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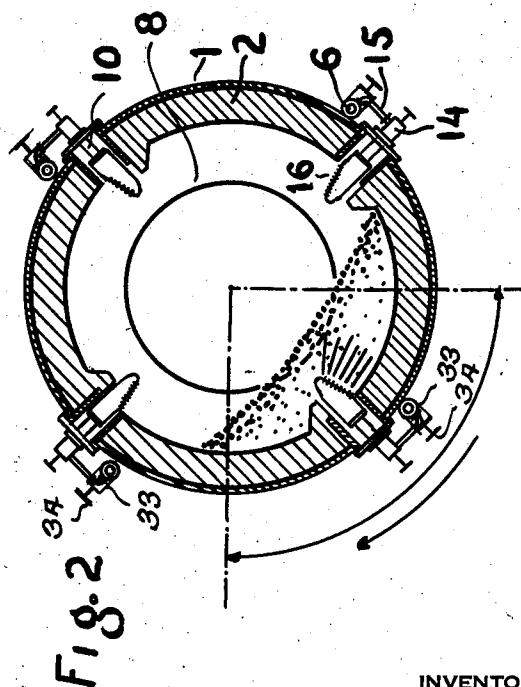
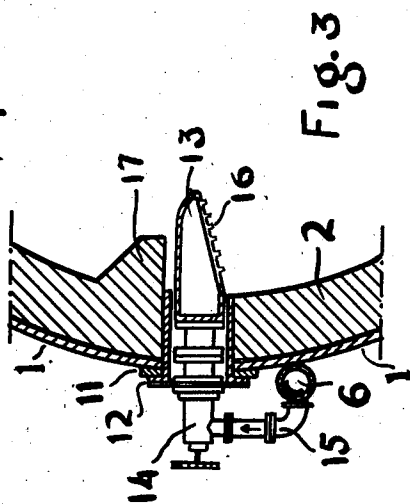
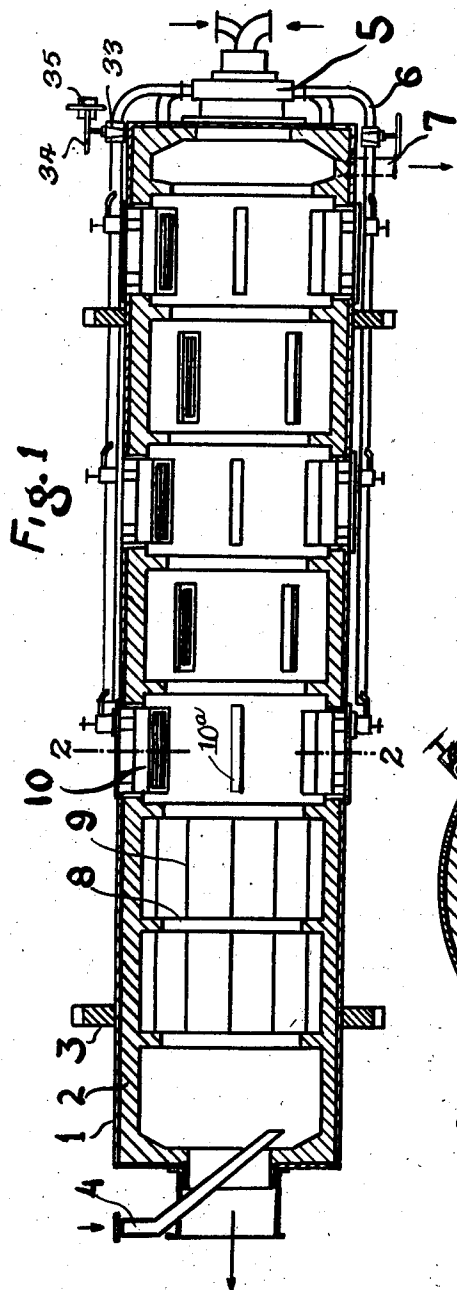
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2,091,850

