Jan. 30, 1923.

1,443,529

A. DWORZAK.
ROTARY FURNACE OR KILN.
FILED JUNE 16, 1920.

3 SHEETS-SHEET 1

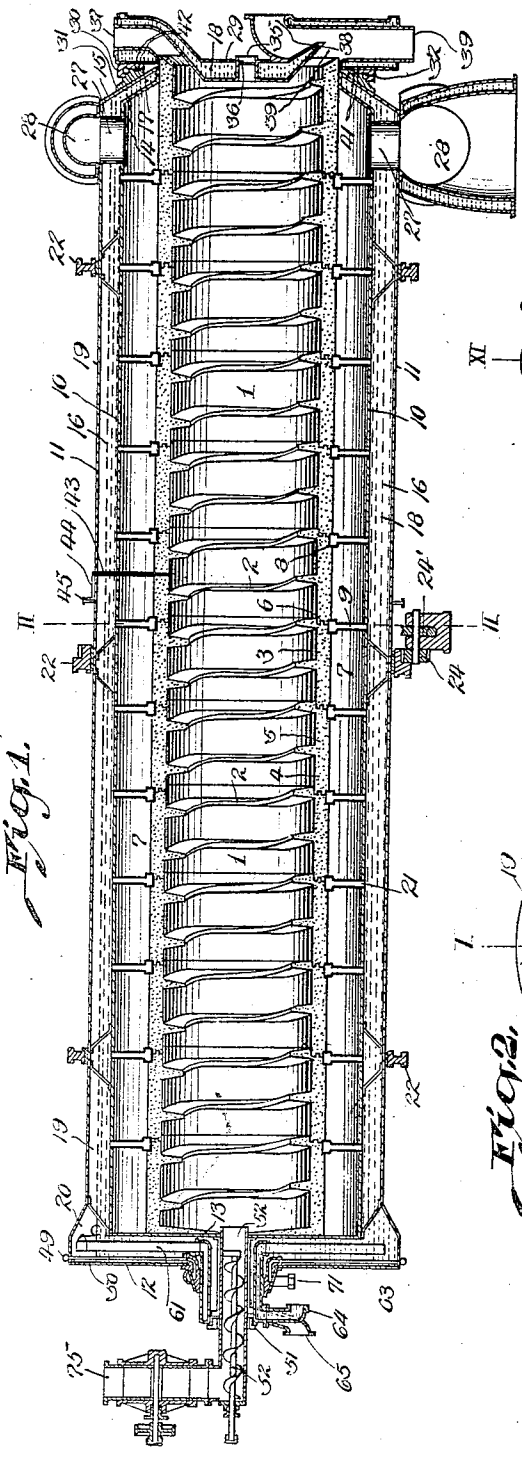


Fig. 1.

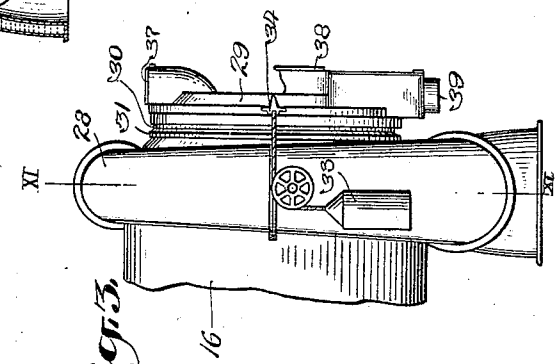


Fig. 3.

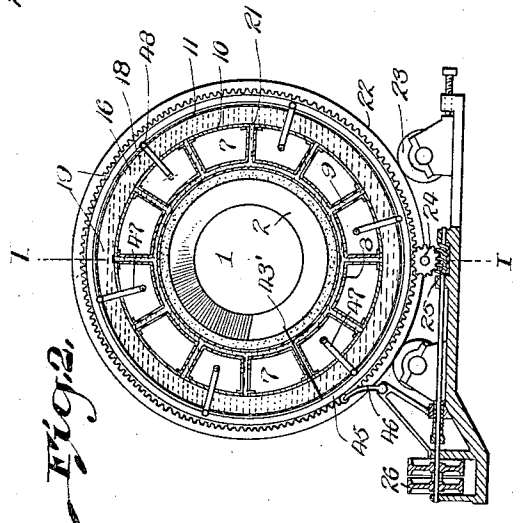


Fig. 2.

