No. 658,727. Patented Sept. 25, 1900.

P. NAEF.

CHEMICAL APPARATUS.

(Application filed June 18, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

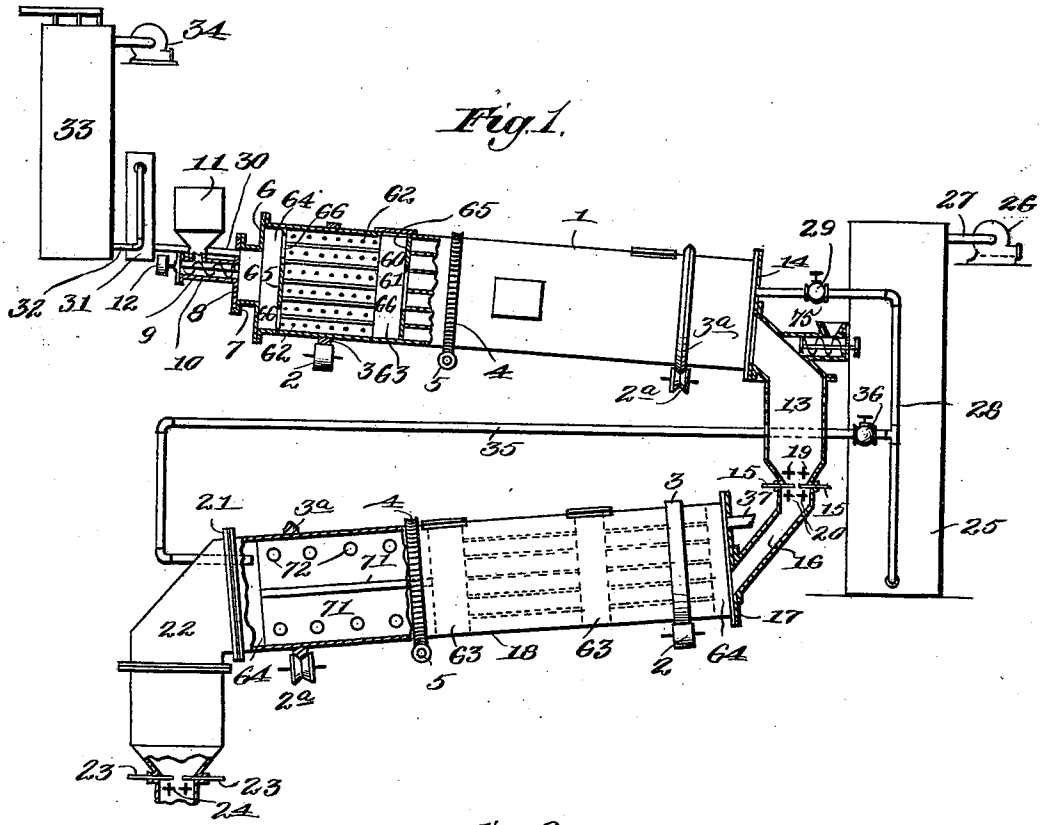
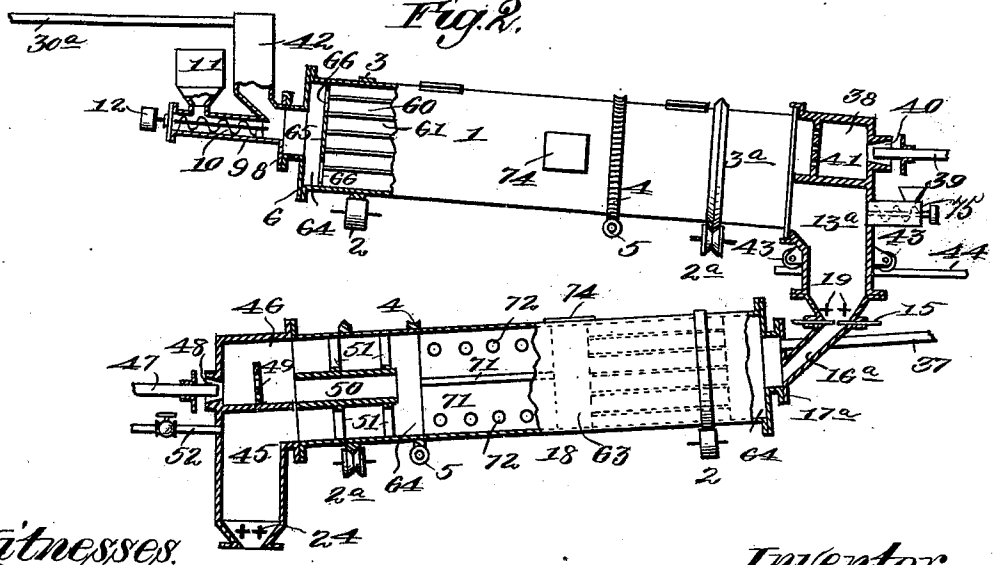


