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COMBUSTION OF FUEL.

APPLICATION FILED NOV. 5, 1910. RENEWED DEC. 29, 1919.

1,349,040. Patented Aug. 10, 1920.

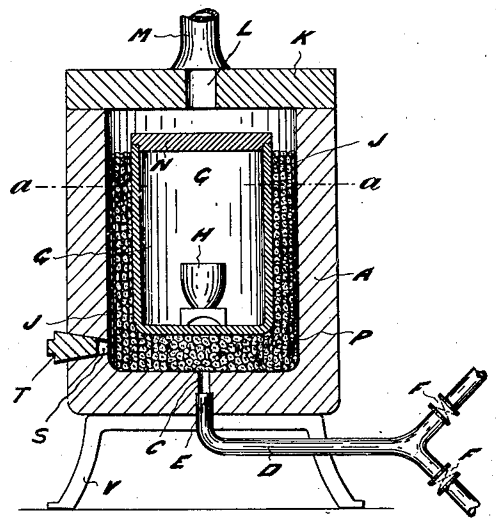

Fig. 1.

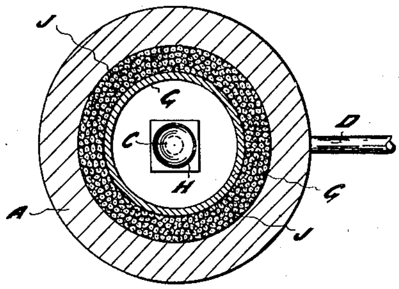

Fig. 2.

WITNESSES

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UNITED STATES PATENT OFFICE.

WILLIAM ARTHUR BONE AND JAMES WILLIAM WILSON, OF LEEDS, AND CYRIL DOUGLAS McCOURT, OF LONDON, ENGLAND, ASSIGNORS, BY MESNE ASSIGNMENTS, TO SURFACE COMBUSTION, INC., OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

COMBUSTION OF FUEL.

1,349,040. Specification of Letters Patent. **Patented Aug. 10, 1920.**

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To all whom it may concern:

Be it known that we, William Arthur Bone, of the University, Leeds, in the county of York, England, James William Wilson, of Carlton Works, Armley, Leeds, in the said county, and Cyril Douglas McCourt, of 13 Malwood road, Balham Hill, London, S. W., England, subjects of the King of Great Britain and Ireland, have invented new and useful Improvements in and Relating to Combustion of Fuel, of which the following is a specification.

This invention relates to the combustion of gaseous fuel in such a way as to enable a large proportion of the heat of combustion to be utilized at a high temperature (in a space which is more or less inclosed) in a variety of furnaces applicable to a number of industrial or laboratory operations. According to this invention a mixture of combustible gas or vapor (*e. g.* coal gas) and air or the like in proper proportions, that is, proportions to produce a self-burning, or explosive, mixture, is introduced through a suitable passage or passages at a velocity greater than the speed of ignition of the mixture into a bed of refractory granular material of suitable texture in which it is burnt. Combustion of the mixture takes place in the bed around and against the granules, thus maintaining the said bed in a state of incandescence; this bed, part of which thus constitutes the seat of an intense combustion, is disposed around or in proximity to the retort, muffle, chamber, or body to be heated, in such a manner as to produce the desired heat distribution. The said bed of refractory material is inclosed or retained in position by an outer shell or walls of refractory material of low heat conductivity, the said shell or walls being of sufficient thickness to give efficient heat insulation.

A feature of our invention is that it is well adapted for the combustion of a large variety of combustible gases, as for example blast furnace gas, producer gas, water gas, coke oven gas, coal gas, petrol air gas and natural gas, although the temperature attainable in any particular case will naturally depend upon the calorific value of the gas employed.

This invention lends itself to a variety of applications, thus for example it may be employed in the construction of tube furnaces, muffle or retort furnaces, crucible furnaces, saggar furnaces, furnaces adapted to annealing operations, and for the heating of chambers and bodies in general.

We will now describe by way of example how our invention may be employed in, and applied in the construction of a typical furnace, but we wish it to be understood that we do not limit ourselves in these cases.