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Jan. 30, 1923.

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3 SHEETS-SHEET 2

Fig. 4.

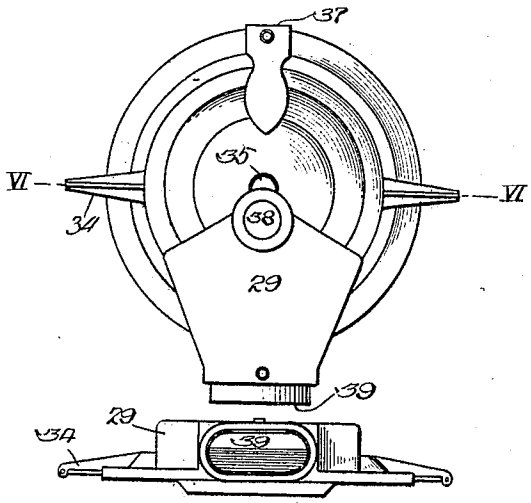


Fig. 5.

Fig. 6.

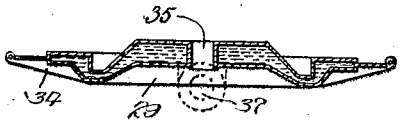
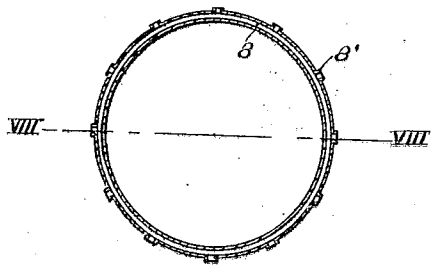


Fig. 7.



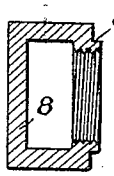
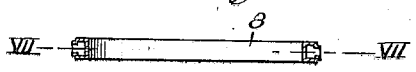


Fig. 9.

Fig. 8.



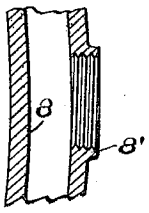


Fig. 10.

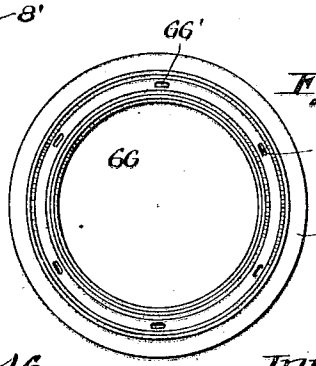


Fig. 15.

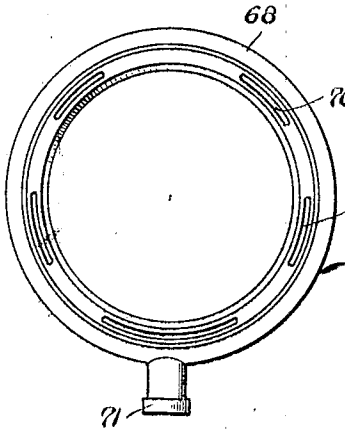


Fig. 16.

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Jan. 30, 1923.

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ROTARY FURNACE OR KILN.
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3 SHEETS-SHEET 3

Fig. 12.

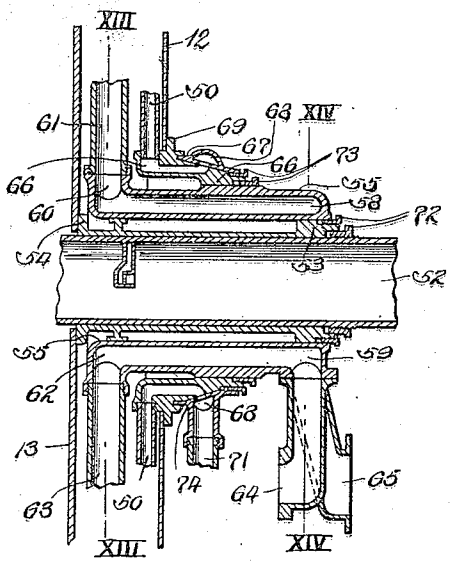


Fig. 13.