Fig. 2.



Witnesses.
Robt. Ernett.
H. B. Keeler

Inventor.
Paul Naef.
By James L. Norris.
Atty.

No. 658,727. Patented Sept. 25, 1900.

P. NAEF.

CHEMICAL APPARATUS.

(Application filed June 13, 1900.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3.

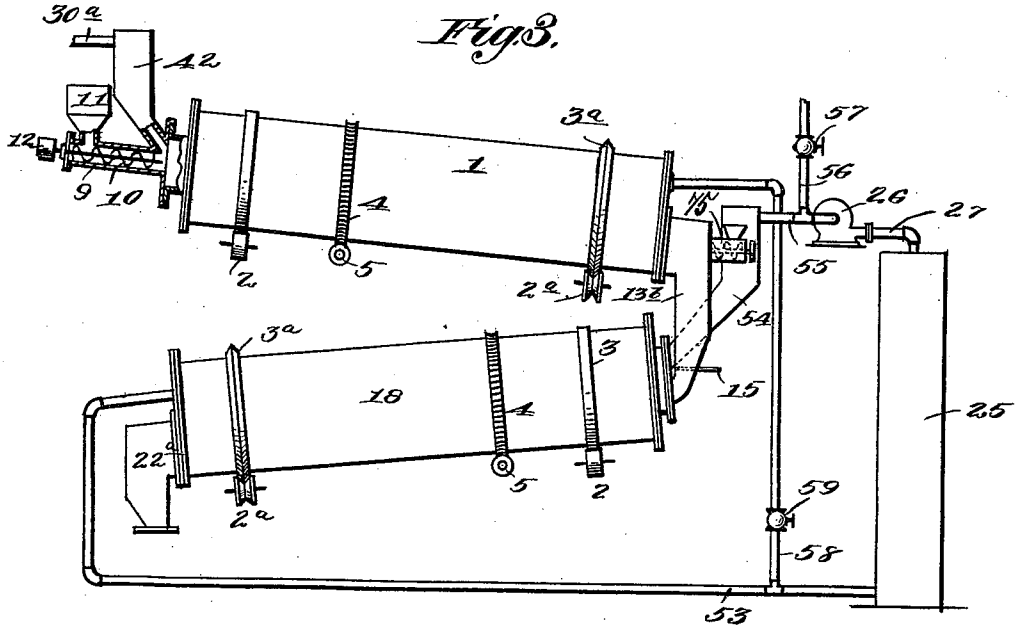


Fig. 4.

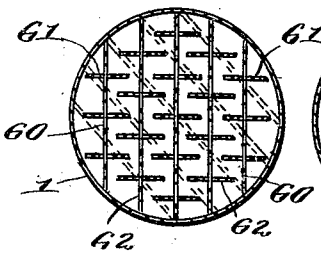


Fig. 5.

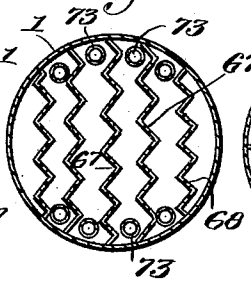


Fig. 6.

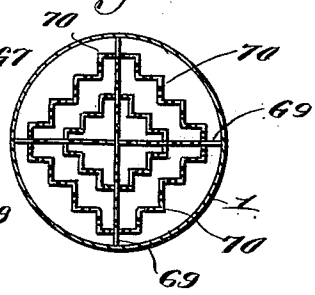
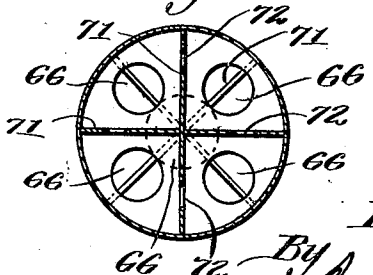


Fig. 7.



Witnesses,
Robert Emmett.
J. B. Keely

Inventor,
Paul Naef.
By James L. Norris
Atty.

UNITED STATES PATENT OFFICE.

PAUL NAEF, OF NEW YORK, N. Y.

CHEMICAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 658,727, dated September 25, 1900.

Application filed June 13, 1900. Serial No. 20,190. (No model.)

To all whom it may concern:

Be it known that I, PAUL NAEF, a citizen of the Republic of Switzerland, residing at New York, in the county of New York and State of New York, have invented new and useful Improvements in Apparatus for Treating Solid Materials with Gas, of which the following is a specification.

This invention relates to an apparatus for treating solid materials with gas, and has for its object to provide an apparatus adapted for use in the production of carbonate of soda from bicarbonate and which shall be also applicable to other purposes.

In the annexed drawings, illustrating the invention, Figure 1 is a part-sectional elevation of one form of my improved apparatus for treating solid material with gas—as, for instance, hot carbonic-acid gas when the apparatus is employed in the conversion of bicarbonate to monocarbonate. Fig. 2 is a part-sectional elevation of a modified form of the apparatus as especially constructed for the treatment of various materials with gases of combustion which are rich in carbonic acid. Fig. 3 is a part-sectional elevation of another form of the apparatus constructed for the continuous circulation of gas through a gas-heater and through a portion of the apparatus. Figs. 4, 5, 6, and 7 are cross-sectional views, hereinafter referred to, illustrating forms of agitating and lifting devices that may be employed in the rotary cylinders of the apparatus for facilitating intimate contact of the gas and the material treated therewith.

Referring first to Fig. 1, the numeral 1 designates an upper rotary cylinder or furnace that is preferably arranged in a horizontally-inclined position. As shown, the cylinder 1 may be mounted on rollers 2 and 2^a of any suitable character, and for this purpose it is preferably provided with annular bands 3 and 3^a to engage or bear on said rollers. For the purpose of rotating the said cylinder it may be provided at any suitable point with a worm-gear 4, meshing with a worm-shaft 5, to which power can be readily applied. The upper end of the cylinder 1 is provided with a head or cover 6, having a central opening provided with an annular flange 7, that is constructed to fit rotatably against or around a stationary plate 8 on one end of a conveyer-casing 9, in which there is a screw conveyer 10 for feed of solid material into the cylinder. A hopper 11 communicates with the conveyer-casing for supply of the material to be treated. The conveyer may be operated through a pulley 12 on the conveyer-shaft or by any other convenient means.

At the lower end of the rotary cylinder 1 there is located a hopper 13 to receive the material that has been treated in said cylinder. On the inlet end of this hopper 13 there is a flange or plate that forms stationary cover 14 for the lower end of the cylinder, which is arranged to rotate in contact with said cover.

The bottom of the hopper 13 is arranged to communicate, through sliding doors or gates 15, with the upper end of a chute 16, the discharge end of which supports a flange or plate that constitutes a stationary cover 17 for the upper or elevated end of a lower rotary cylinder 18, that is shown as horizontally inclined in a reverse direction to the inclination of the upper cylinder. It is preferable to arrange a pair of rotatable and longitudinally-corrugated rollers 19 above the doors 15 and a similar pair of rollers 20 below said doors to assist in controlling the discharge of material to the lower cylinder uniformly and without clogging. The lower cylinder 18 is rotatably mounted, as shown in Fig. 1, by means of devices similar to those employed with the upper cylinder 1 and designated by like reference characters.

At its lower end the cylinder 18 is provided with a stationary cover 21, that is supported by the inlet portion of a hopper 22, which receives the treated or finished material from said cylinder. The discharge portion of this hopper 22 may be provided with doors 23 and longitudinally-corrugated rollers 24 to control the delivery of material.

In Fig. 1 I have shown a gas-heater 25, that may be arranged to receive carbonic-acid gas through a fan 26 and pipe 27 from any suitable source.

Hot gas from the heater 25 may be passed at will into the upper rotary cylinder or furnace 1 through a pipe 28, as controlled by a valve 29 in said pipe. One end of this pipe 28 is connected with the stationary cover 14

at that end of the upper cylinder 1 through which the material under treatment is discharged to the passages that lead to the lower cylinder. Gas from the gas-heater 25 is thus passed through the rotary upper cylinder 1 in a reverse direction to the passage through said cylinder of the material under treatment.

When bicarbonate is subjected to treatment for effecting its conversion into monocarbonate in this apparatus, the action of the hot gas on the material contained in the upper cylinder 1 will first drive off all ammonia and moisture. Gas containing ammonia will leave the cylinder 1 through a pipe 30, Fig. 1, one end of which is connected with the stationary cover 8, while its other end connects with a cooler 31, that delivers the gas through a pipe 32 into an ammonia-absorber 33 of any suitable construction. The washed gas may be withdrawn from the washer or absorber 33 by means of a fan 34 and can be utilized for any suitable purpose—as, for instance, in an ammonia-soda process when this apparatus is employed in that connection.

The pipe 28, Fig. 1, that leads from the gas-heater 25, is provided with a branch pipe 35, leading into the lower end of the lower rotary cylinder 18, and this branch pipe 35 may be provided with a hand-valve 36 for controlling the flow of gas into and through said lower cylinder in a reverse direction to the passage of the material to be treated therein as the same is received from the upper cylinder. A portion of the hot gas conducted into and through the lower cylinder 18 will pass therefrom through the chute 16 and hopper 13, and thereby enter the upper cylinder. When bicarbonate is under treatment, the contact of the hot gas with the material passing through the upper cylinder 1, hopper 13, and chute 16 will drive off any ammonia and moisture contained in the bicarbonate, and the material thus treated will be delivered to the lower cylinder 18 in a dry and heated condition. In the lower cylinder 18 the material is still further heated and bicarbonate is converted into carbonate, excess of carbonic acid being driven off. A pipe 37 may be connected with the stationary cover 17 at the upper end of the lower cylinder 18 to carry away any excess of gas.

In Fig. 2 I have shown an apparatus similar to that already described, but which is particularly adapted to the heating of the material under treatment by means of a hot combustion-gas. The upper rotary cylinder 1 in this construction has at its lower end a discharge-hopper 13^a and a furnace or fire-box 38, that is preferably supported on or carried by said hopper. This fire-box 38 may be arranged for combustion of solid, liquid, or gaseous fuel. Gas may be admitted to the fire-box through a pipe 39, and an inlet 40 is provided for admission of air to support combustion, the inlets for gas and air being preferably concentric. In the furnace or fire-box 38 there is a perforated wall 41, through which the hot products of combustion will readily pass into the upper rotary cylinder.

The gases that leave the upper cylinder 1 may be conducted through a dust-chamber 42, Fig. 2, from which the gas may pass through pipe 30^a to a washer or absorber such as hereinbefore described. As before, the material that is treated in the upper rotary cylinder 1 passes thence through the hopper 13^a, rollers 19, and gates 15 to a chute 16^a, which communicates with the lower rotary cylinder. This chute 16^a carries a flange or plate 17^a, which serves as a stationary cover for the lower cylinder and supports a pipe 37, as before, for carrying away any excess of gas.

