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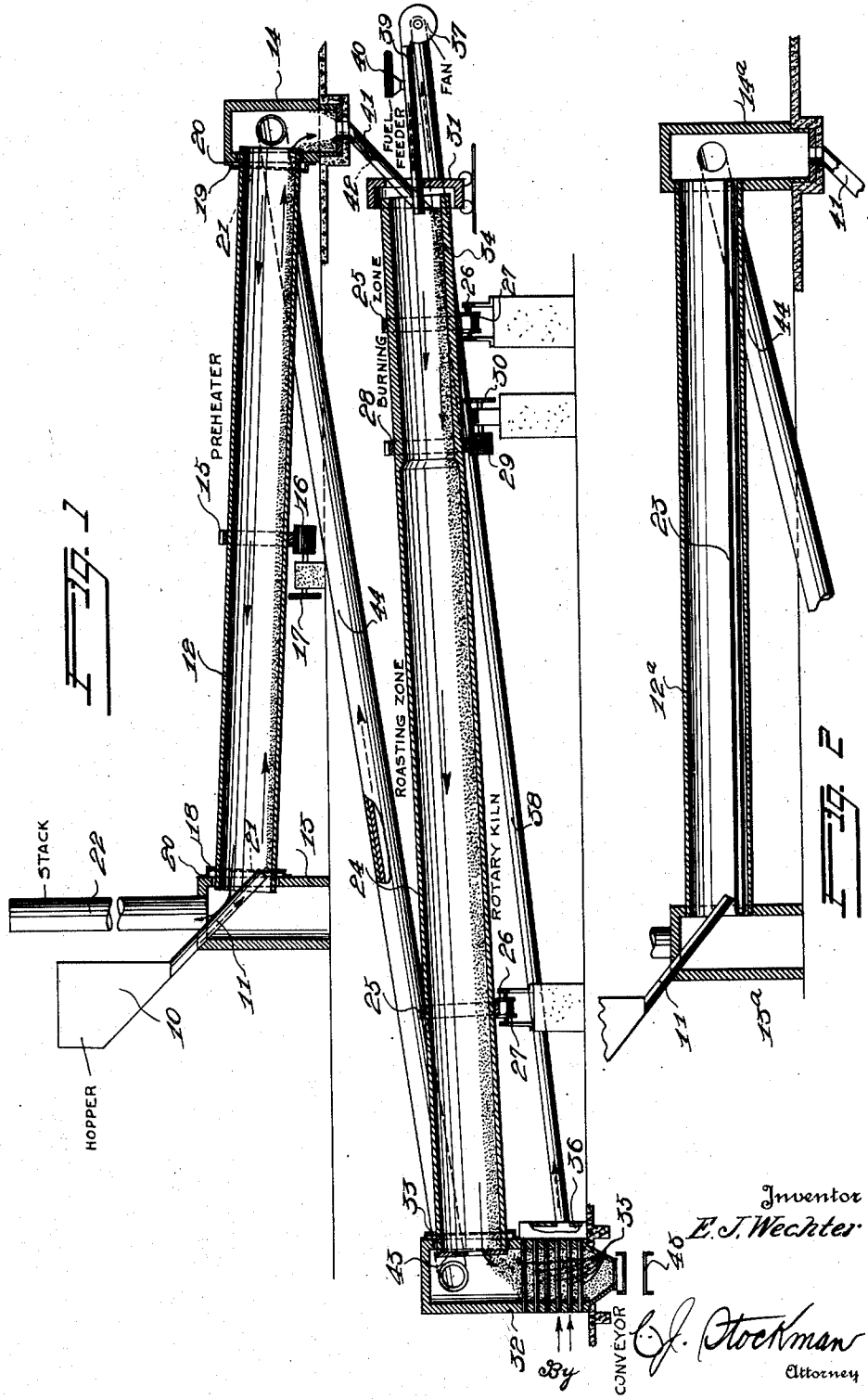


Fig. 1

Fig. 2

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APPARATUS FOR BURNING LIME AND CEMENT

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A leading purpose of this invention is to provide an apparatus for burning lime and cement, in rock form of those sizes which cannot successfully be burned in vertical kilns, namely, of those sizes from three to four inches down to dust. The sizes named constitute about twenty-five per cent of lime rock or natural cement rock and ordinarily are thrown away or used for other purposes. Hence, an apparatus which will successfully and economically calcine or burn these small sizes of rock will introduce important economies since it will enable the plant to convert all of its raw material into calcined material, by using vertical kilns for the larger rock and an apparatus of the construction constituting the subject of the instant application for its smaller rocks.