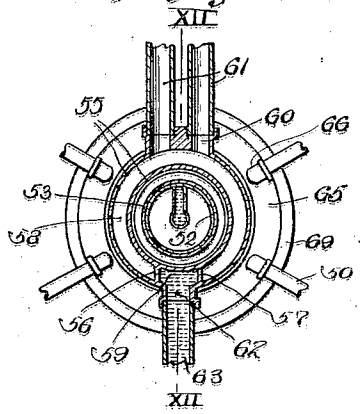


Fig. 14.

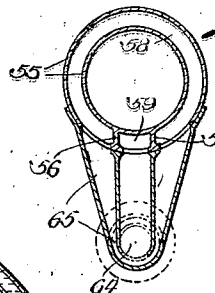


Fig. 11.

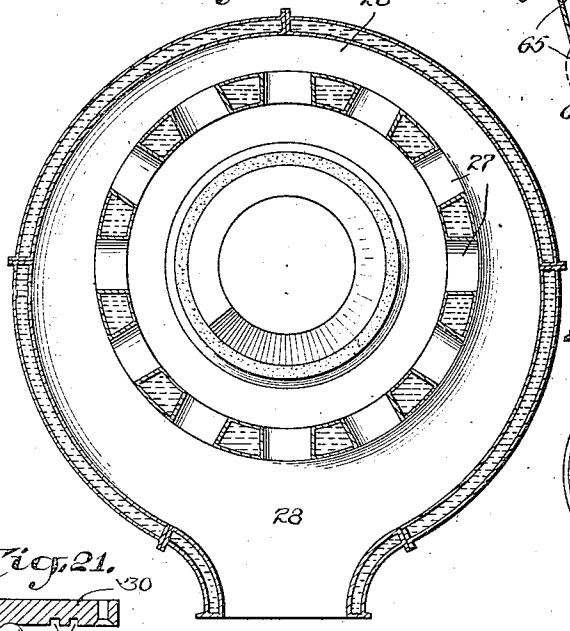


Fig. 17.

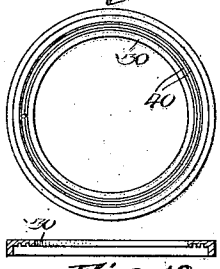


Fig. 18.

Fig. 20.



Fig. 19.

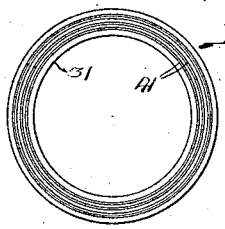


Fig. 21.

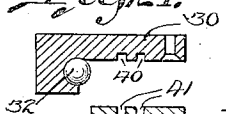
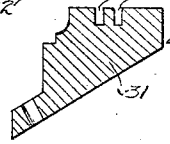


Fig. 22.



Inventor:
Adolph Dworzak

by John Lotka
Attorney.

Patented Jan. 30, 1923. 1,443,529

UNITED STATES PATENT OFFICE.

ADOLPH DWORZAK, OF NEW YORK, N. Y.

ROTARY FURNACE OR KILN.

Application filed June 16, 1920. Serial No. 389,360.

To all whom it may concern:

Be it known that I, ADOLPH DWORZAK, a citizen of Russia, and resident of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Rotary Furnaces or Kilns, of which the following is a specification.

My invention relates to rotary apparatus for agitating and feeding granular or pulverulent material while it is being heated, for the purpose of calcining such material, or driving off gases, or obtaining any action thereon which is produced by passing the material through such apparatus. The object of my invention is to construct the apparatus in such a way as to obtain great efficiency in operation and durability of the parts.

Without wishing to restrict myself to the specific structure disclosed herein, I will now describe in detail a typical and preferred form of my invention, with reference to the accompanying drawings, in which Fig. 1 is an axial vertical section of the furnace or kiln, taken on line I—I of Fig. 2, the latter being a vertical cross section on the line II—II of Fig. 1; Fig. 3 is a partial side elevation of the discharge end of the apparatus; Fig. 4 is a corresponding end elevation, and Fig. 5 a corresponding bottom view; Fig. 6 is a horizontal section of certain parts, taken on line VI—VI of Fig. 4; Fig. 7 is a section of a ring forming part of the structure, taken on line VII—VII of Fig. 8, the latter being a section of said ring on line VIII—VIII of Fig. 7; Figs. 9 and 10 show upon an enlarged scale, portions of Figs. 7 and 8 respectively; Fig. 11 is a vertical section on the line XI—XI of Fig. 3; Fig. 12 is a detail longitudinal vertical section on line XII—XII of Fig. 13; Figs. 13 and 14 are detail views in cross section on lines XIII—XIII and XIV—XIV respectively of Fig. 12; Figs. 15 and 16 are detail face views of certain parts; Figs. 17 and 19 are face views of two bearing rings forming part of the apparatus; Figs. 18 and 20 are corresponding diametral horizontal sections of these bearing rings; and Figs. 21 and 22 are corresponding enlarged views showing only the left-hand portions of Figs. 18 and 20 respectively, together with one of the bearing balls.

