No. 819,127. PATENTED MAY 1, 1906.

H. L. DOHERTY.

PROCESS OF CONDUCTING COMBUSTION.

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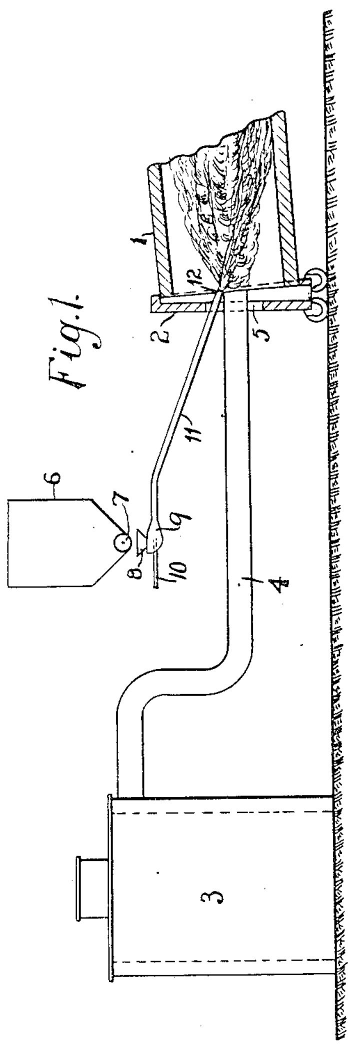

Fig.1.

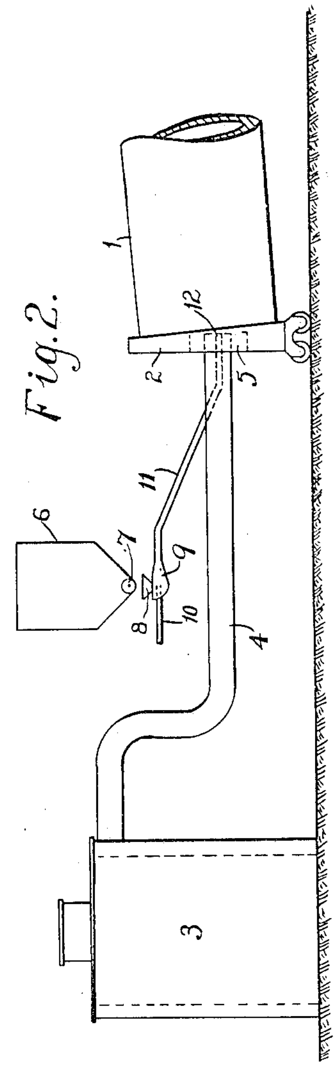

Fig.2.

Witnesses

Henry L. Doherty
Inventor

By his Attorney Carleton Ellis

UNITED STATES PATENT OFFICE.

HENRY L. DOHERTY, OF NEW YORK, N. Y., ASSIGNOR TO COMBUSTION UTILITIES COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

PROCESS OF CONDUCTING COMBUSTION.

No. 819,127. Specification of Letters Patent. Patented May 1, 1906.

Application filed November 14, 1905. Serial No. 287,218.

To all whom it may concern:

Be it known that I, HENRY L. DOHERTY, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Processes of Conducting Combustion, of which the following is a specification.

This invention relates to the art of conducting combustion with composite flames, such as a gas-flame conjoined with a flame produced by the ignition of powdered coal.

In many branches of industrial work where producer-gas or other gaseous fuel is used for heating purposes it is often of the greatest importance to secure a localized heat in one portion of the furnace to effect certain chemical changes in preparation for which the material may be undergoing treatment in another part of the furnace with a flame of lesser heat intensity. With ordinary producer-gas it is difficult to carry out an operation of this sort successfully and economically, and especially is this true of producer-gas made from coke or anthracite coal, owing to the blue or non-luminous flame resulting from its combustion. A non-luminous flame is not a good heat-imparting agent. The potency of the radiative action had never been heretofore clearly appreciated in this connection. Just why the quantity of coke or anthracite coal required in some operations to do a given amount of work is twice that required by a given weight of bituminous coal, which affords producer-gas possessing a considerable degree of flame luminosity, has not been heretofore apparent. The luminous quality of the flame is due to the fine particles in suspension from which the radiations emanate. Radiation varies with the nature of the material, and perfect radiation is possible only with a perfectly black non-reflecting surface. Radiation varies as the fourth power of the temperature. Consequently for high-temperature work while a non-luminous flame is relatively very ineffective, a luminous flame, owing to this rapid increase in radiation with the temperature, has a relatively high efficiency.