In an application for patent filed by me of even date herewith, Serial No. 190,476, I have shown, described and claimed a method by which these small sizes of rock may be successfully burned in a kiln of the rotary type. In the complete method set forth in the said application, the raw material is gradually preheated, the gradual preheating thereof being important since it avoids all danger of explosions of the material inseparably connected with the introduction of the cold and wet material into a flowing current of heated gas or products of combustion having a high temperature. In the method referred to, the cold and wet material is introduced into a current of heated gas at a comparatively low temperature and travels in a direction counter to that of the flow of the gases and is gradually raised in temperature thereby until it has been substantially deprived of its moisture and has reached a temperature favorable for subsequent treatment.

This preheated material is then discharged into a rotary kiln and flows from the feeding end of the kiln to the discharging end thereof in heat transferring relationship with a heated agent which is introduced into the kiln at that end thereof at which the preheated material enters, and flows through the kiln in the same direction as the material. The material has a lesser depth at that end of the kiln at which it is introduced than it has further along in the kiln.

In other words, the method referred to contemplates the formation within the kiln of what has been referred to as a burning or combustion zone, which is near the feeding end of the kiln and at the place where the heating agent has the highest temperature and the material the lesser depth, and a roasting zone, within which the material has the greater depth and the heating agent substantially constant temperature. From the roasting zone, the material is discharged in its hot roasted condition and a current of atmospheric air is passed through this mass of hot, roasted material but out of contact therewith and is forced under pressure with the fuel into the feeding end of the kiln. This air cools the roasted material and is heated thereby and supports combustion within the kiln. The products of combustion, after they have passed through the kiln, are withdrawn from the discharge end of the latter and are conducted to the discharge end of the preheater and serve as the agent which preheats the material. The flow in the preheater is counter to that of the material traversing the preheater and it is drawn off through a stack adjacent the end at which the raw material enters the preheater.

The instant invention relates primarily to an apparatus by which the foregoing method or process may be carried into effect in the most practical way.

Incidental objects of the invention are to provide an apparatus by which lime and natural cement in rock form and in sizes which are not ordinarily successfully burned in vertical kilns may be uniformly burned in a rotary kiln without danger of overburning; will be economical in the use of fuel; and will otherwise utilize the waste heat of combustion.

With these objects in view as well as others as may become apparent from the following disclosure, reference will now be had to the accompanying drawing in which

Fig. 1 is a longitudinal sectional view of the apparatus, some parts being in elevation.

Fig. 2 is a longitudinal sectional view depicting a modification of the preheating structure.

Referring to the drawing, 10 designates a hopper which receives the raw material and from which the material is fed by means of the feeding tube 11 into the feed end of the preheater 12.

The preheater 12 is preferably a cylindrical body having its feed end projecting into a chamber 13 and its discharge end projecting into a chamber 14.

Preferably, and as illustrated in Fig. 1, the preheater is rotatable and has its ends loosely mounted in the chambers 13 and 14 and is inclined downward from the feed end to the discharge end in order that the material will travel from the feed to the discharge end by means of the combined action of gravity and the rotation of the preheater.

In order to effect rotation of the preheater it is provided with a ring gear 15 which is rotated by means of a pinion 16 which is driven by means of a suitable sprocket drive 17.

In order to prevent the escape of gases where the ends of the preheater loosely project into the chambers 13 and 14, rings 18 and 19 closely engage the feed and discharge ends of the preheater respectively and are provided with flanges 20 which are secured to the chambers. The rings 18 and 19 each confine a suitable washer or gasket 21 which tightly surrounds the preheater.

The chamber 13 is provided with a stack or draft 22 projecting from the top thereof.

When the conditions are such as to make it more convenient or desirable to arrange the preheater horizontally, the structure shown in Fig. 2 may be used in which a cylindrical body 12^a has its ends rigidly mounted in the chambers 13^a and 14^a and is provided with a suitable endless conveyor 23 by means of which the material is carried from the feed to the discharge end of the preheater.