The furnace comprises a central longitudinal treatment chamber through which the material travels from one end to the other. This chamber is formed by a casing or muffle 1 the outer surface of which is of circular cross section (Fig. 2), while on the inner surface there is a helical rib 2 which, in conjunction with the cylindrical inner surface portions lying between the convolutions of said rib, forms a helical conveyor groove or channel 3. The muffle 1 with its rib 2 is made of refractory material. The purpose of this helical arrangement is to mix and convey the heated material through the muffle continuously during the rotation of the apparatus, thereby insuring uniform exposure of the individual particles to the heat in the muffle, facilitating the escape of the gases generated within the material, preventing mixture of the fresh incoming material with that already treated, and absolutely controlling the time during which the material is exposed to the heat.

While the muffle might be made of a single piece, it will generally be preferred to construct it in sections, as indicated at 4, 5, the joints 6 being held in place by suitable legs or braces extending through the combustion chamber 7 which surrounds the muffle 1. These legs might be solid, but in the embodiment illustrated they co-operate with hollow metal rings 8 the cylindrical inner surfaces of which are fitted against or into the outer surface of the muffle 1, while at their outer surfaces said rings 8 are formed with nipples 8′ screw-threaded to receive the inner ends of the hollow legs or braces 9, of spoke-like arrangement, the outer ends of said braces communicating with the interior of the cooling jacket which surrounds the combustion chamber 7.

The cooling jacket is formed by two spaced metal walls or shells 10 and 11, the inner shell 10 having metal heads 13 and 14 at its opposite ends, and the outer shell 11 having corresponding heads 12 and 15, the two heads at the same end of the furnace being spaced from each other so that the water or cooling compartment 16 extends between such heads as well as around the combustion chamber 7. At the feeding end (left-hand end in Fig. 1), the cooling chamber extends quite close to the axis of the furnace, while at the discharge end (right-hand in Fig. 1) the cooling chamber extends only to the outer surface of the muffle 1, as indicated at 17. As has been shown in Fig. 2, a liquid 18 (say, water)

is generally employed as the cooling agent, in which case the level of the liquid should be below the top of the jacket, so as to leave a space 19 for evaporation, the steam passing from said space 19 to a collector 20 of circular shape located at the feed end of the furnace. The muffle 1 is thus held in place relatively to the jacket, it being understood that all of these parts are connected rigidly to rotate in unison, as will be set forth below. The inner wall 10 of the jacket has openings 21 through which the liquid-space 18 of the jacket 16 communicates with the interior of the legs or braces 9 and through them with the interior of the rings 8, so that all these parts will be properly cooled. The connections for supplying water or other liquid to the jacket, and for carrying away the steam, vapors, or gases, will be set forth below.

There is a tight joint between the muffle 1 and the inner head 13 at one end, as well as between the other end of the muffle and the reduced portion of the jacket at 17. The muffle and jacket are suitably supported to enable them to rotate about the longitudinal axis of the furnace, for instance the jacket may be provided with external carrying rings 22 resting on rollers 23 (Fig. 2) journaled in stationary bearings, one of the rings 22 being toothed to mesh with a pinion 24 the shaft of which is journaled in stationary bearings and also carries a worm wheel 24′ driven by a worm 25 actuated by power applied to one of the pulleys 26, this drive being of the character well-known in connection with rotary kilns or furnaces.

At a suitable point, preferably at the discharge end of the furnace, a plurality of flues 27 extend outwardly from the combustion chamber 7 through the cooling jacket, to carry away the combustion gases from the chamber 7 in any appropriate manner; for instance, the flues 27 may lead to a water-jacketed metal flue 28 from which the gases escape directly into the atmosphere. Usual expedients, such as fans, may be employed to promote the draft and facilitate the discharge of the combustion gases.

