No. 759,356. PATENTED MAY 10, 1904.

T. A. EDISON.

METHOD OF BURNING PORTLAND CEMENT CLINKER, &c.

APPLICATION FILED APR. 19, 1900.

NO MODEL. 2 SHEETS—SHEET 1.

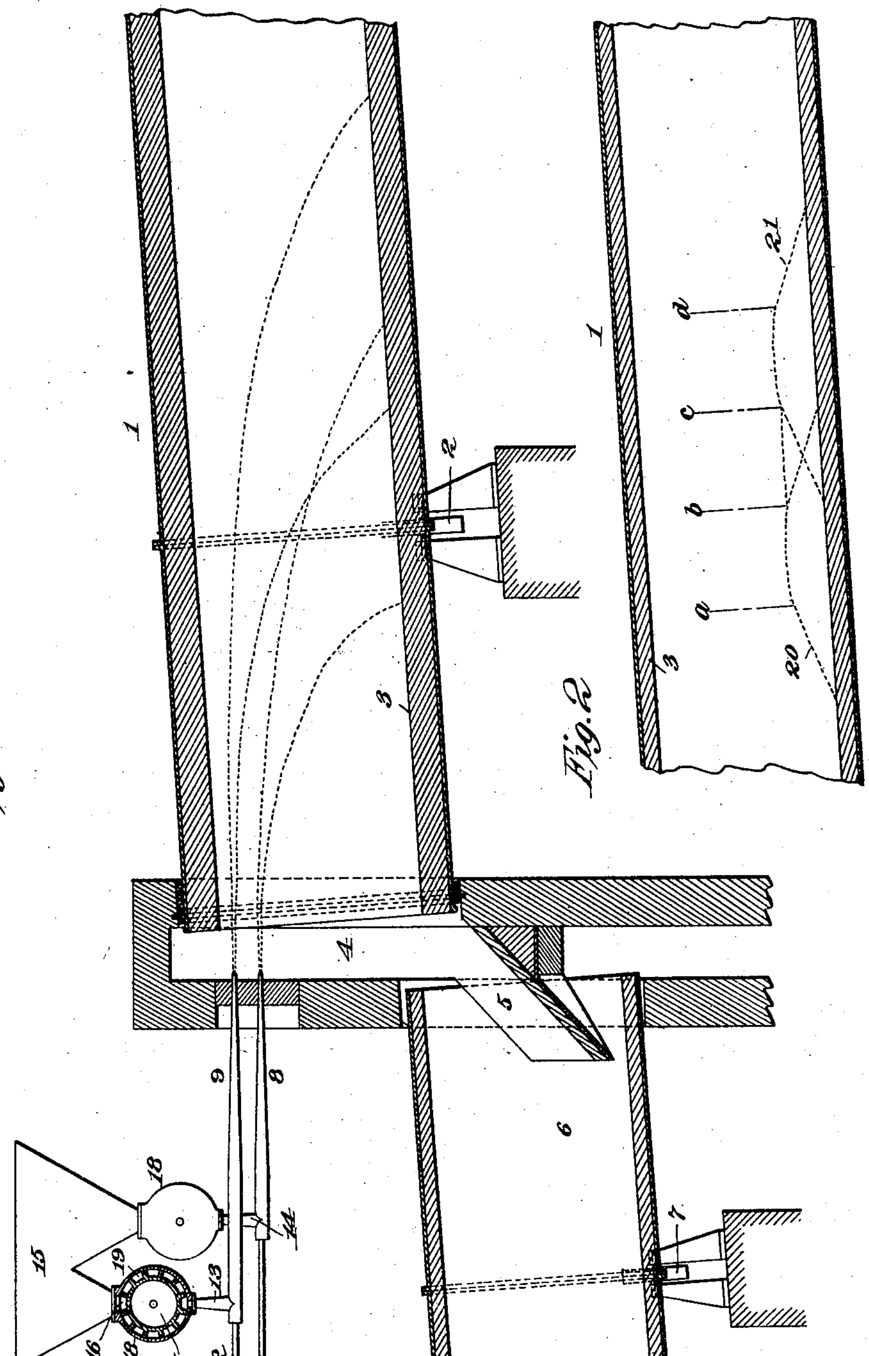

Fig. 1

Fig. 2

Witnesses:
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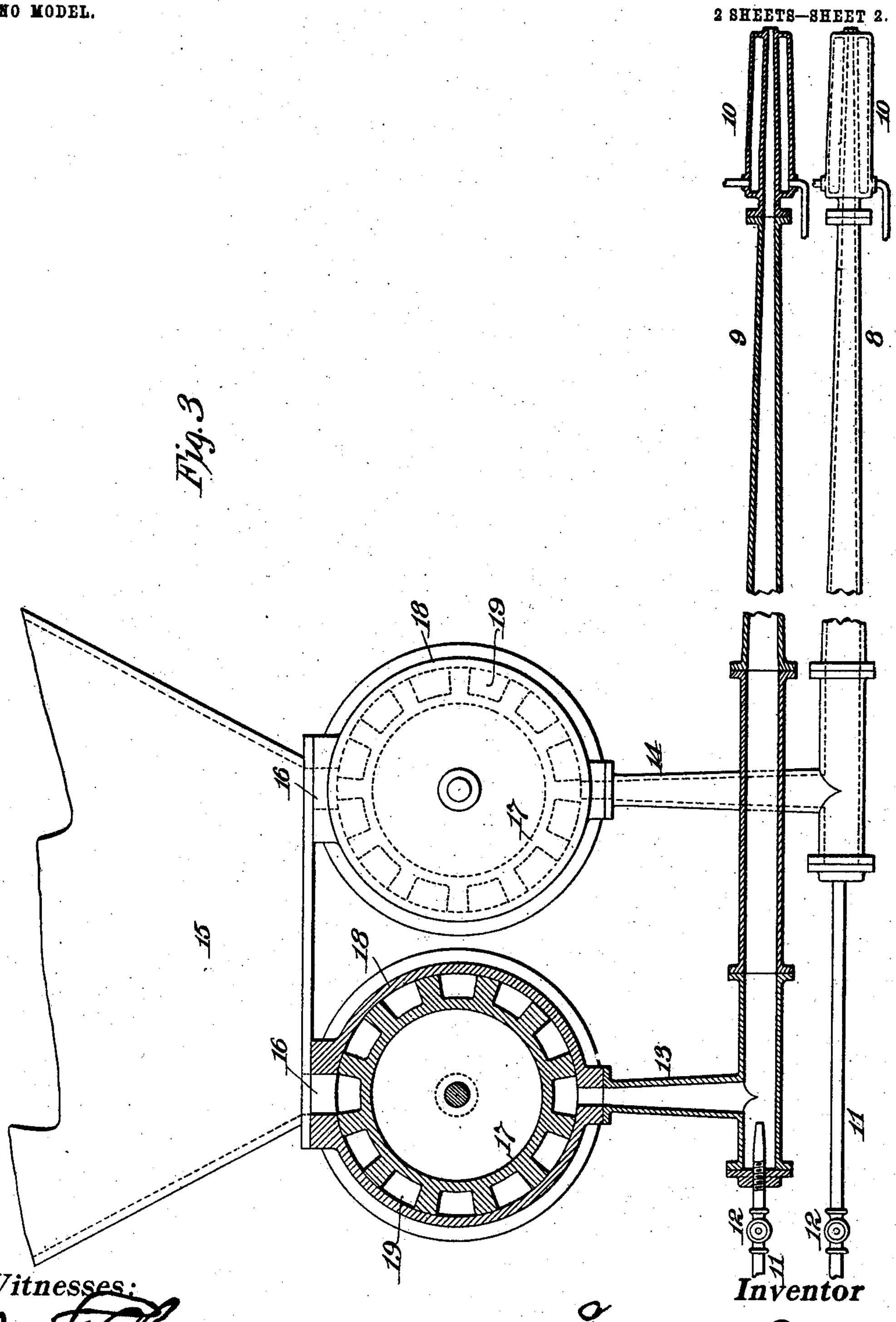
Fig. 3



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

METHOD OF BURNING PORTLAND-CEMENT CLINKER, &c.

SPECIFICATION forming part of Letters Patent No. 759,356, dated May 10, 1904.

Application filed April 19, 1900. Serial No. 13,405. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, (whose post-office address is said Llewellyn Park, Essex county, New Jersey,) have invented a certain new and useful Method of Burning Portland-Cement Clinker and other Materials, (Case No. 1,032,) of which the following is a specification.