APPARATUS FOR THE PERFORMANCE OF METALLURGICAL OR CHEMICAL REACTIONS

Filed July 26, 1934

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

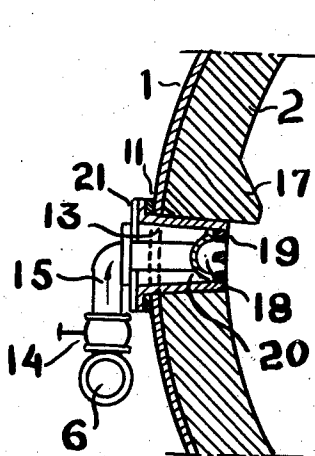


Fig. 4

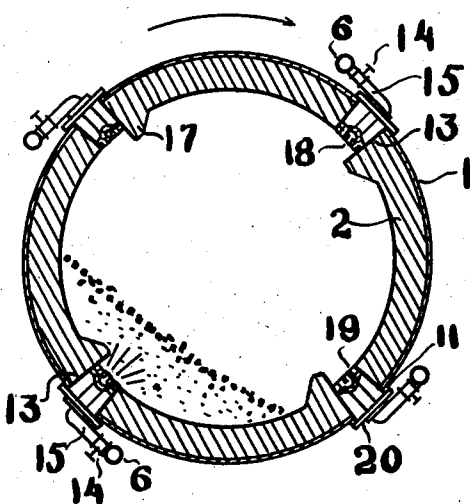


Fig. 5

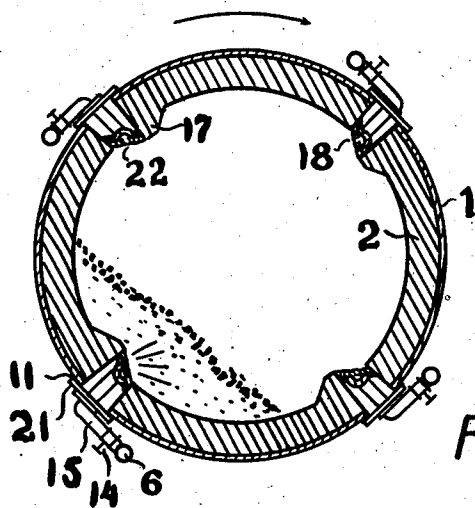


Fig. 6

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3 Sheets-Sheet 3

Fig. 7

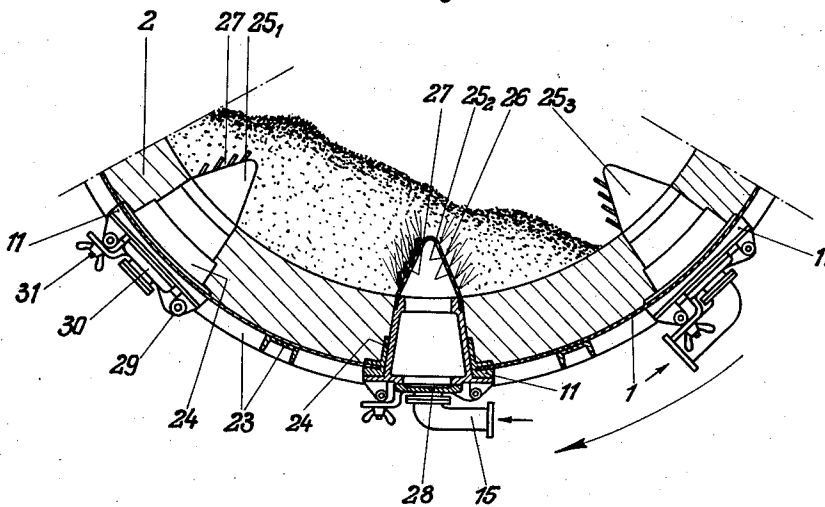
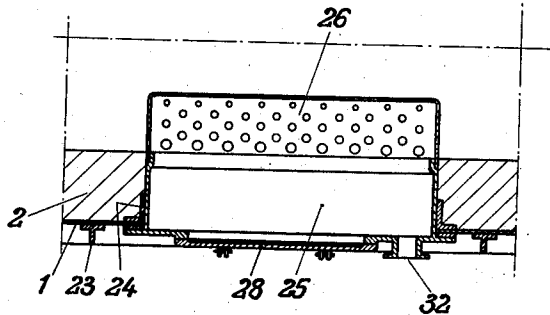