In the accompanying drawings, Figures 1 and 2 represent a laboratory furnace for producing high temperatures, Fig. 1 being a sectional elevation, and Fig. 2 a sectional plan on the line *a. a.* of the Fig. 1, and in both of which the same parts are denoted by the same letters. A is the furnace body constructed of a sufficiently refractory material such as fire-clay, calcined magnesite, or bauxite, and provided at the bottom with a hole C of cylindrical bore having an enlarged lower portion adapted to receive an iron pipe D for the supply of gaseous mixture. The end E of the iron pipe D terminates sufficiently far from the bed of granular material to prevent the end of the pipe from becoming unduly heated. If desired a suitable lighting hole such as S may be formed in the furnace body and normally kept closed by a suitable plug such as T. F, F are two valves for the regulation of the air and gas respectively, G is a cylinder constructed of a very refractory material such as bauxite and having comparatively thin walls as shown and adapted to receive the crucible H or other article to be heated and forming a heating chamber. In the combustion chamber or space between the outer walls A and the walls of the heating chamber, and filling such space where the combustion is to take place and extending upward about the side walls of the heating chamber, is the refractory granular material J which, provided the furnace body A and vessel G are sufficiently free from ferric oxid and the like as hereinafter explained, may consist of carborundum crushed and meshed to such a size, for example, as will pass a sieve of two meshes to the linear inch but will not pass a sieve of four meshes to the linear inch. A few larger fragments may be disposed at P in the neighborhood of the hole C. The furnace is provided with a cover K through a hole L in which the products of combustion escape to a chimney M. The chamber G is provided with a lid N, and the furnace body may be carried on a tripod or other convenient stand V. The pressure of air and gas required will depend on the temperature desired and on the relative dimensions of the parts. In practice when using coal-gas we find it convenient to employ a pressure of from one to two pounds per square inch.

The above description will suffice to make clear the principle involved in our invention and the way in which it may be generally applied in furnace construction. We will now indicate certain conditions which must be fulfilled in employing and applying the invention in the above and other cases as well as modifications of construction which may be found useful or desirable in special cases.

The granular material must be of a nature sufficiently refractory to stand the temperature produced by the combustion of the gaseous mixture, which as hereinbefore stated will depend largely on the nature of the gas employed. For example, where blast furnace gas, producer gas, or other gas of low heating power is employed, a large variety of refractory materials may be used, as for example calcined fire-clay, ganister, or the like. But where the highest temperatures are produced, as for example by the use of coal-gas or oxy-hydrogen gas sufficiently diluted with nitrogen, special pains must be taken in providing a refractory material of a sufficiently refractory nature. For example, carborundum may be employed as the granular material, provided it is not in contact with any material or body containing ferric oxid or other oxid which at high temperatures will re-act chemically with the carborundum. Or, very pure calcined magnesite may be employed, in which case the body or bodies in contact with such granular material must be of a basic nature. The size of granular material employed will be determined by the size of the chamber or body to be heated, thus, for heating small crucibles or muffles, we have used granular material crushed to such a size as will pass a sieve of four meshes to the linear inch but will not pass a sieve of eight meshes to the linear inch. On the other hand, in constructing a furnace for the heating of large saggars, we have used granular material the individual fragments of which are one or two inches in diameter.

In general, the method of starting up a furnace and initially raising the bed of granular material to the state of incandescence required for the combustion of the gaseous fuel according to our invention will consist in first turning on the combustible gas and causing it to ignite by applying a flame thereto as it issues from the bed of granular material, and immediately afterward turning on the supply of air gradually until the flame strikes back and combustion takes place in the granular bed, thereby raising it or the lower layers of it to the required state of incandescence. The proportions of gas and air are then adjusted so as to produce the desired conditions. Combustion then takes place near the entrance opening and the products of combustion pass on and give up heat in passing through additional portions of the bed of granular refractory material. In certain cases where the furnace construction admits thereof a stoppered lighting hole or holes in proximity to the point or points where the gaseous mixture enters the bed may be provided.

Where the combustible gas is of too poor a quality to allow of the lighting back as hereinbefore described, the bed may be previously raised to a state of incandescence by the employment of a richer gas or vapor (as for example coal-gas or petrol vapor) and the mixture of poorer gas and air afterward turned on.

The gases employed when working this invention should be substantially free from dust in order to prevent clogging of the granular material.