I have found that if coal-dust or other solid material or liquid fuel, such as oil, be injected into non-luminous flames of the character above mentioned a decided improvement is made with respect to their power to transmit or impart heat. Hence with producer-gas from anthracite coal or coke, which has heretofore been regarded as a relatively poor heating agent, almost the same efficiency is realized as from bituminous coal.

My invention consists in the introduction of powdered coal, coke, or other solid or liquid compounds or combustible substances into a flame or flame-current of gaseous or other fuel; and the object of the invention is to convert flames deficient in luminosity, and therefore inferior as a heat-imparting agent, into highly-luminous heat-reverberating flames which have a most powerful and rapid heating action.

The accompanying diagrammatic drawings illustrate the application of my process to a cement-kiln for the burning of cement, an operation for which it is particularly well adapted, as cement-burning requires a high temperature of flame near the completion of the operation—that is, at the time when the calcined material is being converted into cementitious matter or clinker—while the operation of calcination or removal of carbon dioxid contained in a limestone requires a relatively low temperature. It must not be inferred, however, that in so illustrating this embodiment of my invention that I limit myself in the application thereof solely to the burning of cement. The process is also of value in various metallurgical operations, such as the manufacture of glass, of open-hearth steel, of various metals other than iron or steel, such as copper and zinc, and in miscellaneous heating operations.

The accompanying drawings diagrammatically indicate a cement-kiln fired by producer-gas and having means for supplying thereto powdered fuel.

Figure 1 shows the powdered fuel injected across the path of travel of the producer-gas flame, and Fig. 2 shows an axial injection of the powdered fuel.

Like reference characters designate like parts in the drawings.

Referring to Fig. 1, 1 is the cement-kiln in section, the lower portion or end only of the kiln being shown.

3 represents a gas-producer conventionally indicated. From the gas-producer 3 a conduit 4 conveys the gas to the kiln. A supply

of air is admitted through an annular space 5 around the gas-inlet pipe. This air may be supplied under pressure and may be preheated, if desired, by any suitable means.

6 is a bin or hopper containing powdered coal or other pulverized fuel, from the lower end of which, by means of a conveyer 7, the fuel is discharged in uniform stream of predetermined amount into the hopper 8 of the injection-chamber 9. Entering this chamber from the rear is the air-blast pipe 10, through which compressed air or a blast of air from a fan or blower (not shown) is admitted. 11 is a discharge-pipe. In Fig. 1 this is shown terminating at 12 above the gas-port. In Fig. 2 the terminus of the discharge-pipe is centrally placed in the gas-port in order to discharge the powdered coal axially along the kiln.

My method of operation is as follows: The kiln 1 is put in revolution and a stream of the raw material in a finely-ground condition is caused to travel downwardly toward the point at which the gas enters the kiln. In the gas-producer 3 a bed of ignited coal or other fuel of gas-producing depth is brought to a state of suitable ignition, and therethrough is passed a blast of air containing steam or products of combustion or carbon dioxid or other endothermic agent in such quantity as will maintain the fire at the proper temperature for effective operation without formation of clinker in objectionable amount—that is, clinker in such quantity and of such size that the air-blast is obstructed materially in its passage through the fire. The fuel used in the producer may be bituminous coal or coke, or anthracite, or mixtures of these fuels. The gas so produced is conducted or forced through the conduit 4 and enters the kiln 1. There it mixes with air entering through the inlet 5 and a long voluminous flame characteristic of ignited producer-gas is developed. This flame travels in a direction opposite to that of the raw material and imparts its heat to the latter. The compressed air or other supply of air under pressure is admitted through the pipe 10 and coal is discharged from the bin 6 into the hopper 9. The jet of air exerts an inductive action on the coal-dust in the hopper and subsequently blows it through the passage 11 into the kiln 1, where in the case of the apparatus illustrated in Fig. 1 there will (provided the force of the blast is sufficient) be a certain amount of impingement of the flame so produced upon the walls of the kiln. In Fig. 2 the powdered coal mixes with the producer-gas and burns in the central part of the kiln and in its combustion gives rise to a flame of extreme luminosity. The greater the quantity of pulverized fuel so supplied within certain limits the more luminous the flame. The air supplied through the inlet 5 or pipe 10 may, if desired, contain a diluent gas, such as carbon dioxid, or a non-gaseous body, such as steam or water vapor, in order to better regulate the rate of combustion and to place under control or determine the zone of the highest or clinkering temperature.