Fig. 8



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UNITED STATES PATENT OFFICE

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APPARATUS FOR THE PERFORMANCE OF
METALLURGICAL OR CHEMICAL REAC-
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many, assignor to American Lurgi Corporation,
New York, N. Y., a corporation of New YorkApplication July 26, 1934, Serial No. 737,025
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17 Claims. (Cl. 263—22)

The present invention relates to an apparatus for performing metallurgical or chemical reactions in a rotary kiln.

The performance of metallurgical and chemical processes in a rotary kiln is advantageous inasmuch as the material is continuously turned over and thoroughly mixed during the whole time of treatment. The inner walls of the rotary kilns have also been equipped with turning or transporting devices which lifted a certain part of the material so that it could fall through the free space of the kiln. Furthermore it has been proposed to have the shell of the rotary kiln made of grates through which air was to be blown into the sulphidic material roasted within the kiln, in a similar way as is customary in the blast roasting process; or else, several openings provided in the shell of the kiln were used for blowing the air through the layer of material within the kiln. In this latter case, no uniform distribution of the roasting air could be obtained within the material treated, whilst in the former case its temperature rose so quickly and to such high degrees that sintering took place, the grates were clogged up, and crusts formed on the walls of the kiln. For all these reasons it has been impossible up to now to get a satisfactory working of the kiln with these known arrangements.

Now according to the present invention the shell of the rotary kiln is provided with a number of boxes placed within that shell, and each of these boxes is provided with grates or with perforated plates or with a great number of nozzles or tuyères which are used for the introduction of air, steam, combustible gases, heating gases, or similar gaseous substances, or for withdrawing gases from the kiln. These boxes are interchangeable and they are designed in such a way that their openings for the gas passage (grates, holes, nozzles, tuyères etc.) are easily accessible even when the kiln is working, so that these openings can be cleaned, or the boxes removed and replaced by others, if necessary of a different shape, all as may be required.

This invention offers the advantage that the aforesaid openings for the supply or for the withdrawal of gases can be kept under continuous observation and in good order, without disturbing the regular work. This control ensures a very uniform distribution of the reaction gases into the layer of material thus enabling the material to be treated most intensively with reaction gases introduced or withdrawn through the boxes.

The longitudinal direction of the boxes placed within the shell extends more or less parallel with

the kiln axis or is inclined with respect to it, and the individual boxes placed in the longitudinal direction of the rotary kiln in an interrupted or uninterrupted sequence can be arranged either in one row or in several rows with alternative positions to each other. The gas passage openings of the boxes can be disposed in the cylindric shell of the kiln or in an inclined or a radial vertical position, and the boxes may be placed in recesses or on projecting parts of the brickwork. In some cases it will be sufficient to provide in the cross-section of the kiln only one row of boxes. But it is quite feasible as well to have several rows of boxes distributed over the circumference of the kiln. In this case, however, the invention provides for them to be arranged with considerable intervals between each other, so that during the turning of the kiln the material will slide in a continuous layer alternately over a box and then again over a part of the brickwork of the kiln. The advantages resulting from this embodiment of the invention will be explained by way of example in the performing of exothermic reactions, e. g. roasting sulphidic ores with or without additional fuel.

