and short axes of the rectangle. The furnace may have a square or rectangular cross-section, and if rectangular the long axis may be two or three or more times as long as the short axis. The exact configuration of the cooling chamber channel or channels beneath the chunk-breaking and air-introducing means is a matter of indifference, and its cross-section or their cross-sections may be round or oval as well as square or rectangular.

As will be appreciated, the novel chunk-breaking means of the present invention is not restricted to a combination of three upper and four lower breaker shaft members: the combination may consist essentially of at least one upper breaker shaft member and at least two lower breaker shaft members disposed in staggered relation to the upper breaker shaft member or members. The arc of rotation of the upper breaker shaft members may be the same as, or different than, that of the lower members, as desired, and may be less than or greater than the 30° arc above recited.

We claim:

1. The combination with a generally vertical shaft-type furnace, of substantially rectangular cross-section, for heat-treating discrete fluent pellets gravitationally descending therethrough from top to bottom thereof in a substantially continuous column, said furnace comprising an upper part which constitutes an unobstructed generally straight-walled shaft and a lower part which is relatively constricted, of means for disintegrating chunks of agglomerated pellets in such column said means comprising a plurality of horizontally disposed parallel, rotatable breaker shaft members extending across the shaft intermediate its top and bottom and above the relatively constricted lower part of the furnace said members being arranged in two substantially horizontal rows one above the other there being a plurality of members in each row and one less member in the upper row than in the lower row, the members of the lower row being staggered in non-overlapping relation with respect to the members of the upper row, said members being spaced apart from each other a distance substantially as great as is the diameter of any of the breaker shaft members and sufficiently great to enable discrete pellets freely to gravitate therebetween and said members being adapted upon rotation thereof to disintegrate fused-together chunks of agglomerated pellets gravitating into contact with said means into pieces having such small size as to be incapable of obstructing gravitational flow of particles through the relatively constricted lower part of the furnace, and means for rotating said members to effect such chunk-disintegrating function.

2. The combination with a generally vertical shaft-type furnace, of substantially rectangular cross-section, for heat-treating discrete fluent pellets descending therethrough from top to bottom thereof in a substantially continuous column, said furnace comprising an upper part which is an unobstructed generally straight-walled shaft and a lower part which is relatively constricted, of means for disintegrating chunks of agglomerated pellets in such column said means comprising a plurality of horizontally disposed parallel, rotatable breaker shaft members extending across the shaft intermediate its top and bottom and above the relatively constricted lower part of the furnace said members being arranged in two substantially horizontal rows one above the other there being a

plurality of members in each row and one less member in the upper row than in the lower row, the members of the lower row being staggered with respect to the members of the upper row, said members being spaced apart from each other for a distance sufficiently great to enable discrete pellets freely to gravitate therebetween and said members being adapted upon rotation thereof to disintegrate fused-together chunks of agglomerated pellets gravitating into contact with said means into pieces having such small size as to be incapable of obstructing gravitational flow of particles through the relatively constricted lower part of the furnace, means for rotating said members to effect such chunk-disintegrating function, and means for introducing streams of cooling gas under pressure into the shaft furnace at a plurality of loci adjacent to and between said breaker shaft members whereby to effect substantially uniform distribution of cooling gas across the cross-section of the shaft in the zone of said members.

3. The combination with a generally vertical shaft-type furnace, of substantially rectangular cross-section, for heat-treating discrete fluent pellets composed of mineral particles descending therethrough from top to bottom thereof in a substantially continuous column, said furnace comprising in its upper part a heating chamber and in its lower part a cooling chamber, in which the heating chamber and upper part of the cooling chamber are substantially co-extensive in cross-sectional area and together present an unobstructed generally straight-walled shaft while the lowermost part of the cooling chamber is relatively constricted, said furnace being provided adjacent its top with means for continuously depositing such pellets onto the top of such column and adjacent the bottom of the constricted lowermost part of the cooling chamber with means for discharging heat-treated pellets from the furnace, of means for disintegrating chunks of agglomerated pellets in such column said means comprising a plurality of horizontally disposed parallel, rotatable breaker shaft members extending across the cooling chamber above the relatively constricted lowermost part thereof said members being arranged in two substantially horizontal rows one above the other there being a plurality of members in each row and one less member in the upper row than in the lower row, the members of the lower row being staggered with respect to the members of the upper row, said members being spaced apart from each other for a distance sufficiently great to enable discrete pellets freely to gravitate therebetween and said members being adapted upon rotation thereof to disintegrate fused-together chunks of agglomerated pellets gravitating into contact with said means into pieces having

such small size as to be incapable of obstructing gravitational flow of particles through the relatively constricted part of the cooling chamber, means for rotating said members to effect such chunk-disintegrating function, means for introducing streams of cooling gas under pressure into the cooling chamber at a plurality of loci adjacent to and between said breaker shaft members whereby to effect substantially uniform distribution of cooling gas across the cross-section of the cooling chamber in the zone of said members, said gas-introducing means including at least one plenum chamber elongated in a plane normal to the major axes of said breaker shaft members and a plurality of spaced horizontally disposed apertured duct members extending across the cooling chamber generally parallel to said breaker shaft members, each of said duct members being in communication at one end thereof with said plenum chamber and adapted to discharge cooling gas adjacent to at least one breaker shaft member, and means for supplying cooling gas under pressure to said plenum chamber.

4. The combination defined in claim 3, further characterized by the provision of a pair of said plenum chambers at opposed sides of the cooling chamber, said duct members being in communication with both of said plenum chambers.

5. The combination defined in claim 4, in which there are as many duct members as there are upper row breaker shaft members and in which each duct member is disposed beneath one upper row breaker shaft member and between adjacent lower row breaker shaft members.

6. The combination defined in claim 5, in which the upper parts of at least some of said duct members are pyramidal in cross section the sloping side walls of which are louvered.

7. The combination defined in claim 6, further characterized by the provision of supplemental means for introducing streams of cooling gas adjacent those opposed side walls of the cooling chamber which are parallel to said breaker shaft members.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,884,237

Arthur Wark Storm et al.

April 28, 1959

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 9, lines 11 and 12, for "constricted" read ~~constricted~~ constricted.

Signed and sealed this 18th day of August 1959.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents