F. L. WOODS & M. BOYD.

BURNING PORTLAND CEMENT.

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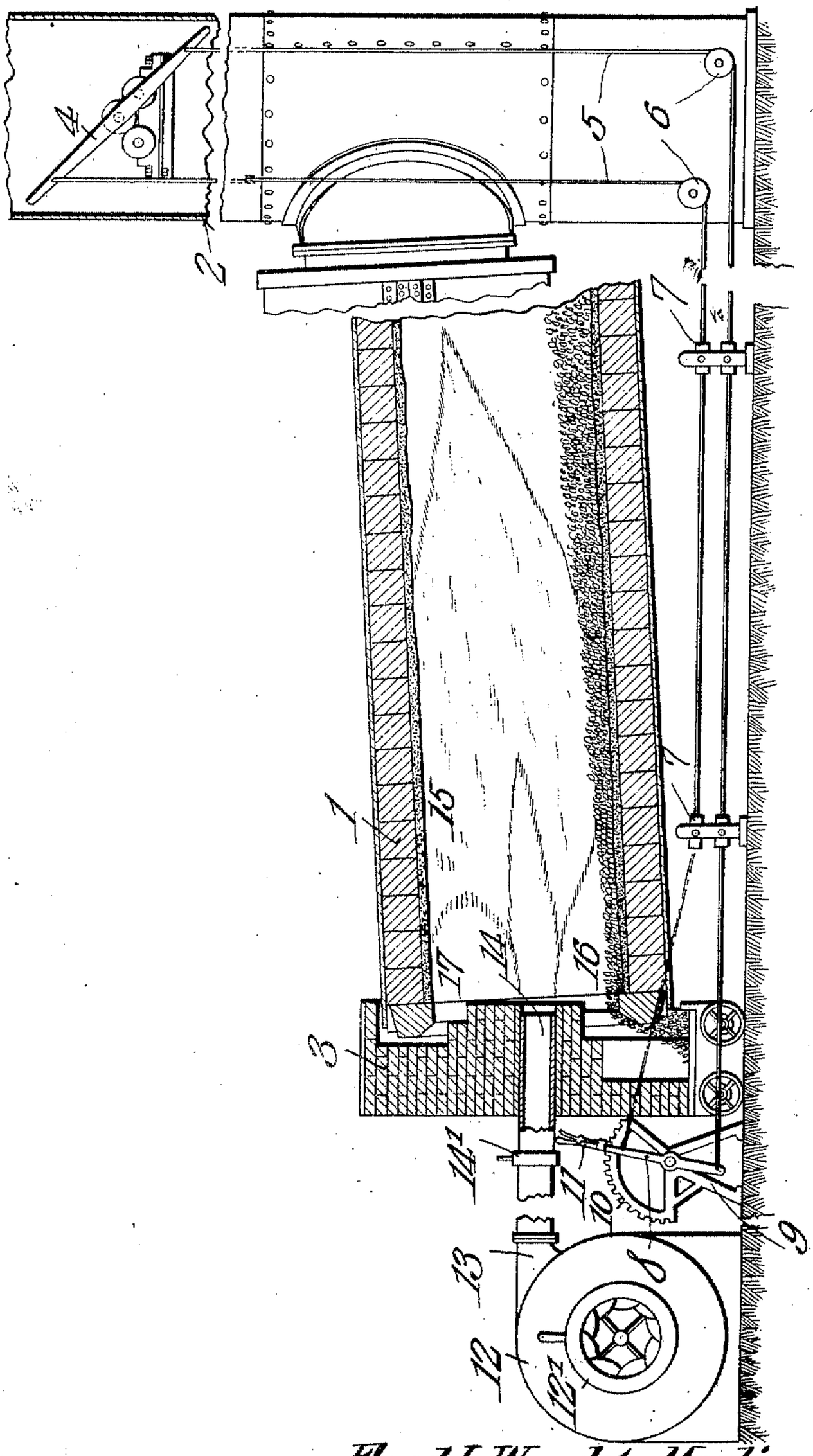
985,313. **Patented Feb. 28, 1911.**



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UNITED STATES PATENT OFFICE.

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BURNING PORTLAND CEMENT.

985,313. Specification of Letters Patent. Patented Feb. 28, 1911.

Application filed February 27, 1909. Serial No. 480,378.

To all whom it may concern:

Be it known that we, FRED L. WOODS and MERLIN BOYD, citizens of the United States, residing at Iola, in the county of Allen, State of Kansas, have invented a new and useful Improvement in Burning Portland Cement, of which the following is a specification.

This invention relates to a process of burning cement material.