According to the revolving speed of the kiln, new parts of material are always brought to the gas inlet or outlet openings of a particular box. In a continuous layer they slide over the openings and then gradually are farther removed from them. In the immediate neighbourhood of the openings, or above them, they are thoroughly flooded by great quantities of reaction gases and therefore a very intensive reaction is here brought about. On the other hand the particles of material are soon removed from the openings so that the reaction temperature never attains an inadmissible height which might cause e. g. a premature sintering or smelting of the material. On the contrary, the reaction temperature remains almost unchanged for a certain length of time because the quantity of reaction gases going through the layer gradually decreases with the removal of the particles from the gas inlet or outlet openings, until finally the gas passage is stopped. In this manner the zone of reaction is very much broadened and the reaction takes place at a comparatively uniform temperature.

If the grate or nozzle surfaces are arranged in an inclined or in a radial position, the reaction gases are blown through the layer of material essentially in the directions of the circumference of the furnace shell. In that case the surface of the boxes with its grates, holes, or nozzles is generally arranged so that the reaction gases are

discharged opposite to the revolving direction of the kiln. In order to speed up the reaction it may be useful in some cases to provide as well for some grate surfaces where the reaction gases are discharged in the sense of the kiln rotation and in other cases it may be even useful to have only such openings by which the air is blown into the oncoming material.

It is advisable to conduct the process according to the present invention in such a manner that only as long as the boxes fitted in the shell are covered with material, the reaction gases, e. g. the roasting air, is admitted or discharged through these boxes as long as the latter are covered by material, and the gas pipe is either throttled or entirely closed when the boxes are freed from material. During this time, other reaction gases might be blown into the kiln through the boxes. If exothermic reactions are performed in this rotary kiln, there is the great advantage that these reactions proceed very rapidly even at medium temperatures of the kiln, so that the formation of rings or crusts either in the kiln itself or at the gas inlet or outlet devices will hardly occur. For the removal of any incrustation the boxes are all accessible from the outside, e. g. through the gas supply device. Otherwise those boxes which are clogged up or which cannot be used any more for some other reason may be replaced within a very short time.

Generally these boxes fitted within the shell, or those parts of them which are most exposed to heat, are made of refractory material, e. g. ceramic or metallic material, as heat-proof steel, especially so if hot reaction gases are passed through them or if higher temperatures are maintained in the kiln (800-1000° C.). In certain particular cases, e. g. if air or other gases which are not very hot are used for performing the reaction, the boxes can be made of ordinary wrought or cast iron or the like, as they are continuously cooled by the air which passes through them.

A rotary kiln designed in accordance with the present invention can be used successfully for a great variety of processes and may be equipped in many different ways.

In the case of roasting processes for example, the upper part of the rotary kiln is equipped with barrier rings and, if necessary, with turning devices only. The preheating of the material and the first part of the roasting is performed here. The remaining part of the kiln is equipped with the boxes as provided by this invention for the supply of further quantities of roasting air. There the roasting is then performed much more uniformly and down to a much lower sulphur content than in the rotary kilns known heretofore, where the reaction takes place very slowly in the lower part.

A furnace according to the present invention can also be used for the volatilization of metals, such as zinc, lead, tin, antimony, cadmium, either with or without preliminary roasting of the material in the upper part of the kiln.

Air, or oxygen, combustible gas, or steam, or mixtures of these substances can be used as reaction gas if a sulphur containing material, such as pyrites or spent oxide, to which fuel can be added is to be treated according to known processes with a view to the recovery of sulphur or sulphur compounds. By this process there may be produced gases containing vapors of elementary sulphur, carbon oxide, hydrogen, hydrogen

sulphide, and sulphur dioxide, or mixtures of these.

Calcining processes can also be carried out in a kiln according to the present invention. Such a kiln is suitable, e. g. for burning lime, magnesite, cement, etc., or it can be used as a gas producer or a low temperature carbonization apparatus. In that case, the gasification or the carbonization medium respectively is introduced into the fuel layer through the boxes which may be provided either in the whole furnace or in certain parts of it.

The rotary kiln of this invention may be equipped with all arrangements and devices which are otherwise customary for such a kiln. For instance, the kiln can be divided by means of barrier rings into several compartments, and an adequate size of these barrier rings will ensure that the layer of material in the several compartments is kept larger or smaller according to the reactions desired. The kiln can be worked under pressure as well.

