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PROCESS FOR PRODUCING HEAT.

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1,223,249. Patented Apr. 17, 1917.

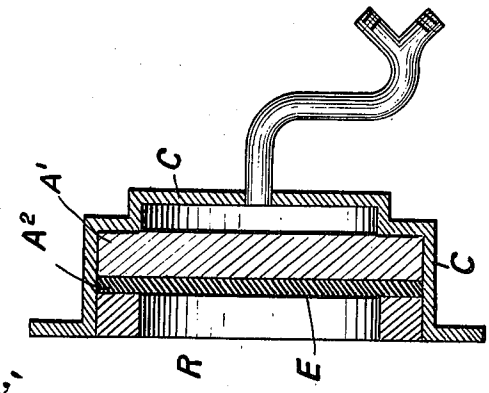


Fig. 2.

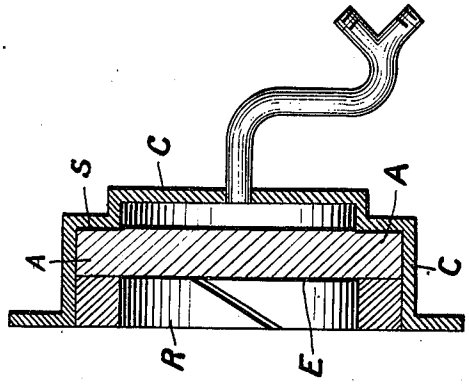


Fig. 1.

WITNESSES

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PROCESS FOR PRODUCING HEAT.

1,223,249. Specification of Letters Patent. Patented Apr. 17, 1917.

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To all whom it may concern:

Be it known that we, WILLIAM ARTHUR BONE, of Leeds, in the county of York, JAMES WILLIAM WILSON, of Armley, Leeds, in the said county, and CYRIL DOUGLAS McCOURT, of Balham Hill, London, S. W., England, have made certain new and useful Inventions Relating to Processes for Producing Heat, of which the following is a specification, taken in connection with the accompanying drawings, which form part of the same.

This invention relates to processes for utilizing the accelerating influence of the incandescent surface of a porous refractory diaphragm upon the combustion of a suitable explosive mixture of gaseous fuel and air fed through the diaphragm toward its incandescent, outer surface, so that a large proportion of the potential energy of the fuel is liberated as radiant energy from the incandescent surface so as to be available in connection with many industrial gas heating operations. When an explosive mixture of coal gas and air, for instance, in their combining proportions or with air in slight excess thereof is forced at a sufficiently high velocity to prevent back firing through the pores or interstices of a suitable porous refractory diaphragm into its incandescent surface layer a many fold accelerated and substantially flameless combustion of the gas takes place within the interstices, pores or parts of the incandescent diaphragm layer which are more or less impregnated or in contact with the gaseous mixture; and energy thus developed by this intensified complete and efficient combustion is absorbed by the adjacent surface layer of the diaphragm and maintains it in a state of incandescence, thus securing a very convenient and efficient source of radiant energy. This highly accelerated or intensified surface combustion seems to be due to the emission of charged corpuscles or electrons from such incandescent solids, and the consequent formation of layers of electrified gas in which the chemical changes incident to combustion proceed with extraordinary rapidity. It has been demonstrated that the incandescent solid plays an active and important part in the combustion of the explosive gaseous mixture under these conditions, the particles of the incandescent solid apparently forming a composite system with the adjacent molecules of the combining gases, so that such combustion complex acts in a manner very different from what occurs in normal flame combustion. For example it has been proved that the presence of water vapor certainly accelerates, if it is not essential to, the normal flame combustion of carbon monoxid in air or oxygen, whereas the presence of even a small quantity of water vapor such as will saturate the gases at 18° C. greatly retards the surface combustion of an explosive mixture of carbon monoxid and oxygen in contact with heated fire clay surfaces, the reaction constant falling from .20 to .09. Another thing which indicates the distinctive and qualitative difference between such surface combustion and normal flame combustion is the fact, that in ordinary combustion methane and other hydrocarbons have much greater affinity for oxygen than either hydrogen or carbon monoxid have; while in surface combustion these selective affinities are completely reversed, apparently because of the controlling action of the heated solid particles on the manner of combustion.

This invention is adapted for the combustion of a large variety of combustible gaseous material, as for example blast furnace gas, producer gas, water gas, which may be carbureted, coke oven gas, coal gas, petrol air gas and similar hydrocarbon gas and other combustible vapors, natural gas and mixtures thereof, all of which are hereinafter refered to as combustible gases, although the temperature attainable in any particular case will naturally depend upon the calorific intensity of the gaseous material employed. The combustible gas is combined with air or other available supporter of combustion preferably in substantially the combining proportions or with a slight excess or deficiency of air, although the proportions of the constituent gaseous materials may vary considerably and still secure an explosive gaseous mixture, such as is capable of explosive combustion or inflammation, possibly under conditions of increased pressure and temperature.

The accompanying drawings show in a somewhat diagrammatic way certain illus-

trative apparatus adapted for carrying out the invention.

Figure 1 is a sectional elevation through a simple diaphragm unit.

Fig. 2 is a similar view through a unit having a composite diaphragm.

Fig. 1 of the accompanying drawing represents a simple form of that which may be described as the fundamental unit of our apparatus, which consists essentially of a permeable diaphragm A of sufficiently refractory material in conjunction with a chamber or casing C. The porous diaphragm constitutes one wall of the chamber, into which an explosive gaseous mixture is led through a pipe or from any desired injecting or mixing device such as the connected Y pipes shown for connection with the ultimate sources of combustible gas and air or the like under the proper pressure. The mixture passes through the diaphragm and is caused to ignite on the face of exit E or in close proximity thereto. For instance a combustible mixture of coal gas and air in proper proportions and at various pressures, examples of which are hereinafter given, may be used for many household and industrial purposes. The supply of gas and air in proper portions is preferably suitably regulated by ordinary means, so that the combustion may take place substantially within the diaphragm surface layer one eighth of an inch or so thick. The regulation of the supply of the mixture having been adjusted, the face E of the diaphragm A becomes incandescent, and is maintained in a heated or incandescent state by the continued flow of the combustible mixture through the porous diaphragm, and its combustion within the surface layer of same. The flow can be regulated so that little or no flame appears beyond the surface of the diaphragm while the said surface is maintained in a state of glow or incandescence. With regard to the combustible mixture the proportions of the combining gases will preferably be substantially the proportions necessary for complete combustion. In general with coal gas, we prefer to employ a little excess of air. For example, in the case of a coal gas which theoretically requires about five and a half times its own volume of air for complete combustion, we have obtained good results with about seven times its own volume of air.

The joint between the diaphragm A and its seating S may be of white lead or an asbestos paste or other suitable luting material, and any suitable retainer or ring R may be used to secure the porous diaphragm in position. The margin of the diaphragm may be glazed so as to prevent escape of gas through its edges. The diaphragm may be arranged in various ways depending on the object in view, and in some cases more than one diaphragm may be employed. The diaphragms may also be placed horizontally, vertically or at any desired angle and the diaphragm unit may be so turned that the heated external surface may be either the superior or inferior surface. It should be noted however that where there is, with any particular mixture of gases a tendency to heat the diaphragm so much as to cause back firing, the arrangement must be such as to utilize or convey away the heat with sufficient rapidity to prevent such back firing. For instance, in using water-gas there is always a tendency to back fire, but this may be in a large measure counteracted by employing diaphragms of a closer or less permeable texture so as to produce a steeper pressure gradient in the diaphragm, thereby increasing the velocity of flow of the explosive gaseous mixture through the diaphragm. Accordingly it is desirable in any given case to select from a series of diaphragms of different permeabilities that diaphragm which on trial is found to be sufficiently impervious to prevent back firing under the given conditions. Also the tendency to back fire may be checked by mixing a larger proportion of inert gas or air with the combustible mixture. Further, where there is risk of back firing the progressive accumulation of heat in a confined space must be avoided. On the other hand when using poor gases as for example blast furnace gas, the production of the glow or incandescence depends on conserving a certain amount of the heat on the surface of the diaphragm.