At the outlet or discharge end of the furnace is a stationary discharge valve 29, which I prefer to provide with a water jacket, for cooling purposes. This valve is provided with, or secured to, a bearing rim 30 which fits within a companion rim 31 attached to the jacket head 15. These rims 30, 31 are arranged to overlap, and one of them rotates adjacent to the other, balls 32 being preferably interposed between the rims to reduce friction. The valve 29 is preferably pressed or held against the jacket by suitable yielding means, for instance weights 33 hung on flexible connections which are attached to arms 34 of the valve. The latter is also provided with one or more observation holes or sights 35 with tightly-fitted lenses 36, and with one or more outlets 37, 38 through which gases or vapors evolved in the treatment chamber may be led away, either to the surrounding air, or, if desired, to any suitable suction apparatus connected with said outlets and producing a partial vacuum in the furnace. The discharge spout 39 for the heated solid material is suitably connected according as the furnace is operated with a vacuum or not. When operating with a vacuum, the rims 30, 31 have one or more annular grooves 40, 41 respectively, into which project rings 42, preferably with the interposition of packing (not shown) in one or both of the grooves, to be engaged by the edge of the ring. A tight joint is thus obtained as one of the rims, 31, rotates and causes the rings 42 to slide on said packings. When operating with a vacuum, a suitable vessel, under partial vacuum (not shown) is required to receive the heated material discharged through the spout 39.

At suitable places I may install thermo-couples 43 extending through the muffle wall 1, the combustion chamber 7, and the jacket 10, 11, and properly insulated in the combustion chamber 7. As indicated at 43′ in Fig. 2, the thermo-couples may pass through a leg 9 and a ring 8. The thermo wires 44 are connected on the outside of the jacket to collector rings 45 secured to the jacket, and from these rings 45 the current is taken by means of trolleys or contacts 46 mounted on stationary supports, and connected in any well-known or approved manner with temperature-indicating devices (not shown).

Spaced conveniently throughout the heating or combustion chamber 7 are a number of burners or nozzles 47 for the admission of fuel, leading through the walls 10, 11 of the jacket. These nozzles or jets 47 are built on the injector principle, and are connected on the outside of the jacket to pipes 48, 49, and 50 which extend to the head of the jacket and to the head valve 51.

This head valve 51 has a central tube 52 leading to the muffle, for feeding the material into the muffle axially, which tube 52 may be stationary and is preferably provided with a screw conveyor 52′. The tube 52 is fitted into a cylinder 53 the end flange of which, 54, is conveniently fastened to the inner plate 13 of the jacket and rotates together with the drum part of the furnace. The cylinder 53 fits into another hollow cylinder 55 which is stationary and has radial or transverse walls 56 and 57 (see Fig. 13) dividing it into two longitudinal compartments or sectors, 58 and 59. The compartment or sector 58 is illustrated as provided with inlets 60 on the end reaching into the jacket, and there connected to pipes 61 which lead to the upper

space 20 for the collection of steam or vapors generated in the jacket, while the other compartment or sector, 59, has a port 62 and an outlet pipe 63 dipping into the lower portion of the jacket (see Figs. 1 and 12) for the supply of water or other liquid in connection with the cooling and evaporating action referred to above. Both compartments or sectors 59 and 58 have other pipes 64 and 65 respectively at the opposite end (exteriorly of the furnace), and from these pipes 64, 65 suitable connections may be made for supplying water or other liquids to the jacket, and for carrying away the vapors from the jacket.

The cylinder 55 is surrounded by a drum 66 which is provided, at the portion located within the jacket 10, 11, with ports 66′ connected with the pipes 48, 49, 50 mentioned above as leading to the jets or burners 47. At the other end, that is to say, outside the jacket, there are, leading into the interior of the drum 66, the same number of ports 66″ as there are pipe connections leading to the jets 47. This end of the drum is preferably of a conical shape, as indicated at 67, and fitted into a hollow distributing rim 68. By means of its flange 69, the drum 66 is attached to the outer shell plate 12 of the jacket 10, 11, so as to rotate therewith. I prefer to make the distributing rim 68 with a circular series of openings 70 of graduated length (Fig. 16), for the admission of fuel and air to the drum ports 66″ at points corresponding to the location of the openings 70, and during intervals of time which correspond to the relative lengths of said openings and also depend, of course, on the speed at which the drum or furnace is rotating. The fuel supply will therefore be cut off and re-established at predetermined intervals and points, it being understood that the rim 68 is stationary owing to its attachment to the stationary pipe 71 through which the mixture of fuel and air is supplied. Stuffing boxes such as 72, 73, and 74 are supplied at suitable points of the cylinder ends and of the rim.