As shown in Fig. 2, it is sometimes preferable to mount the hopper 13^a on rollers 43 to run on tracks 44, thereby permitting said hopper and attached parts to be readily moved away from the ends of the cylinders 1 and 18 to give easy access to the interior of said cylinders.

At the lower end of the cylinder 18 and communicating therewith there is a discharge-hopper 45, Fig. 2, having its upper part constructed with or supporting a fire-box 46 for solid, liquid, or gaseous fuel. As shown, a pipe 47 is provided for conducting gas into this fire-box, which is also provided with an air-inlet 48, as before. The hot products of combustion pass over and through a perforated bridge-wall 49 in the fire-box and thus enter the lower cylinder, passing through said cylinder in intimate contact with the material therein, and thence finding an exit, in part, through the chute 16^a and hopper 13^a to the upper cylinder, while any excess of gas may pass off through the pipe 37. In the lower end portion of the cylinder 18 and communicating with the bottom part of the fire-box 46 there is a pipe or flue 50, Fig. 2, which is supported concentrically within said cylinder by means of arms 51 and may be extended into the cylinder for any suitable or desired distance. The hot combustion-gases will enter the cylinder through this flue 50 and partly above the same, while the treated material will pass out beneath said flue and into the discharge-hopper 54, which may be provided with a valved inlet-pipe 52 for admission of cold air from any suitable source to cool the finished material during its discharge. To further cool the material, it may be passed, if desired, from the discharge-passage of the cylinder 18 into another rotary cylinder, (not shown,) where it can be brought into contact with cold air.

In Fig. 3 I have shown another form of this apparatus, wherein provision is made for the continuous circulation of gas through the cylinder 18 and the gas-heater 25, whereby the gas is heated repeatedly alternately with its passage through the rotary cylinder. A discharge hopper or chute 13^b, Fig. 3, is arranged to conduct partly-treated material from the upper rotary cylinder 1 into the lower rotary cylinder 18, a grate 15 or other regulating de-

vice being provided to control the flow of the material. A discharge-hopper 22^a is arranged to communicate with the lower end of the cylinder 18, as shown. Hot gas from the heater 25 is conducted through a pipe 53 into the lower end of the cylinder 18 to be brought therein in intimate contact with the material under treatment and which passes through said cylinder in a reverse direction. From the cylinder 18 a portion of the hot gas may be allowed to pass upward through the chute 13^b into the upper cylinder 1 to act on material passing through the same, as before described. Another portion of gas from the lower cylinder 18 passes out at the upper end of said cylinder into a dust-chamber 54, Fig. 3, and thence through a pipe 55 to the fan 26, by which the gas is forced through pipe 27 into the gas-heater, thus completing a circuit of gas through said heater and the lower rotary cylinder. The pipe 55, between the dust-chamber 54 and fan 26, communicates with an inlet-pipe 56, having a valve 57 for controlling the supply of fresh gas to the heater. The pipe 53, that conducts gas from the heater, is shown as being provided with a branch pipe 58, Fig. 3, having a valve 59 for controlling the supply of gas direct from the gas-heater to the upper rotary cylinder. The gas that leaves the upper cylinder may be passed through a dust-chamber 42, and thence to a washer or absorber, as before described.

The form of apparatus shown in Fig. 3 is very economical in the use of gas by reason of its continuous circulation through the gas-heater and the lower cylinder. In each form of apparatus only the gas that passes through the upper cylinder will need washing, as when the apparatus is employed for the conversion of bicarbonate into monocarbonate, if the gas is to be used again. The gas that leaves the lower cylinder through the pipe 37, Figs. 1 and 2, or through the dust-chamber 54, Fig. 3, does not require washing and may be used continuously—as, for instance, in the employment of this apparatus in connection with the ammonia-soda process.

In order to insure intimate contact between the gas and the material under treatment passing through the rotary cylinders in opposite directions, it is preferable to provide suitable agitating devices in the interior of each cylinder.