The diaphragms may be produced from various materials either separately or in combination, and may vary considerably in their nature, shape and construction, examples of which are hereinafter specified. But it must be understood that we do not confine ourselves solely to the said examples and that we may adopt other constructions in the nature of a diaphragm, so long as same enables us to burn a mixture of gases or the like and produce within the surface of the coherent medium a combustion with little or no flame. In some cases we may combine two or more diaphragms of differing degrees of permeability or porosity such diaphragms being formed into one or superimposed, the more porous diaphragm being that which is on the side of exit of the gaseous mixture as shown in Fig. 2. In the production of the diaphragms suitable refractory materials are employed and combined so as to give the desired degree of porosity and permeability somewhat in the manner usual in the production of porous refractory blocks. Materials of a nature to burn out and leave pores or interstices may be combined with refractory materials. For example we have used mixtures of fire clay with fine seed, bran and spongy plumbago produced by acting on

Ceylon flake plumbago with strong fuming nitric acid and applying heat. The degree of porosity will be determined by the quantity of organic material employed. In general we prefer to employ the fine seed for this purpose as being a material the individual grains of which are substantially of the same size and shape. We find that rape seed is specially suitable for this purpose. The proportions will vary somewhat with the nature of the clay employed, some clays being by nature when burnt more porous than others, and in every case it is necessary to determine by trial the proper proportions for producing a desired degree of porosity. But the examples which we will give will serve to indicate in some measure the nature of the mixtures which are found suitable in practice. In making diaphragms suitable for working with coal gas and air at a pressure of six inches water gage, we mix 18 parts by weight of powdered Stourbridge fire clay in the dry state with 8 parts by weight of English rape-seed, and mix therewith sufficient water to render the mixture suitable for molding. It will be found that the plasticity of the mixture becomes rapidly lost on standing owing to the absorption of the water by the dry seed. Only sufficient of the mixture should be made to suit immediate requirements, and the diaphragms should be molded immediately after the mixture is made and before it has lost its plasticity. To obviate in part the loss of plasticity hereinbefore mentioned the rape-seed may be steeped in water prior to mixing with the clay. The molded diaphragms are carefully dried, baked and burned in an oxidizing atmosphere so as to insure the complete burning out of the seed. After burning, that surface of the diaphragm which is to form the heated surface is preferably roughened with a rasp, sand blast, or by any other known means. Or both surfaces of the diaphragm may be so roughened. By employing the above mentioned proportions we have made diaphragms which when three quarters of an inch thick are able at a pressure of six inches water gage to admit of a flow per square inch of heating surface of 6.4 cu. ft. per hour of a gaseous mixture consisting of one volume of gas with 6 or 7 volumes of air. By employing a mixture consisting of 18 parts by weight of dry powdered Stourbridge fire clay with 12 parts by weight of English rape-seed we have made diaphragms which when three quarters of an inch thick admit of the same gaseous flow at a pressure of one inch water gage.

Another method of making porous diaphragms consists in consolidating a mass of granules or fragments most desirable of porous or non-vitreous refractory material in such a manner as to leave pores or interstices throughout the mass. For example burnt fire clay coarsely ground and preferably meshed to a uniform size mixed with a powder adapted to act as a cementing material when highly heated may be molded in the form of the diaphragm required, and burned. Thus for working at a pressure of about one-quarter of an inch water gage, with a mixture of coal gas and air the grade of fragments employed is that which passes through a sieve of eight meshes to the linear inch but will not pass a sieve of sixteen meshes to the linear inch when the thickness of the diaphragm is about an inch to an inch and a half. These fragments may be moistened, mixed with one-tenth of their weight of finely ground feldspar and molded or disposed into the form of diaphragm required, slight pressure only being used to give the diaphragm the desired form or configuration and burnt at a temperature of 1300 or 1400° C. Diaphragms one inch and a quarter thick formed of such porous fire clay granules of about uniform sixteen mesh size and cemented together in this way give good results with explosive coal gas mixtures supplied under pressure of about two to three tenths inches of water.