At 75 I have indicated a rotary so-called vacuum valve, which may be of well-known construction, for preserving a tight joint while permitting the material to be fed to the conveyor 52′.

The heating of the treatment chamber and of the material therein is of a peculiar character, owing especially to the provision of openings 70 of different length. Thus the lower portion of the muffle, which contains the greatest amount or thickness of material, is heated most strongly, since the bottom opening 70 is the longest (circumferentially). Not only is this bottom opening longer than the others, but its length is such that it will always connect with at least one of the openings or ports 66′, the circumferential length of said lowermost opening 70 being at least equal to the circumferential distance between two ports 66′. It follows that the lowermost burners, controlled by the lowermost openings 70, will burn permanently, while the other burners or nozzles, controlled by the higher openings 70, will burn only intermittently. Overheating of the upper portion of the furnace is thus avoided. Inasmuch as the lowermost burners are in operation constantly during the use of the furnace, the other burners will re-light automatically, from the flames of said lowermost burners, as soon as the supply of the fuel to the intermittently-operating burners is re-established as set forth.

Various modifications may be made without departing from the nature of my invention as defined by the appended claims.

I claim as my invention:

1. A device of the class described, provided with a casing and means within said casing for feeding the material to be treated, lengthwise within said casing, a shell surrounding said casing at a distance, means for leading heating gases into the space between said casing and said shell, and another shell surrounding the first-named shell at a distance and forming therewith a jacket for the reception of cooling water.

2. A device of the class described, provided with a central treatment casing, a cooling jacket surrounding said casing at a distance, an annular heating chamber interposed between said casing and said jacket, hollow braces communicating with said jacket and extending inwardly therefrom toward said casing, and hollow rings in communication with the inner ends of said braces and in engagement with said casing.

3. A device of the class described, provided with a central casing made in sections set end to end, a cooling jacket surrounding said casing at a distance, an annular heating chamber interposed between said casing and said jacket, hollow braces communicating with said jacket and extending inwardly therefrom through the heating chamber, and hollow rings in communication with said braces and in engagement with said casing at the joints of its sections.

4. A device of the class described, provided with a central treatment casing made in sections set end to end, a cooling jacket surrounding said casing at a distance, an annular heating chamber interposed between said casing and said jacket, and hollow rings communicating with said jacket and engaging the casing at the joints of its sections.

5. A device of the class described, provided with a central treatment chamber, an annular heating chamber surrounding said

casing, and a cooling jacket surrounding said heating chamber and also having head portions extending transversely across the ends of said heating chamber.

6. A device of the class described, provided with a central treatment chamber of substantially cylindrical shape, an annular heating chamber surrounding said casing, and a cooling jacket surrounding said heating chamber and also having head portions at the respective ends of the said chamber, one of said head portions terminating at the outer surface of the casing, and the other extending inwardly beyond said surface.

7. A device of the class described, provided with a central treatment chamber of substantially cylindrical shape having an outlet at one end and axial inlet means at the other end, an annular heating chamber surrounding said casing, and a cooling jacket surrounding said heating chamber and having head portions extending transversely at the ends of said chamber, the head portion of the jacket at the outlet end of the casing extending to the outer surface of the casing, while the head portion of the jacket at the inlet end of the casing extends inwardly to said inlet means.

8. A device of the class described, provided with a rotary structure comprising a central treatment casing, an annular heating chamber surrounding said casing, a cooling jacket surrounding said heating chamber, and stationary means forming an outlet from the upper portion of the jacket, to carry away steam or other gaseous matter therefrom.

9. A device of the class described, provided with a rotary structure comprising a central treatment casing, having an inlet at one end and an outlet at the other end for the discharge of the treated material, an annular heating chamber surrounding said casing, a cooling jacket surrounding said heating chamber, and stationary means forming an outlet for gaseous product from the upper portion of the said jacket, near the inlet end of the casing.