In Figs. 1, 2, and 4 I have shown agitating devices consisting of parallel longitudinally-extended partitions 60, having series of ribs or shelves 61 thereon projecting at right angles from said partitions. The ribs 61 on adjoining parallel partitions 60 preferably alternate with each other and may overlap to some extent, as shown in Fig. 4. The partitions 60 and their ribs or shelves 61 are preferably provided with perforations 62 to effect a finer subdivision and more intimate contact of the gas and the material under treatment in the rotary cylinders. The partition or agitating devices in the several cylinders may be grouped in sections throughout each cylinder, with spaces between the several groups or sections, as at 63, Figs. 1 and 2, and with spaces 64 at the ends of the cylinder or beyond the groups of agitating devices therein. Vertical cross-partitions 65 may be arranged in each cylinder at the head of each group of longitudinally-arranged partitions, as shown in Figs. 1 and 2. These cross-partitions 65 are provided with openings 66 for passage of material and gas, and, as shown in Figs. 1, 2, and 7, the said openings in some of these cross-partitions are located near the periphery of the cylinder, while alternating partitions are each provided with a single larger opening, located at the center of the partition, the purpose being to break the current of gas through the cylinder and compel it to take a tortuous or zigzag course.

In place of the form of partitions shown in Fig. 4 I may employ parallel-arranged corrugated partitions 67, Fig. 5, provided with perforations 68, the corrugations serving the same purpose as the ribs or shelves 61 to agitate the material and gas passing through the cylinder, and thereby secure intimate contact and a thorough reaction. The ribs 61, as well as the corrugations, also serve as lifters to raise the material under treatment and shower it through the gas during the whole revolution of the cylinder.

Another form of agitating or lifting device is shown in Fig. 6, consisting of longitudinally and radially extended partitions 69, arranged at right angles to each other. Between these radial partitions 69 there may be arranged one or more series of corrugated partitions 70, preferably in inclined positions. All these partitions 69 and 70 may be provided with perforations.

When the material to be treated is of such nature as to incur risk of clogging, it is preferable to employ only an arrangement of radially and longitudinally extended partitions 71, such as shown in Figs. 1, 2, and 7, with perforations 72 therein, or the parallel and longitudinally arranged partitions 60, Fig. 4, may be used with narrow ribs thereon. Other lifting devices in the form of perforated tubes 73, Fig. 5, may be sometimes employed to advantage in each cylinder, adjacent to its periphery, and either alone or in connection with other forms of agitating and lifting devices. Doors 74 are preferably provided in each cylinder, opposite the spaces 63, to facilitate cleaning out the cylinder when necessary.

It will be understood that the arrangement of the agitating devices may be varied, according to the material to be treated, the purpose being to secure the most intimate contact of the material and the gas without clogging the cylinder. In cases where the temperature is not very high, as in the upper rotary cylinder, the parallel longitudinally-arranged partitions, Figs. 4 or 5, may be used with advantage. These partitions are pref-

erably arranged in sections or groups radially offset from each other to increase the contact of the material and gas and secure a more perfect agitation. The distance of one partition from another and also the dimensions of the perforated ribs or shelves on the partitions will be varied, according to the nature of the material to be treated. With material that clogs easily the partitions are set farther apart and the ribs are made smaller. With other materials that are not likely to clog the ribs or shelves may be made wider and arranged so as to overlap, thus providing extensive surfaces over and through which the material will glide and by means of which it is exposed constantly to the gas in a state of fine division. Wire-gauze and corrugated wire-gauze can be sometimes used to advantage in the construction of the different forms of partitions. In the lower cylinder where the temperature is high the partitions may be made of fireproof material.

The apparatus is adapted for the treatment of various materials with gas and can be used for the production of by-products from fuel and for other purposes. It can be also used for the treatment of liquors.

Instead of placing one partition between each set of longitudinal partitions for the purpose of guiding the flow of gas it is of great advantage to use the following arrangement with materials which do not easily clog the apparatus. There are then arranged sections of longitudinal perforated partitions and afterward sections of vertical perforated cross-partitions with spaces between the two. The gas and material has alternately to pass sections of longitudinal and afterward of vertical cross-partitions. The arrangement increases the contact of material and gas and prevents material and gas from passing in places through the apparatus too quickly. The perforated vertical partitions are adapted to the material and are often with advantage made corrugated and of wire-gauze.