Heretofore, so far as we are aware, cement materials have been burned in rotary kilns under subatmospheric conditions due to the draft methods employed. We have discovered that by positively feeding air under superatmospheric pressure to the firing zone of the kiln in sufficient quantities to support complete combustion and to maintain superatmospheric pressure in the firing zone, and by maintaining between the firing zone and the stack a zone of kiln gases under superatmospheric pressure, and by utilizing this zone of kiln gases to control the position of the firing zone and by retarding the escape of kiln gases at the stack, thereby increasing the time of contact of the hot kiln gases with the raw materials and causing the operation of the kiln to be independent of atmospheric conditions the effective intensity of the firing zone is increased and maintained and the cement material reaches the firing zone in proper condition, thereby producing a quick, thorough, incipient fusion of the cement material which results in a clinker that is uniform in size and grade, easily ground and perfectly sound. We have also discovered that by means of our method, the daily output of a rotary kiln is almost doubled and considerably less fuel per barrel is consumed than is necessary when using the same kiln in the ordinary manner.

The invention may be carried out with various kinds of fuel such for example as gaseous or liquid fuel or fine coal or the like.

While usually it is advantageous to maintain positive pressure throughout the length of the kiln, this does not preclude the use of natural, that is stack draft, or forced draft at the stack end of the kiln to aid in discharging the waste gases from the kiln, but even under such conditions there is a positive pressure throughout the firing zone and beyond. The invention will be best understood, however, from a consideration of the following detail description taken in connection with the accompanying drawing forming a part of this specification, with the understanding, however, that the drawings show but one of the many apparatuses which may be employed in the carrying out of the process.

In the drawings: the figure is a longitudinal section with parts broken away of a kiln adapted to the purposes of the present invention.

Referring to the drawing there is shown a kiln 1 which may be of the usual rotary type employed in the manufacture of cement and consequently needs no specific description. At the inlet end of the kiln there is provided a stack 2 and at the delivery end of the kiln there is provided a housing 3.

Within the stack 2 is mounted a damper 4 controlled by strands 5 extending over suitable pulleys 6 and through guides 7 to the discharge end of the stack where a lever 8 is provided and is connected to the strands 5 so that by moving the lever about its pivot the damper 4 may be regulated as desired. A stand 9 is provided for the support of the lever 8 and on this stand is a rack segment 10 while the lever carries a hand latch 11 adapted to engage between the teeth of the segment 10 and so lock the lever in adjusted positions.

At a suitable distance from the discharge end of the kiln is a blower 12 which may be taken as typical of any device for delivering air above atmospheric pressure and which is driven by mechanical means, which latter, under usual conditions, will be an electric motor directly connected to the shaft of the blower by a flexible coupling, but as these features are common to blowers it is not deemed necessary to illustrate them in the drawings. In order to control the output of the blower irrespective of its speed, the intake is provided with a valve structure 12′ which is preferably of the iris diaphragm type. A conduit 13 leads from the blower and has an extension 14 entering the housing 3 in position to discharge into the kiln preferably in substantially the central longitudinal axis thereof. The conduit 13 and end 14 are made perfectly straight and of sufficient diameter to cut down the friction of the air and fuel particles thereon to a minimum and yet permit the velocity neces-

sary to deliver a sufficient volume of air to the kiln to convey the mixture to a complete combustion, without an excessive expenditure of power at the blower shaft. Of course such regulating means as may be necessary to control the delivery of air and fuel to the kiln may be provided since different kinds of fuel require different modes of handling. Another iris diaphragm valve 14′ is provided in the conduit 13 near the housing 3, such type of valve being preferable since the walls of the opening therethrough irrespective of size is substantially concentric with the central longitudinal axis of the conduit 13. If greater velocity of the fuel blast be needed on the kiln side then the diaphragm valve 14′ is contracted and the penetration of the fuel blast and flame into the kiln is increased because of the increased velocity of the blast due to the decreased opening in the valve. Of course, increasing the opening through the valve 14′ lowers the velocity of the blast correspondingly.

The burning mixture enters the kiln preferably in the longitudinal axis thereof and extends along the length of the kiln until it impinges against the zone or cushion of gases therein, which cushion is made up of the evaporation of moisture, if present, from the green material, the gases given off during the calcining operation, and the gaseous products of combustion from the flame, the incoming fuel under pressure serving to continuously force out the kiln gases from the stack against the throttling action of the damper 4 while the zone of kiln gases determining the extent of the flame remains substantially constant for the same conditions of throttling by the damper 4 and the pressure of the incoming air and fuel making up the self-burning mixture at the extension 14.