10. A device of the class described, provided with a rotary structure comprising a treatment casing, a heating chamber surrounding said casing, burner jets in said chamber, a rotary drum in permanent connection with said burner jets, and a stationary fuel-supply ring having ports which by the rotation of said drum are brought alternately into and out of communication with the interior of the drum.

11. A device of the class described, provided with a rotary structure comprising a treatment casing and a heating chamber surrounding said casing, and means, controlled by the rotation of said structure, for admitting fuel to said chamber intermittently.

12. A device of the class described, provided with a rotary treatment casing, a rotary heating chamber surrounding said casing, burner jets in said chamber, a drum mounted to turn in unison with said chamber and casing and in permanent communication with said burner jets, and also provided with fuel-supply openings, and a stationary fuel-supply member having ports of different circumferential extent arranged to come successively into and out of registry with said fuel-supply openings of the drum.

13. A device of the class described, provided with a rotary treatment casing, a rotary heating chamber surrounding said casing, a rotary cooling jacket surrounding said heating chamber, a stationary member divided into two compartments in permanent communication with the upper and with the lower portion of the said jacket, to receive gaseous matter from said upper portion and to supply liquid to said lower portion respectively, and a rotary drum surrounding said stationary member and communicating with the heating chamber, and means for supplying fuel to said drum during its rotation.

14. A device of the class described, provided with a chambered body mounted to turn about a substantially horizontal axis, means for heating the lower portion of said body permanently, and means controlled by the rotation of said body for heating the upper portion of said body intermittently during its rotation.

15. A device of the class described, provided with a treatment casing mounted to turn about a substantially horizontal axis, a heating chamber surrounding said casing, burners located in said chamber and mounted to turn with said casing, and means, operated by the rotation of the said casing and burners, to cause an intermittent operation of the burners at the upper portion of the heating chamber.

16. A device of the class described, provided with a treatment casing mounted to turn about a substantially horizontal axis, a heating chamber surrounding said casing, burners rotating with said casing and located in said heating chamber, a drum rotating with said casing and communicating with said burners, said drum having inlet ports of even circumferential spacing, and a stationary fuel-supply member having ports adapted to register with said drum ports, the lowermost port of said member being of a circumferential extent at least equal to the circumferential distance between two adjacent drum ports, and the other ports of said member being of less circumferential extent.

17. A device of the class described, provided with a rotary treatment casing having separate means for discharging the

treated material and gaseous or volatile matter evolved therefrom respectively, and a heating chamber separate from the material-containing space of said casing, so as to keep the heating gases out of contact with the material.

18. A device of the class described, comprising a rotary structure composed of an outer shell, an inner shell spaced from said outer shell, and a casing within said inner shell and spaced therefrom, stationary means extending into the space between said two shells to supply a cooling liquid thereto and to allow vapors to escape therefrom, stationary means for supplying heating gases to the space between the inner shell and the casing at one end thereof, and for withdrawing such gases at the other end, material-supplying means located at one end of said rotary casing and having provisions for preventing the entrance of outside air, and a stationary material-discharge device located at the other end of said casing and having an air-tight joint surface against which the said casing bears while rotating.

19. A device of the class described, provided with a rotary casing adapted to contain the material to be treated, material-supplying means located at one end of said casing and having an air-tight joint surface against which the casing bears while rotating, and a stationary material-discharge device located at the other end of the casing and having an air-tight joint surface against which said casing bears while rotating, said discharge device also having a tubular outlet for gaseous matter from the casing, so that a vacuum may be produced in the casing by connecting an exhausting device with said tubular outlet.

20. A device of the class described, provided with a casing made of refractory material and having a longitudinal central space for the reception of the substances to be heated to a high temperature, means for heating the substances in said casing, and hermetically-closing inlet and outlet devices at opposite ends of said casing, to allow the substances under treatment to enter and leave said casing while excluding the entrance of outside air into the said casing.

21. A device of the class described, provided with a longitudinal rotary casing having an internal thread for feeding the material lengthwise as the casing rotates and for preventing the material lying between the turns of the thread near the entrance end of the casing, from mixing with material which has progressed farther toward the outlet end of the casing, and hermetically-closing inlet and outlet devices at opposite ends of said casing.

In testimony whereof I have signed this specification.

ADOLPH DWORZAK.