The pipe 50, Fig. 2, leading into the cylinder is often with advantage connected directly to a gas-main. Combustion then takes place at the end of said pipe, and the first part of the cylinder near the discharge end is used for the purpose of heating the air. If the apparatus is used for the treatment of fuel, it is often of advantage to mix the material before entrance into the second cylinder. The fuel is then distilled by itself in the upper cylinder, and the material to be calcined or otherwise treated is introduced through conveyers 75, Figs. 1, 2, and 3.

What I claim as my invention is—

1. In apparatus for treating material with gas, the combination of a rotary cylinder mounted in a horizontally-inclined position, agitating devices arranged in said cylinder to effect intimate contact of the material and gas passed through said cylinder in reverse directions, conveyer devices for feeding the material into the upper end of said cylinder, means for conducting gas into the lower end of said cylinder, a discharge-hopper in communication with the lower end of the cylinder, for discharge of the treated material, a washer or absorber, and means for conducting gas from the upper end of the cylinder to said washer or absorber.

2. In apparatus for treating material with gas, the combination of a rotary cylinder mounted in a horizontally-inclined position, rollers on which said cylinder is mounted, gearing for rotating said cylinder, agitating devices arranged in said cylinder to effect intimate contact throughout the entire revolution of the cylinder between the material and the gas that are passed through the same in reverse directions, conveyer mechanism for feeding the material into the upper end of the cylinder, a discharge-hopper communicating with the lower end of the cylinder and through which the treated material is to be discharged, means for conducting gas into the lower end of the cylinder, a washer or absorber, and means for conducting gas from the upper end of said cylinder to the absorber or washer.

3. In apparatus for treating material with gas, the combination of an upper rotary cylinder, a lower rotary cylinder, means for mounting said cylinders in reversely-inclined positions with relation to each other, gearing for rotating said cylinders, agitating devices arranged in each cylinder to effect intimate contact between the material and the gas passed through said cylinders in reverse directions, a discharge hopper and chute through which the lower end of the upper cylinder is adapted to communicate with the upper end of the lower cylinder, means for controlling the discharge of material through said hopper from the upper cylinder to the lower cylinder, a discharge-hopper communicating with the lower end of the lower cylinder and provided with means for controlling the discharge of finished material, a gas-heater, and means for conducting gas therefrom into the lower end of each cylinder, respectively.

4. In apparatus for treating material with gas, the combination of an upper rotary cylinder, a lower rotary cylinder, said cylinders being arranged in horizontally-inclined positions and in relatively-reverse directions, conveyer mechanism for feeding material into the upper end of the upper cylinder, discharge devices through which the lower end of the upper cylinder is adapted to communicate with the upper end of the lower cylinder, a discharge-hopper in communication with the lower end of the lower cylinder, for discharge therefrom of finished material, a gas-heater having a pipe for conducting hot gas into the lower end of the upper cylinder to pass therethrough in a reverse direction to the passage through said cylinder of the material under treatment, said heater having also a branch pipe for conducting hot gas into the lower end of the lower cylinder, to pass therethrough in a reverse direction to the passage through said

cylinder of the material under treatment, a pipe leading from the lower cylinder to convey away excess of gas, an absorber or washer, and means for conducting gas from the upper end of the upper cylinder to said absorber or washer.

5. In apparatus for treating material with gas, the combination of one or more horizontally-inclined rotary cylinders, conveyer mechanism for conducting the material to be treated into the upper end of the cylinder, a gas-heater, means for conducting gas from said heater into the other end of the cylinder to pass therethrough in a reverse direction to the passage through said cylinder of the material under treatment, an absorber or washer, means for conducting gas from said cylinder to the absorber or washer, and series of perforated partitions extended longitudinally in the cylinder and radially offset from each other to effect agitation and intimate contact between the material and the gas that are passed through the cylinder in reverse directions.