When operating my process with other fuels than producer-gas—as, for instance, with uncarbureted water-gas and the like—it is evident that the quantity of powdered coal has to be varied from time to time to allow for variation in the quantity and quality of the gas.

Uniformity of heat application in cement-burning is a *sine qua non*. The material travels along the barrel of the kiln at a certain fairly constant speed and at a certain well-defined zone or point near the lower end of the kiln is converted into cement-clinker. The area of this clinker zone is small, and should the flame vary in quality only for a short space of time some of the material may in that interval be delivered through the clinkering zone unburned and will be discharged from the kiln as brown soft-burned clinker, which will not stand the boiling or other tests, and a little of which underburned material is sufficient to injure a large quantity of good clinker. It is therefore imperative that the flame should be of uniform quality, and inasmuch as it is almost impossible to supply a uniform quality of gas continually without preceptible variation it follows that troubles have arisen in the application of this heating agent. My system of increasing flame luminosity in a very large measure compensates for fluctuations in the gas, and should the gas at any time suddenly deteriorate it is an easy matter to increase the supply of coal fed through the discharge-pipe 11, and thereby for the time being makes up for any insufficiency of heat in the producer-gas. Even without such a variation in the coal-supply the producer-gas flame works more uniformly and imparts its heat more rapidly to the cement material when it is given the characteristic highly-luminous qualities furnished by the particles of solid or liquid fuel. My invention, therefore, removes a difficulty which has heretofore been considered almost impossible of correction—namely, that of remedying fluctuations in producer-gas in order to permit of that uniform travel of the cement material through the kiln which is demanded for a commercial output.

What I claim is—

1. The process of producing a localized intense heating effect from a non-luminous gas-flame at a desired point which consists in blowing into said flame at said point a stream of fuel capable of burning with production of radiant heat.

2. The process of operating a cement-kiln

which consists in producing in the same a flame of producer-gas and in injecting into said flame in proximity to the clinkering zone of the kiln, a stream of fuel capable of burning with production of radiant heat.

3. The process of operating a cement-kiln which consists in producing in the same a gas-flame and in locally intensifying the heat-radiating effect of such flame at a desired point by injecting thereinto at said point a stream of powdered coal.

4. The process of operating a cement-kiln which consists in producing in the same a gas-flame and in locally intensifying the heat-radiating effect of such flame at a desired point by injecting powdered coal carried in suspension in an air-current thereinto at said point.

5. The process of conducting combustion in cement-kilns which consists in introducing into the kiln a stream of producer-gas; in injecting across the path of travel of said stream of producer-gas a stream of powdered coal; and in subjecting the combustible mixture so produced to an igniting temperature in the presence of air.

6. The process of operating a rotary cement-kiln which consists in producing therein a flame of producer-gas opposite in direction to the flow of cement material through such kiln and in injecting powdered coal into said flame at a point in proximity to the clinkering zone of the kiln.

7. The process of operating a rotary cement-kiln which consists in producing therein a flame of producer-gas opposite in direction to the flow of cement material through such kiln and in injecting commingled air and powdered coal into said flame at a point in proximity to the clinkering zone of the kiln.

Signed at New York, in the county of New York and State of New York, this 10th day of November, A. D. 1905.

HENRY L. DOHERTY.

Witnesses:

CARLETON ELLIS,

FLETCHER P. SCOFIELD.