The resistance offered by the zone or cushion of kiln gases tends to spread out the flame until it is brought into contact with the walls of the kiln and with the material traveling along the same toward the discharge end. The operator by watching the fire can readily control the penetration of the flame either by controlling the velocity of the incoming blast or the density of the cushion or zone of kiln gases. Under varying loads this causes the flame to diverge at such an angle that it strikes the lining and the material in progress through the kiln for a proper burning zone. This method, which is independent of the stack for combustion purposes, permits the kiln operation to be unaffected by atmospheric conditions. Observation has shown that the density of this divergent and retarded flame is greater at the top of the kiln. This may be explained by the fact that the rapid evolution of carbon dioxid given off by the raw material in progression through the kiln forces the main part of the live heat toward the top of the kiln to such a place as for instance is indicated at 15. This increased pressure at the top causes the rebound and consequent change of direction of the fuel particles in the upper part of the flame and this part of the flame, therefore, tends to lap back toward the front of the housing 3. At the zone indicated by the numeral 16 there is just enough pressure to balance the atmospheric pressure while at the zone indicated by the numeral 17 there is a positive pressure. Observations of the conditions in these parts will determine the nearest to the most economical position of the cushion.

The burning of the fuel mixture under compression, that is under a positive pressure above atmospheric pressure, or as it may be termed compressional burning, results in a rapid acquirement of an intense heat in an easily controllable zone for the calcination and incipient fusion of the clinker. It offers all the conditions of perfect mixing, greatest effective temperature and intensity, thorough diffusion, and that suffusion which results from the condition of pressure in the kiln which leads to a rapid and intimate mingling of fuel particles and air and the consequent quick intense combustion. The method of the present invention puts the control and regulation of the quality and quantity of the fire completely in the hands of the operator and reduces the stack to its proper function, that is, an outlet for waste gases and for the regulation of kiln pressure.

Pressure curves taken from kilns while operated under the compressional system of the present invention show that good results are obtained by operating the kiln under a pressure of approximately three and one half inches of water at the discharge or firing end of the kiln, this pressure curve dropping to about one inch of water at a point twenty feet from the discharge end of the kiln and dropping to one-half inch at a point forty feet inside of the kiln, and becoming a negative pressure at a point approximately seventy-five feet from the discharge end of the kiln, and, in case of a kiln exceeding seventy-five feet in length, continuing as a negative or subatmospheric pressure from there to the stack end of the kiln. If the kiln be seventy or seventy-five feet in length the superatmospheric pressure will extend from the discharge end to the stack. Moreover, in kilns exceeding seventy-five feet, the positive pressure may be maintained entirely to the stack by increasing the size and power of the fan or blower which positively supplies the air.

In operating a kiln according to the present invention, the firing zone usually extends thirty or forty feet into the kiln from the discharge end and is thus under

a superatmospheric pressure of from three and one-half inches at the discharge end to three quarters or one-half of an inch at its inner end. The cushion or zone of kiln gases under superatmospheric pressure will extend usually from the inner end of the firing zone to a point seventy or seventy-five feet from the discharge end of the kiln and its pressure will curve from three quarters or one-half of an inch at its outer end to atmospheric pressure at its inner end.

What is claimed is:

1. A method of burning cement which consists in feeding fuel into a cement kiln, feeding air under pressure in sufficient quantities to support complete combustion of said fuel, and maintaining superatmospheric pressure throughout the clinkering zone.

2. A method of burning cement which consists in feeding fuel into a cement kiln, feeding air under pressure in sufficient quantities to support complete combustion of said fuel, and maintaining superatmospheric pressure throughout the firing zone.

3. A method of burning cement which consists in feeding fuel into a cement kiln, feeding air under pressure in sufficient quantities to support complete combustion of said fuel, maintaining superatmospheric pressure in the firing zone, and controlling the position of the firing zone by a zone of kiln gases maintained at superatmospheric pressure between the firing zone and the stack.

4. A method of burning cement which consists in feeding fuel into a cement kiln, feeding air under pressure in sufficient quantities to support complete combustion of said fuel, maintaining superatmospheric pressure in the firing zone, and retarding the escape of the kiln gases, whereby an increased time of contact with the raw material is obtained and the operation of the kiln is caused to be independent of atmospheric conditions.

5. A method of burning cement which consists in feeding fuel into a cement kiln, feeding air under pressure in sufficient quantities to support complete combustion of said fuel and to maintain superatmospheric pressure in the firing zone, maintaining a zone of kiln gases under superatmospheric pressure between the firing zone and the stack, and retarding the escape of kiln gases at the stack.

In testimony that we claim the foregoing as our own, we have hereto affixed our signatures in the presence of two witnesses.

FRED LEROY WOODS.
MERLIN BOYD.

Witnesses:
EDMUND C. CHAMPION,
W. H. KLEIN.