Located below the structure above described is a rotary kiln 24 which comprises a cylindrical member inclined downward from the feed end to the discharge end, the feed end of the kiln preferably being adjacent to the discharge end of the preheater.

The kiln 24 is provided with rings 25 adjacent to its ends which rings engage between flanges 26 of suitable rollers 27. The kiln is rotated by means of a ring gear 28 secured to the kiln and engaging a pinion 29 driven by a suitable sprocket drive 30.

The kiln 24 has its feed end loosely projecting into a cap member 31 and its discharge end loosely projecting into a chamber 32.

A gas tight connection 33 similar to the connection above referred to for the ends of the preheater is provided where the discharge end of the kiln enters the chamber 32.

The kiln is preferably reduced in diameter adjacent to its feed end, as designated at 34 in order that the hot gases will come more intimately into contact with the material.

Extending transversely through the bottom of the chamber 32 is a plurality of tubes 35 which are in communication with a chamber 36.

The numeral 37 designates a suitable fan and communicating with the fan and the chamber 36 is a tube 38.

In communication with the fan and extending therefrom into the feed end of the kiln is a tube 39.

In communication with the tube 39 is a suitable conveyor 40 by means of which a suitable fuel is introduced into the kiln.

The feed end of the kiln is in communication with the bottom of the chamber 14 through a conduit 41 by which the material is fed from the discharge end of the preheater to the feed end of the kiln.

In order to prevent gases passing from the kiln into the chamber 14 a suitable flap valve 42 is provided in the conduit 41.

The discharge end of the kiln 24 is preferably provided with a ring or perforated cap 43 in order that a greater mass of material will remain in the kiln and thus be subjected to a longer period of heat treatment.

In communication with and extending from the chamber 32 to the chamber 14 is a suitably insulated conduit 44. The product is discharged through the bottom of the stack 32 and conveyed to any desired place by means of a suitable conveyor 45.

It will be noticed that the depth of the material at that end of the kiln at which the material in its preheated condition enters the kiln is less than its depth within the remainder of the kiln. This is important since it insures a rapid rise in temperature of the preheated material and the substantial retention of the material at its latter temperature: due to the fact that the material almost immediately after it enters the kiln and while it is of its lesser depth in the kiln comes into contact with the hottest part of the flame and then progresses throughout the remainder of the kiln with the products of combustion whose temperature has become less and then remains substantially constant while the depth of the material has become greater. The portion of the kiln in which the temperature of the material is raised to the calcining point has been herein referred to as the "burning or combustion zone" and the remainder of the kiln has been referred to as the "roasting

zone" to distinguish them from each other: although in a broad sense, of course, all parts of the kiln may, in fact, constitute a burning zone and all parts a roasting zone.

It is, of course, difficult and unnecessary to set forth accurately herein the exact boundaries of the hottest parts of the flame, or any precise point at which the burning zone, so called, ends and the roasting zone, so called, commences: but the zone which has been herein referred to as the burning zone may be arbitrarily assumed to be that portion in the length of the kiln which is traversed by the raw material during the period in which it is being raised to the calcining temperature, and is of the lesser depth. The zone which has been referred to as the roasting zone for the purposes of this explanation may be assumed to be that portion of the kiln through which the material passes after it has been raised to a calcining temperature and is of the greater depth and during which it is substantially maintained at said temperature.

It may be here mentioned that in my practice, and with a kiln of about 100–125 feet in length, I have found that the best results have been secured when the fuel at its point of ignition (which is about ten feet from its inlet to the kiln) has a temperature of about 2000° F. and a flame temperature of about 2500° F. a few feet further along in the kiln, while the temperature of the gases of combustion at the outlet from the kiln is about 1400° F. and at the inlet to the preheater about 1250° F., gradually reducing within the preheater to about 300° F. where it first comes in contact with the raw material and then enters the stock 22. At these temperatures, the raw material will leave the preheater at a temperature of about 500° F.–800° F. and will be quickly raised in the kiln to an optimum temperature to lose carbon dioxide as 1250° F.–1400° F., or thereabouts, in the case of natural cement rock or 1500° F.–1600° F., or thereabouts, in the case of lime. These temperatures may vary, as is evident.

I have also found it to be beneficial to maintain the material at a depth varying from about one foot in what has been referred to as the "burning zone" to about two feet in what has been referred to as the "roasting zone".