My present invention relates to an improved method particularly designed for the burning of Portland-cement clinker; and my object is to provide a method whereby may be secured an increase in the output of Portland-cement clinker in burners of the rotary-cylinder type.

The invention consists in a method whereby a greater amount of fuel may be consumed in such cylinders without raising the temperature of any part thereof above the greatest temperature to which they are now usually subjected, whereby the desired quality of the material may be secured, while the output thereof will be very largely increased.

The rotary-cylinder burners now in common use for burning Portland-cement materials consist of a cylinder about sixty feet in length lined with fire-brick and having an inside diameter of from four to five feet, the cylinder being set at a slight angle and the powdered material being fed in at the upper end thereof, whereby the rotation of the cylinder will by reason of its inclination slowly advance the material toward and out of the lower end thereof. The speed of progression of the material lengthwise through the cylinder depends obviously upon the speed of rotation and the inclination thereof. The exit or lower end of the cylinder opens into a closed chamber provided with an orifice at the bottom, through which the burned material may make its exit. With such cylindrical burners as now used there is inserted in this chamber, in an axial line with the bore of the cylinder, a nozzle, through which, by means of compressed air, a stream of powdered or pulverized coal may be projected into the cylinder and there consumed. Total combustion of the pulverized fuel takes place over a relatively limited area near the lower end of the cylinder, such area being, perhaps, not over twenty feet in length. The very high temperature necessary for the final clinkering of the cement materials is restricted, however, to a much smaller area—say about eight feet of the length of the cylinder. With cylinders of the dimensions indicated and providing for total combustion of the pulverized fuel in approximately the areas mentioned about twenty-eight hundred pounds of cement clinker are produced per hour with an expenditure of about eight hundred pounds of coal-dust, the maximum temperature reached being approximately 3,000° Fahrenheit. The gases of combustion are swept forward in the cylinder and impart their heat to the advancing material, finding exit through a stack at the feed end, at which the cold material is introduced. The compressed air for projecting the powdered coal through the nozzle into the cylinder being insufficient to effect its complete combustion, the additional air necessary for that purpose is introduced through the exit-orifice for the burned clinker, the air being thus introduced and passing through the cylinder by reason of the draft therein created by the stack and by the compressed air. The small amount of material which passes through the cylinder has so limited a capacity for the absorption of heat when it enters the contracted zone of high temperature that it effects very little lowering thereof, and even if material were not introduced within the zone of high temperature the latter would be raised only a few degrees. In practice it is necessary that the temperature in the contracted zone, or in the zone of effective clinkering, should not vary except in narrow limits, for the reason that if the temperature is too low the chemical reaction of the various ingredients which compose a good cement does not take place, or only partially so, whereas if the temperature is too high the clinker will be nearly melted, and when thus overburned undesirable chemical reactions take place, making an inferior cement. If with the proper proportion of coal and air adjusted to produce the desired clinkering temperature the amount of material fed into the cylinder were doubled, with a corresponding increase in the amount of fuel and air, it would follow that twice as much coal would be burned in substantially the same area, and the temperature would, therefore, rise in the clinkering zone, or zone of maximum heat, to so great an extent that the material would be overburned and the fire-brick lining of the cylinder would itself suffer injury. This result would take place, since the additional amount of material would not be sufficient to materially lower the temperature in the clinkering zone, and hence with the usual cylinders as now arranged and operated the output is nearly fixed and cannot be exceeded.

I have invented a method by which the output of material in burners of the type described can be very greatly increased. This I accomplish by altering the conditions of combustion and extending the area of high temperature—*i. e.*, the clinkering zone—over a greater length of the cylinder, whereby I am enabled to burn a very much greater amount of fuel and carry through the cylinder and properly burn a very much greater amount of cement or other material without raising the temperature in any part of the zone of maximum heat above that required to secure proper results. To this end I employ two or more combustion zones within the cylinder, each providing for a zone of clinkering heat, and the point of maximum temperature of one zone being preferably so closely adjacent to the point of maximum temperature of the adjacent zone as to secure between such points a sufficiently high temperature to obtain the desired clinkering effect. In this way I am enabled to secure within the burner a much larger proportional area of effective combustion with respect to the quantity of fuel used than is now possible.