In addition to the above features, the present invention offers a further advantage inasmuch as the quantity of material which is constantly in the kiln may be very large. For instance, the rotary kiln can be kept filled constantly up to about one half of its diameter.

The number of revolutions can be low as compared with that of the kilns known until now, e. g. one revolution in 70 to 400 seconds. In this way the formation of dust in the kiln is considerably reduced.

The process according to the present invention can also be used for the agglomeration of ores and the like. In this case air is passed through the charge of the rotary kiln, and then again the charge moves over the brickwork of the rotary kiln without introduction of air, so that a solid agglomerate of a uniform size of grain is obtained at a comparatively low kiln temperature and any formation of crusts on the walls of the rotary kiln as well as any clogging of the air passages is avoided.

In order more clearly to explain the invention, reference is made to the accompanying drawings which illustrate one embodiment of the new rotary kiln.

Figure 1 shows a longitudinal section through the rotary kiln. Figure 2 is a section in line 2-2 of Figure 1. Figures 3 to 8 show on a larger scale various embodiments of the box arrangement according to the invention.

1 is the shell, 2 the pressed-in lining or the brickwork of the rotary kiln which is provided with the usual annular runners 3 and an appropriate drive, and which may have the usual, if necessary variable inclination. 4 is the feeding device, 5 the lower furnace head which may be provided with a connecting and distributing device for one or several gaseous or liquid substances or other fluids. Pippings 6 which may be placed at the outside of the furnace shell or else in the brickwork go from this point to the individual gas inlets or outlets of the kiln. 7 is a discharge device. 8 are barrier rings, and 9 turning devices. 10 are the boxes. According to Figs. 2, 5, and 6, four of them are provided for one compartment of the kiln. In Figure 1, the boxes of any two succeeding compartments are arranged in an alternative position with respect to each other; and in accordance with the interruption of the brickwork at the points where these boxes are placed, reinforcements are provided within the furnace shell or outside of it.

either in the form of proflated or sheet iron. In Figure 3, box 13 is placed in the slots made in the shell and the brickwork of the kiln and protected by plate 11 and insertion part 12, that box being furthermore connected with the reaction gas supply line 6 by means of connections 15 provided with valve 14. Box 13 projects somewhat into the kiln, one of its side walls being closed and the other perforated. Both these walls have an approximately radial position in the kiln, and the wall 16 which is provided with grates is placed backward in the sense of kiln rotation. The front wall of the grate box is protected by projecting part 17 in the brickwork of the kiln, that part ensuring at the same time an orderly relative movement of material and grate box. By means of an appropriate arrangement the grate box is fixed in the slot in such a way that it can be removed any time whilst the kiln is working. Valve 14 effects the adjustment and, if required, the periodical admission and stopping of the current of reaction gas going to grate box 13.

In case it is desired to shut off the supply of gas to the grate boxes during the time the boxes are not covered by the charge, valves 33 may be provided in conduits 6. These valves are preferably controlled in such manner that the reaction gases are admitted or discharged through the grate boxes as long as the latter are covered by the charge, and the flow of reaction gases is throttled or is completely interrupted when the boxes rise above the level of the charge in the kiln.

The grate boxes may also have some other form, for example both side walls may be provided with a grate. It is also possible to provide perforated plates or nozzles instead of the grates. Figs. 7 and 8 illustrate such grate boxes, by way of example. In Fig. 7 the box 25₂ is depicted in section and the two other boxes are illustrated in a side view looking at them from their narrower side. Fig. 8 shows a longitudinal sectional view through one of these boxes.