In the use of the apparatus described, the rock is introduced into the hopper 10 and by the action of gravity is fed through the tube 11 into the feed end of the preheater 12.

The material slowly travels from the feed end to the discharge end of the preheater by means of the rotation of the preheater and the action of gravity or by means of the conveyor 23. Since the material first comes in contact with the coolest portion of the gases, and travels thence in a direction counter to that of the flow of gases in the preheater, it follows that the temperature of the raw material is gradually raised and the raw material is gradually dried without any danger of popping or explosions.

The material passes from the discharge end of the preheater through the tube 41 into the feed end of the kiln 24.

Fuel is introduced at the feed end of the kiln by the conveyor 40 and the fan 37 draws air through the tubes 35 thus heating the air and thence through the tube 38 and fans the heated air with the fuel into the feed end of the kiln.

The material is thus subjected to the most intense heat in the restricted portion or burning zone 34 of the kiln, in which it is of the lesser depth.

The material travels from the burning zone and enters the portion of the kiln of the greatest diameter, in which it is of the greater depth and has its speed correspondingly reduced, and in this portion of the kiln is mainly subjected to a roasting action.

The hot burned material passes out of the discharge end of the kiln into the bottom of the stack 32 with the tubes 35 imbedded therein and thus heating the air drawn through the tubes by means of the fan 37.

The waste heat of combustion in the kiln is, by means of the stack or draft 22, drawn through the conduit 44 into the discharge end of the preheater and therein to the feed end of the preheater over the raw material which is slowly descending in the preheater thus drying and preheating the material before it enters the kiln.

The apparatus, due to its construction, also is capable of burning high grade limestone and natural cement rock of all small sizes down to dust in a much shorter period of time than that required in the burning of lime or cement rock of the larger sizes in the usual vertical type of kiln, the usual time required for burning lime and cement in the vertical kiln being from 24 to 72 hours whereas only from three to six hours, or thereabouts, are required in the apparatus forming this invention.

In short, this apparatus provides a means for burning lime and cement in which the entire mass of raw material can be burned more uniformly, more economically and in a shorter period of time than heretofore, and in which the product compares favorably with that burned in the vertical type of kiln.

In conclusion it may be here stated that although reference has not hereinbefore been made to the fact, yet in the use of this apparatus in the treatment of the special materials herein named, a portion of the carbonic acid—approximately from five to ten per cent thereof—is expelled from the raw

material in its passage through the preheating chamber, the remainder thereof being expelled in the rotary kiln, in which latter the treatment is finished.

Having now described the invention, what I believe to be new and desire to secure by Letters Patent, and what I therefore claim, is:—

1. An apparatus for the burning of limestone or natural cement, in rock form, comprising a rotary kiln, a preheating chamber having openings through which the rocks to be treated are initially fed into and discharged from said chamber, respectively, means separate from each other through which the preheated rocks discharged from the preheating chamber and a combustible fuel, respectively, are independently delivered into the same end of the rotary kiln, said kiln having means at its opposite end through which the calcined rocks are discharged, and means, including a conduit extending between the discharge end of the rotary kiln and the discharge opening of the preheating chamber, through which the products of combustion which have treated the rocks in the kiln in a parallel flow with said rocks are conducted to the discharging end of the preheating chamber for the initial treatment of the rocks in the latter by a flow through said chamber counter to that of the rocks.

2. An apparatus for the treatment of limestone or natural cement, in rock form, comprising a rotary kiln, a preheating chamber, means through which the rocks are fed into one end of the preheating chamber, means through which the preheated rocks are discharged from the other end of the preheating chamber and into the kiln, means forming part of the kiln and operative to form the rocks therein into a mass whose depth at the receiving end of the kiln is less than its depth throughout the succeeding part of the kiln, means by which a combustible fuel is introduced under pressure into that end of the kiln in which said mass is of the lesser depth, and means by which the gases which have passed through the kiln are introduced into the material discharging end of the preheater and caused to flow through the latter in a direction counter to that of the raw material.

3. In an apparatus for burning limestone or natural cement, in rock form, a rotary kiln, and means for introducing a combustible fuel under pressure into the material receiving end of said kiln, means forming part of the kiln and by which the material is formed into a mass whose depth at the hottest part of the flame formed from said fuel is less than that throughout the succeeding portion of the kiln, for the purposes specified.