This application is based upon and contains subject-matter taken from our copending United States application, Serial No. 586,058, filed October 8, 1910. Having described these inventions in connection with a number of illustrative embodiments, arrangements, proportions, materials, pressures, conditions, processes and orders of steps, to the details of which disclosure the inventions are not of course to be limited, what is claimed as new and what is desired to be secured as Letters Patent is set forth in the appended claims:

1. The process of producing heat which consists in combining a combustible gas and a combustion supporting gas in proportions to form an explosive gaseous mixture, maintaining a supply of the explosive mixture thus formed against one face of a porous refractory diaphragm under a pressure to cause the mixture to flow, at a speed sufficient to normally prevent back-firing, through the passages of the diaphragm to a highly heated surface layer thereof, and effecting combustion of the mixture within said highly heated surface layer of the diaphragm, whereby the combustion is localized within the surface layer of the diaphragm and such surface layer is maintained in a state of incandescence.

2. The process of producing heat which consists in combining a combustible gas and a combustion supporting gas in proportions to form an explosive gaseous mixture, maintaining a supply of the explosive mixture thus formed against one face of a porous refractory diaphragm to cause the mixture

to flow through the passages of the diaphragm to a highly heated surface layer thereof, effecting combustion of the mixture within said highly heated surface layer of the diaphragm, and adjusting the pressure under which the mixture is supplied to maintain the combustion localized within the surface layer of the diaphragm, whereby such surface layer is maintained in a state of incandescence.

3. The process of burning explosive gaseous mixtures which consists in maintaining a supply of the explosive mixture against one face of a porous refractory diaphragm under a pressure to cause the mixture to flow, at a speed sufficient to prevent backfiring, through the passages of the diaphragm to a highly heated surface layer thereof, and effecting the combustion of the mixture within said highly heated surface layer of the diaphragm, whereby the combustion is localized within the surface layer of the diaphragm and such surface layer is maintained in a state of incandescence.

4. The process of burning explosive gaseous mixtures which consists in maintaining a supply of the explosive mixture against one face of a porous refractory diaphragm to cause the mixture to flow through the passages of the diaphragm to a highly heated surface layer thereof, effecting combustion of the mixture within said highly heated surface layer of the diaphragm, and adjusting the pressure under which the mixture is supplied to maintain the combustion localized within the surface layer of the diaphragm, whereby the surface layer of the diaphragm is maintained in a state of incandescence.

5. The process of producing heat which consists in combining a combustible gas and a combustion supporting gas in proportions to form an explosive gaseous mixture with the amount of combustion supporting gas somewhat in excess of the amount required for complete combustion of the combustible gas, maintaining a supply of the explosive mixture thus formed against one face of a porous refractory diaphragm to cause the mixture to flow through the passages of the diaphragm to a highly heated surface layer thereof, effecting combustion of the mixture within said highly heated surface layer of the diaphragm, and adjusting the pressure under which the mixture is supplied to maintain the combustion localized within the surface layer of the diaphragm, whereby such surface layer is maintained in a state of incandescence.

6. The process of burning explosive gaseous mixtures which consists in maintaining a supply of the explosive mixture against one face of a porous refractory diaphragm of porous combustion accelerating material to cause the mixture to flow through the passages of the diaphragm to a highly heated surface layer thereof, effecting combustion of the mixture within said highly heated surface of the diaphragm, and adjusting the pressure under which the mixture is supplied to maintain the combustion localized within the surface layer of the diaphragm, whereby the surface layer of the diaphragm is maintained in a state of incandescence.

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