The slots in the furnace mantle 1 in which the boxes 25 are arranged are protected by means of cover plates 11. In addition, reinforcement rings 23 are provided on the outside of the furnace mantle which as it appears from Figs. 7 and 8, may have a U or T-like profile. Angle irons 24 and the like are arranged on the inner surface of the furnace mantle which surround the slots and also contribute to eliminate weakening of the mantle caused by the slots for the boxes. The side walls 26 and 27 of the grate boxes in which the gas inlets are arranged, may have the form of grates, but in many cases preferably perforated plates or nozzle plates are used. Preferably these holes or nozzles are so arranged that the distance between the rows of holes or nozzles decreases from the top to the base of the side walls, or the diameter of the holes in the individual rows increases from the top to the base in order to take into account the different resistance of the charge layer above the openings which the gas stream has to overcome.

In case the side walls are arranged in the form of grates the resistance against the gas stream may be balanced out by providing an increasing distance between the individual rods of the grate from the top down to the base.

If there is danger of the charge entering from the furnace into the grate openings or nozzles, it may be arranged in a jalousie-like manner. Fig. 7 illustrates such jalousie-like arrangement

on the interior wall 27 of the grate boxes. It is also possible to provide openings for the removal of the charge which entered the box through the gas openings, for example, the box may be provided with a removable cover plate 28 on its surface which is accessible from the outside. This cover plate is held in position by means of two or more arms 30, pivoted in 29. The arms 30 may be pressed against cover plate 28 by means of screws 31 whereby the cover plate is tightly applied to its seat. In this manner it is possible to easily open and to close the cover 28, to check and if necessary, to clean the openings for the passage of the gases in any phase of the operation.

A short piece of tube 32 is arranged on the bottom surface of the grate box which by means of connecting piece 15 is connected to the conduit 6 for the introduction or removal of gases.

The grates or nozzles are to be designed in accordance with the experience of blast roasting.

Figures 4 to 6 show inserted boxes having gas passage surfaces placed in an inclined or flat position. These boxes can also be placed in insertion parts 13 and connected to the gas inlet or outlet lines 6 by means of connections 15 provided with valves 14. 11 are plates which strengthen the furnace shell at those points where the openings for taking up the insertion boxes are provided. Laterally from these boxes, the furnace lining is provided with projecting parts 17, but these can just as well be dispensed with.

In Figure 4 box 18 consists of plate 19 provided with nozzles and of an arched wall 20 which closes the box towards the outside. In this wall ends connecting line 15 going through lid 21 which fixes the box to insertion piece 13.

Figure 5 shows the arrangement of four such boxes in the same kiln compartment. The reaction gases pass into the layer of material through the insertion box which is covered with material, whilst the three other boxes, which are just in the gas chamber of the kiln, are not working at that time.

The boxes according to Figure 6 can be designed and connected to the kiln and the reaction gas lines in the same manner as those shown in Figures 2 or 5, the only difference being that plates 22, where the nozzles or similar openings for the gas passage are arranged have an inclined position.

In order to control the flow of the reaction gases through the openings, it may be convenient in the case of all forms of design to have the boxes provided with working openings which are accessible from the outside and which, if necessary, can be used for cleaning the grate or nozzles as well.

As to the blowers for introducing air into the pipework or into the inserted boxes respectively or for drawing off gases from and, as the case may be, for returning them into the kiln or its several compartments, an adequate number of these blowers may be provided and arranged, e. g. on the shell of the kiln.

The kiln represented in the drawings is particularly appropriate say for one stage roasting of zinc sulphide. In the first part of the kiln, which part is only equipped with barrier rings and turning devices but not yet with inserted boxes, the blende is preheated. In the second part of the kiln, deadroasting or preroasting down to say 2 to 8% of sulphur takes place. In the third part, prior to discharging the ore from the kiln, an agglomeration can still be accomplished,

either alone or along with deadroasting, e. g. by adding fuel or fluxes and by heating the roasted ore to the sintering temperature.