4. In an apparatus for burning limestone or natural cement, in rock form, comprising a rotary kiln, having an opening at one end through which the raw material is introduced and also having a member partially closing its other end and causing an increase in the depth of the material toward the discharge end of the kiln, and means through which a combustible fuel is introduced into the material receiving end of the kiln independently of the material and causes the hottest part of the flame formed therefrom to be in that portion of the kiln which contains the lesser depth of the raw material.

5. An apparatus for burning lime and cement, in rock form, comprising a rotary kiln having its material receiving end of restricted internal diameter and also having at its material discharging end a member which partially closes the latter end and provides a shoulder adjacent the discharge opening to cause an increase in the depth of material toward said discharge end, and means through which a combustible fuel is introduced under pressure into the kiln at the material receiving end of the latter to cause the hottest part of the flame to be in that part of the length of the kiln which is of restricted diameter and contains the lesser depth of material.

6. An apparatus for burning limestone or natural cement, in rock form, comprising a rotary kiln having means through which rocks to be calcined are delivered into one of its ends and means through which the calcined rocks are discharged from its other end, a chamber in communication with the discharge end of the kiln to receive the hot calcined rocks therefrom, said chamber having means through which said rocks are discharged from it, an atmospheric air pipe embedded in the hot calcined material in said chamber, a fuel supply means, means having communication at one of its ends with said atmospheric air pipe and at its other end with the fuel supply means and through which air preheated in said pipe is delivered to the fuel, and means through which the mixture of fuel and preheated air is discharged under pressure into the end of the kiln at which the rocks to be treated are delivered and separately from said rocks.

7. An apparatus for burning limestone or natural cement, in rock form, comprising a preheating chamber through which the raw material is moved progressively from one end to the other thereof, a draft stack at the material receiving end of the preheating chamber, a chamber at the opposite end of the preheating chamber to receive the material discharged from the preheating chamber, a conduit leading from the chamber at the discharge end of the preheating chamber, a rotary kiln to the material receiving

end of which said conduit is connected, a chamber at the discharge end of the kiln to receive the treated material therefrom, means independent of said conduit and through which a combustible fuel is discharged into the material receiving end of the kiln and a conduit to lead the gases of combustion from the latter chamber to the chamber at the material discharging end of the preheating chamber.

8. An apparatus for burning limestone or natural cement, in rock form, comprising a preheating chamber through which the raw material is moved progressively from one end to the other thereof, a draft stack at the material receiving end of the preheating chamber, a chamber at the opposite end of the preheating chamber to receive the material discharged from the preheating chamber, a conduit leading from the chamber at the discharge end of the preheating chamber, a rotary kiln to the material receiving end of which said conduit is connected, means separate from said conduit through which a fuel material is supplied to said receiving end of the kiln, a chamber at the discharge end of the kiln to receive the treated material therefrom, an atmospheric air pipe extending through the mass of hot treated material in the latter chamber, means by which air is caused to flow through said pipe and is mixed with the fuel material to support combustion of the latter and a conduit to lead the gases of combustion from the chamber at the material discharging end of the kiln to the chamber at the material discharging end of the preheating chamber.

9. An apparatus for burning lime or cement, in rock form, comprising a rotary kiln, separate means through which the material to be treated and a fuel respectively are independently discharged into the same end portion of said kiln, and means through which a current of air is caused to flow through, but out of contact with the burned material at the opposite end of the kiln and is forced under pressure, with the fuel, directly into the first mentioned end of the kiln.

10. An apparatus for burning lime or cement in rock form, comprising a rotary kiln, having means at one end through which the raw material is delivered into it and means at its opposite end from which said material is discharged, and means for discharging a mixture of preheated atmospheric air and a fuel into the material-receiving end of the kiln separately from the material to be treated, the latter means including a pipe open at one end to the atmosphere and embedded in the hot calcined material discharged from the kiln and a conduit having communication with the discharge end of said pipe at one end and with the material-receiving end of the kiln at its opposite end, and also including a fan operatively related to said conduit to draw the preheated air through said atmospheric pipe and to force it, with the fuel, into the material-receiving end of the kiln.

In testimony whereof I affix my signature.

EUGENE J. WECHTER.