To illustrate the invention generally, assume two nozzles to be employed, one being supplied with powdered coal and air at, say, fifty pounds pressure per square inch, which serves to throw the fuel with great velocity into the cylinder, so that the center of its zone of combustion is, say, twenty-five feet from the exit end of the cylinder, and the other being supplied with coal and air at, say, twenty pounds pressure, whereby the zone of combustion thereof will be located between the first zone and the exit end. The columns of air and powdered coal from the nozzles on account of their great velocity pass into the cylinder for a considerable distance before spreading and before the temperature of each reaches the combustion-point. By employing a plurality of nozzles each supplied with air at different pressures and with the proper amount of coal fed to each a very large amount of coal can be burned and the extent of clinkering temperature be increased to occupy a comparatively large area, whereby output of the material may be very largely augmented. In this way a considerable saving in investment and labor of operating cylindrical burners will be secured per ton of output, while an additional saving is secured in the relative diminution of the amount of coal necessary to burn a given quantity of material, due to the diminished loss by radiation. In other words, by so directing the different columns or streams of pulverized coal within the cylinder that the areas of combustion will, so to speak, "overlap" it is possible to secure an additional area of clinkering temperature or an additional zone of high heat which would not be secured with only a single burning column of fuel or with a plurality of such columns of fuel separated to too great an extent. The quantity of material and the speed of passage can thus be greatly increased.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a diagrammatic view illustrating the lower part of a cylinder-burner, showing the employment of two nozzles for directing pulverized fuel within the cylinder; Fig. 2, a diagrammatic view illustrating graphically the two zones of combustion of the nozzles shown in Fig. 1 and representing the increase in the area of the zone of high heat which may be secured by causing the zones of combustion to overlap; and Fig. 3, an enlarged sectional view, partly in elevation, showing effective devices for supplying the powdered coal to the two nozzles.

In all of the above views corresponding parts are represented by the same characters of reference.

1 represents the burning-chamber of a cylinder burner supported on rollers 2 and provided with a fire-brick lining 3, which may be longitudinally corrugated. The exit or lower end of the burner opens into a chamber 4, provided with a chute 5, by which the burned material will be directed into a cooling-cylinder 6, the latter cylinder being inclined, as shown, and carried on rollers 7.

8 and 9 represent two nozzles each provided with a water-jacket 10 at its inner end to prevent overheating, and opening into the rear ends of each of said nozzles is a pipe 11 for supplying compressed air thereto, each of said pipes being provided with a valve 12 for controlling the air-supply. Leading into the nozzles 8 and 9 are fuel-pipes 13 and 14, respectively, by which coal or other fuel in pulverized or powdered condition may be introduced into the nozzles, so as to be blown by the compressed air into the cylindrical burner. In order to supply coal to the nozzles, I illustrate a hopper 15, to which the powdered coal is fed in any suitable way, and having outlets 16 16 therefrom. Each of the fuel-pipes 13 and 14 is provided with a rotary feed 17, mounted in a casing 18, as shown, said feed comprising a rotating drum having a series of pockets 19 in its periphery. Obviously a

given quantity of fuel will be received in each of these pockets as they pass successively beneath the exit-openings 16 of the hopper and be discharged by gravity into the fuel-pipe 13 or 14, as the case may be, as the pockets successively pass the upper ends of said pipes. The feeds for both fuel-pipes are rotated at the same speed by any suitable mechanism; but said feeds are proportioned, as shown, so that while one of them is discharging fuel into one of the nozzles the other feed will occupy an intermediate position. In this way the feed of fuel to the cylinder is more uniform than would be the case if fuel were simultaneously deposited into both nozzles followed by a simultaneous cessation of feed therefrom.

In the burning of Portland-cement material with an apparatus like that described I carry out my method as follows: The cylindrical burner 1 is rotated in the usual way, and the cooling-cylinder 6 is also rotated. Compressed air is supplied to the nozzle 9 through its air-pipe 11, say, at a pressure of fifty pounds per square inch, and compressed air is supplied to the nozzle 8 through its supply-pipe at a lower pressure. The hopper 15 being supplied with pulverized coal, the rotary feeds supply the nozzles 8 and 9 with a proper amount of fuel, which by the compressed air will be blown with a velocity depending upon the air-pressure into the cylinder, the fuel spreading more or less as its velocity diminishes. In the assumed case the nozzle 9, owing to the higher air-pressure, will project its stream or column of pulverized fuel into the cylinder farther than the nozzle 8. Combustion is started by igniting the streams of pulverized coal, and the proper additional amount of air necessary to effect complete combustion will be supplied by a controlled forced draft passing into the cylinder through the cooling-cylinder 6. The representation of the streams or columns of pulverized fuel in Fig. 1 is purely diagrammatic, since in practice complete combustion of the fuel will take place before the latter can fall to the bottom of the cylinder, as shown.