Our main object is to produce high temperatures in a confined space, combustion taking place in the mass of refractory material near the entrance opening and the combustion gases giving up heat in passing through additional portions of the bed. The restricted passage or passages through which the gaseous mixture is supplied must be of such length and sectional area in relation to the amount of gaseous mixture flowing therethrough that firing back is prevented. The size or sectional area of the passage or passages must be such that the velocity of flow of the mixture will be greater than the speed of ignition or rate of propagation of flame, and owing to the conduction backward of the heat of combustion by the walls of the passage or passages the restricted passages must extend backward to a point at which the temperature of the walls remains lower than the temperature required to ignite the particular mixture which is being used. The essential features of the present forms of apparatus whereby we obtain high temperatures and concentrate the heat in a space which is more or less inclosed may be enumerated as follows:—

(1) An outer shell or body composed of refractory material and being a bad conductor of heat.

(2) An inner bed or layer composed of

refractory material having interstices into which bed the combustible mixture is introduced and in which it burns.

(3) An internal chamber in which the heat is required to be utilized and which may or may not be surrounded by an internal shell of refractory material.

(4) A passage (or passages) through which the combustible mixture passes of such length and cross section in relation to the gaseous flow that the ignition of the combustible mixture shall not travel backward in the passage.

What we claim as our invention is:—

1. An apparatus for burning explosive gaseous mixtures comprising a furnace structure having an outer wall of low heat conductivity and having a heating chamber having comparatively thin side walls spaced away from the outer wall to provide a combustion space extending about the side walls of the heating chamber, a restricted mixture supply passage opening into the lower part of said combustion space, a bed of granular refractory material in the combustion space filling said space adjacent the inlet opening of the supply passage and extending upward about the side walls of the heating chamber, and means for supplying an explosive gaseous mixture to the supply passage under pressure sufficient to cause the mixture to flow through the passage with a velocity greater than the speed of ignition of the mixture, whereby the mixture is caused to burn within the bed of refractory material near the inlet opening of the supply passage and the products of combustion are caused to pass through additional portions of the bed adjacent the side walls of the heating chamber.

2. An apparatus for burning explosive gaseous mixtures comprising a furnace structure having an outer wall of low heat conductivity and having a heating chamber formed by an inner comparatively thin wall spaced away from the outer furnace wall to provide a combustion space between the bottom and side walls of the heating chamber and the outer furnace wall, a restricted mixture supply passage opening to said combustion space beneath the heating chamber, a bed of granular refractory material in the combustion space filling said space beneath the heating chamber and extending upward about the side walls of the heating chamber, and means for supplying an explosive gaseous mixture to the supply passage under pressure sufficient to cause the mixture to flow through the passage with a velocity greater than the speed of ignition of the mixture, whereby the mixture is caused to burn within the bed of refractory material near the inlet opening of the supply passage and the products of combustion are caused to pass through additional portions of the bed adjacent the side walls of the heating chamber.

3. An apparatus for burning explosive gaseous mixtures comprising a furnace structure having an outer wall of low heat conductivity and having a heating chamber formed by an inner comparatively thin wall spaced away from the outer furnace wall to provide a combustion space between the bottom and side walls of the heating chamber and the outer furnace wall, a plurality of feed orifices opening through the bottom wall of the furnace to said combustion space beneath the heating chamber, a bed of granular refractory material in the combustion space beneath the heating chamber and extending upward about the sides of the heating chamber, a supply conduit, a plurality of mixture distributing pipes leading from the supply conduit one to each of said feed orifices, said pipes being of sufficient length to prevent portions thereof adjacent the supply conduit from becoming heated by conduction of heat through the walls of the pipes to a degree sufficient to ignite the mixture, and means for supplying the explosive gaseous mixture to the supply conduit under a pressure sufficient to cause the mixture to flow through the distributing pipes with a velocity greater than the speed of ignition of the mixture.

4. The method of heating, which comprises causing a stream of an explosive gaseous mixture to enter a bed of granular refractory material with a velocity greater than the speed of back-ignition of the mixture, completely burning the mixture within the bed and near the entrance opening, and causing the hot combustion gases to flow through additional portions of the bed beyond the burning mixture to cause said combustion gases to give up heat.

In witness whereof, we have hereunto set our hands, in the presence of two witnesses.

WILLIAM ARTHUR BONE.
JAMES WILLIAM WILSON.
CYRIL DOUGLAS McCOURT.

Witnesses:
JOHN WILLIAM PICKLES,
H. BEALE.