6. In apparatus for treating material with gas, the combination of a rotary horizontally-inclined cylinder, conveyer mechanism for feeding material into one end of said cylinder, a discharge-hopper in communication with the other end of said cylinder, for the discharge of treated material, a furnace or fire-box mounted on said discharge-hopper and provided with means for the combustion of fuel, means for movably mounting said discharge-hopper and furnace, whereby the same may be moved away from the cylinder end to give access to the cylinder, and agitating devices arranged in the cylinder to effect intimate contact between the material and the gas that are passed through said cylinder in reverse directions.

7. In apparatus for treating material with gas, the combination of an upper rotary cylinder, a lower rotary cylinder, conveyer mechanism for feeding the material to be treated into one end of the upper cylinder, a hopper and discharge devices through which one end of the said upper cylinder is adapted to communicate with the adjacent end of the lower cylinder, a furnace or fire-box mounted on said discharge-hopper, means for movably mounting said discharge-hopper and fire-box, whereby they can be moved away from the cylinders to give access to the interior of the same, a discharge-hopper in communication with one end of the lower cylinder, a fire-box mounted on said discharge-hopper and having a flue extended into said cylinder, means for introducing cold air into said discharge-hopper below the said fire-box and its flue, and agitating devices arranged in the cylinders to effect intimate contact of the material and the gas that are passed through said cylinders.

8. In apparatus for treating material with gas, the combination of an upper rotary cylinder, a lower rotary cylinder, conveyer mechanism for feeding the material to be treated, into one end of the upper cylinder, a discharge-hopper through which one end of the upper cylinder is adapted to communicate with the adjacent end of the lower cylinder, a discharge-hopper in communication with the other end of the lower cylinder, for discharge of finished material therefrom, a gas-heater, means for causing a continuous circulation of gas through said gas-heater and the said lower cylinder, whereby the gas is repeatedly heated in alternation with its passage through the material in the said lower cylinder, means for introducing gas into the upper cylinder, and means for conducting gas from said upper cylinder.

9. In apparatus for treating material with gas, the combination of an upper rotary cylinder mounted in a horizontally-inclined position, a lower rotary cylinder mounted in a horizontally-inclined position and in a reverse direction to the upper cylinder, agitating devices arranged in said cylinders to effect intimate contact of material and gas to be passed through the same in reverse directions, conveyer mechanism for feeding the material to be treated into the upper end of the upper rotary cylinder, a discharge-hopper provided with means for controlling the passage of material from the lower end of the upper cylinder to the upper end of the lower cylinder, a discharge-hopper in communication with the lower end of the lower cylinder for discharge of finished material therefrom, a gas-heater, means for conducting gas into said heater, means for causing a continuous circulation of gas through the gas-heater and the said lower cylinder, whereby gas is repeatedly heated in alternation with its passage through the material in said lower cylinder, and means for passing gas through the upper cylinder.

10. In apparatus for treating material with gas, the combination of a rotary horizontally-inclined cylinder, series of perforated agitating devices arranged in said cylinder in several groups or sections, radially offset from each other, with spaces between the several groups or sections of said agitating devices and with spaces beyond the same at the ends of the cylinder, means for feeding into one end of said cylinder the material to be treated, and means for conducting hot gas into the other end of said cylinder, to pass through the same in intimate contact with the material that is passed through said cylinder in a reverse direction.

11. The combination of several superposed rotary furnaces, combustion-chambers communicating with said furnaces, means for conducting material successively through said furnaces, and means for separately collecting and washing the gas from the furnace through which the material first passes.

12. The combination of several furnaces, combustion-chambers on each furnace, means for conducting material into one furnace and successively through the other furnaces,

means for collecting and washing the gas from the first furnace separately, and means for introducing another material in the second furnace.

13. The combination of several furnaces, means for passing material successively through them, means for heating and collecting the gas from the first furnace separately, means for continuously circulating the same gas a number of times through the lower furnace, and means for heating said gas before each entrance into the lower cylinder.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

PAUL NAEF.

Witnesses:
C. E. LANGDON,
GERRIT SMITH.