Obviously the areas within the cylinder substantially coincident with the ends of each stream of burning pulverized coal will be the combustion zones. Thus, referring to Fig. 2, the line 20 may be taken to represent graphically the combustion zone derived from the burning stream of pulverized coal supplied by the nozzle 8, while the line 21 may be taken to represent graphically the corresponding combustion zone of the nozzle 9. If a single nozzle such as 8 were used, that portion of the area of the combustion zone represented by the line 20 which extends between the vertica llines *a b* may be assumed to be the clinkering zone of the nozzle 8, or, in other words, so much of the heated area derived from the combustion of the pulverized coal supplied by the nozzle 8 as will secure the clinkering effect on the material. Therefore it will be seen that if a single nozzle were used the material would be clinkered or properly burned only during its passage lengthwise of the cylinder to an extent corresponding to the distance between the lines *a* and *b*, the temperature of the zone 20 at the right of the line *b* and at the left of the line *a* being insufficient to effect a clinkering action. Owing, therefore, to the relatively contracted area of clinkering temperature secured in the heated zone derived from a single nozzle, it becomes possible to pass only a relatively small quantity of material through the apparatus. If an attempt were made to pass a greater amount of material through the burner by using an increased quantity of pulverized coal in a single nozzle, the maximum temperature of the single zone would be raised so high as to injure the lining of the burner, since the material, even if of larger volume, would not materially reduce the temperature of the heated zone. By employing, however, a plurality of nozzles, so that a plurality of combustion zones will be secured within the cylindrical burner, the maximum temperature of each of said zones will not be so high as to overburn the material or to injure the lining of the burner. Thus it will be seen that when two nozzles are employed the combustion zone derived from the combustion of the stream or column of pulverized fuel from the nozzle 9 will between the lines *c* and *d* provide for a zone of clinkering temperature. Assuming the air-pressure supplied to the two nozzles to be so widely different as to separate the combustion zones sufficiently as not to influence each other, it will be seen that by doubling the amount of coal supplied to the burner twice the material can be passed through the burner to be effectively clinkered without danger of over or under burning. A greater saving, however, is secured when the air-pressures applied within the several nozzles are so modified as to cause the combustion zone derived from the combustion of the coal supplied by one nozzle to, so to speak, "overlap" upon the combustion zone derived from the other nozzle, as indicated in Fig. 2. When this is done, it will be found that the heat derived from two adjacent combustion zones between the lines *b* and *c* will be sufficient to effect the desired clinkering operation. When the nozzles are thus arranged, it will be seen that by doubling the quantity of coal supplied to the cylinder burner the clinkering zone will be increased approximately three hundred per cent., and it becomes possible, therefore, to pass the material through the burner three times as fast with two nozzles as with one or to pass about three times the bulk of the material at the same speed with two nozzles as with one.

As the material after being clinkered passes down the chute 5 into the cooling-cylinder 6 the cold air entering said cylinder will absorb heat from the material to cool the latter, whereby such air will enter the burning-cylinder in a heated condition, with the advantages derived therefrom as I explain in my said application.

Instead of using my improved method for the clinkering of cement materials it will be obvious that it may be carried out in connection with the burning or roasting of other materials—as, for instance, in the roasting of ores.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

The method of burning clinker or analogous material, which consists in forcing, by compressed air, a plurality of streams of pulverized fuel within the burning-chamber, in establishing combustion of such material, whereby a plurality of combustion zones will be secured, in subjecting the material successively to the heating effect of such zones, and in regulating the air-pressure so as to cause the combustion zones to overlap, substantially as set forth.

This specification signed and witnessed this 10th day of April, 1900.

THOMAS A. EDISON.

Witnesses:
J. F. RANDOLPH,
J. A. BOEHME.