I claim:

1. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers mounted in said shell, means associated with the outer walls of said chambers for admitting gases thereinto, and a plurality of ports in the inner walls of said chambers establishing short and direct conduits between said chambers and the interior of said shell for introducing said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.
2. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers mounted in said shell, means associated with the outer walls of said chambers for admitting gases thereinto, and a plurality of orifices in at least one of the inner walls of said chambers providing direct communication between said chambers and the interior of said kiln for introducing said gases in the form of a large number of fine jets distributed over a wide area into the charge in said kiln.
3. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers mounted in said shell, means for introducing gases into said chambers from the exterior of said shell, a plurality of orifices in the inner walls of said chambers directly connecting said chambers with the interior of said shell for introducing said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell, and a closeable port in the outer wall of each of said chambers said port capable of being opened to make said orifices accessible for inspection and cleaning.
4. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers mounted in said shell, means associated with the outer walls of said chambers for admitting gases thereinto, and a plurality of relatively small orifices in at least one of the inner walls of said chambers providing direct communication between said chambers and the interior of said shell for introducing said gases in the form of a plurality of fine gas jets distributed over a wide area into the charge in said shell.
5. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like, relatively wide and narrow gas disseminator chambers mounted in said shell and extending into the interior thereof, means for introducing gases into said chambers from the outer side of said shell, and a plurality of orifices in the inner walls of said chambers for introducing said gases from said chambers in the form of a large number of fine jets distributed over a wide area into the charge in said shell.
6. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like, relatively wide and narrow gas disseminator chambers mounted in said shell, means associated with the outer walls of said chambers for introducing gases thereinto, and a plurality of orifices in the inner walls of said chambers for conducting said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell, said inner walls substantially conforming with the inner surface of said shell.
7. A rotary kiln comprising a substantially cy-

lindrical shell, a plurality of removable, box-like gas disseminator chambers mounted in said shell, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell, said inner walls being arranged in an inclined position with respect to the inner surface of said shell.

8. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers mounted in said shell and protruding into the interior thereof, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell said inner walls being arranged substantially vertically to the inner surface of said shell.

9. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers of substantially oblong form mounted in said shell and having their longer sides in a direction substantially parallel to the longitudinal axis of said shell, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.

10. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers of substantially oblong form mounted in said shell and having their longer sides in a direction at an angle to the longitudinal axis of said shell, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.

11. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers of substantially oblong shape mounted in said shell to form at least one straight line row, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.

12. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers of substantially oblong form mounted in said shell in a staggered position in a plurality of rows and having their longer sides substantially parallel to the axis of said shell, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in at least one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.

13. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers of substantially

oblong form mounted in said shell in at least one of the cross sectional planes thereof, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in at least one of the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.

10 14. A rotary kiln comprising a plurality of contiguous compartments, a plurality of removable, box-like gas disseminator chambers of substantially oblong form mounted in the shell of at least one of said compartments, means for introducing gases to be disseminated into said chambers through the outer walls thereof, and a plurality of orifices in the inner walls of said chambers for disseminating said gases in the form of a large number of fine jets distributed over a wide area into the charge in said shell.

20 15. A rotary kiln comprising a substantially cylindrical shell, a plurality of box-like gas disseminator chambers mounted in said shell, means for introducing gases to be disseminated into said chambers through the outer walls thereof, a plurality of ports in at least one of the inner walls of said chambers for introducing said gases in

the form of a plurality of gas jets distributed over a wide area into the charge in said shell, and means for controlling the flow of said gases through said disseminator chambers.

16. A rotary kiln comprising a substantially cylindrical shell, a plurality of removable, box-like gas disseminator chambers of substantially oblong form mounted in said shell, means for introducing gases to be disseminated into said chambers through the outer walls thereof, a plurality of ports in at least one of the inner walls of said chambers for introducing said gases in the form of a plurality of fine gas jets distributed over a wide area into the charge in said shell, and projections in the lining of said shell directly adjacent to at least one side of said gas disseminator chambers.

17. A rotary kiln comprising a rotatable shell, a plurality of box-like gas disseminator chambers mounted in said shell, a plurality of orifices in the inner walls of said chambers in intermittent contact with a substantial area of the charge in said shell, and conduit means associated with the outer walls of said chambers for introducing gases into said chambers and for removing gases therefrom.

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