

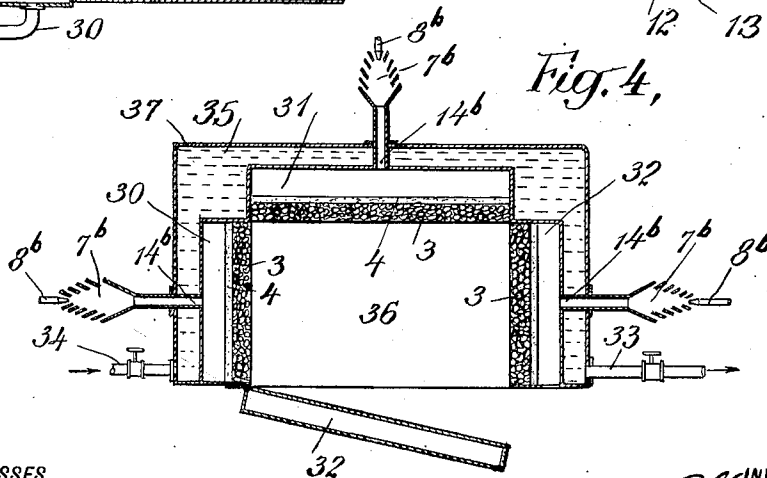
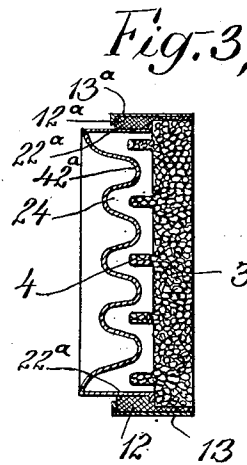
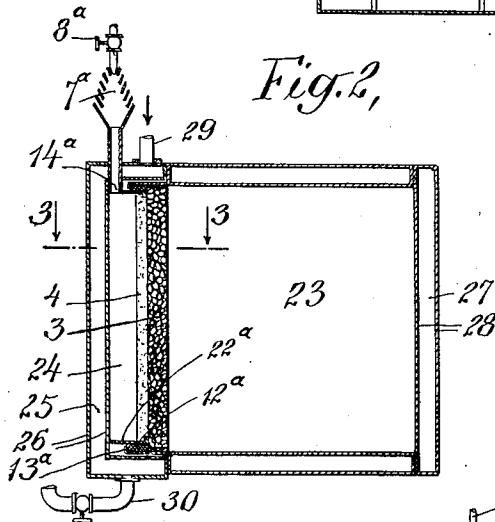
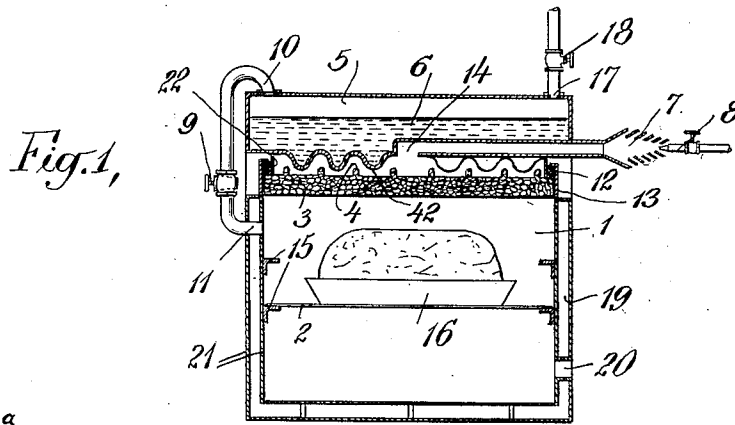
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DOMESTIC GAS HEATING APPARATUS.

APPLICATION FILED JUNE 1, 1912. RENEWED OCT. 12, 1918.

1,304,755.

Patented May 27, 1919.



WITNESSES

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# UNITED STATES PATENT OFFICE.

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## DOMESTIC GAS HEATING APPARATUS.

1,304,755.

Specification of Letters Patent.

Patented May 27, 1919.

Application filed June 1, 1912, Serial No. 700,809. Renewed October 12, 1918. Serial No. 257,885.

*To all whom it may concern:*

Be it known that I, CARLETON ELLIS, a citizen of the United States, and resident of Montclair, Essex county, New Jersey, have made certain new and useful Inventions Relating to Domestic Gas Heating Apparatus, of which the following is a specification.

This invention relates to gas heating apparatus of the diaphragm type in which the porous and permeable diaphragm for burning an explosive gaseous mixture is provided with a casing having special cooling means to prevent back-heating or back-firing, the diaphragm being, if desired, used in inverted or vertical position in which the ascending heat tends to promote the back-heating of the diaphragm.

In the accompanying drawing showing in a somewhat diagrammatic way illustrative embodiments of the invention,

Figure 1 is a vertical section through a domestic heating chamber or oven.

Fig. 2 is a similar section through another form of apparatus.

Fig. 3 is an enlarged sectional view taken substantially along the line 3—3 of Fig. 2; and

Fig. 4 is a horizontal sectional view through another apparatus.

This diaphragm gas heating apparatus is adapted for the baking, heating of calcining of various materials, and especially where an inverted or vertical heating diaphragm is used, special cooling devices are preferably employed to prevent the back-heating or back-firing of the diaphragm which can thus be used even in inverted position with good results, the diaphragm in this way effecting the accelerated surface combustion of the explosive gases fed therethrough and burning the same under highly efficient conditions, this combustion not being interfered with even by the presence of the burned gases, steam or other vapors adjacent the diaphragm. The diaphragm cooling devices may comprise a chamber for liquid adjacent the diaphragm casing which simultaneously serves to heat the cooling liquid so as to effect further economies.

In the illustrative arrangement shown in Fig. 1 the heating chamber or oven 1 is formed with walls which may consist of sheet metal plates 21 having a suitable air space such as 19 between them to minimize heat losses and if desired the heating cham-

ber may be provided with suitable brackets such as 15 at various heights to support the grate or supporting member 2 on which, for example, a baking pan 16 may be placed. The heating chamber may be conveniently heated by the inverted porous refractory diaphragm 3 arranged to cooperate with the top of the heating chamber and cooperating with a suitable casing 22 which may be connected with the diaphragm by interposing non-conducting packing 12 between the edge of this casing and a cooperating diaphragm support 13 which may inclose the edge of the diaphragm. The diaphragm may, if desired, be provided with suitable projections or ribs such as 4 on its rear surface within the gas chamber and the casing may be formed with corresponding projections or ribs 42 which may be located between the diaphragm ribs so as to promote heat transfer therefrom, although such ribbed construction is not of course necessary in all cases on the diaphragm or casing. The gas chamber formed behind the diaphragm by this casing 22 may be supplied with explosive gases through the injecting or supply passage 14 supplied in any desired way with an explosive mixture of combustible gas and air or other supporter of combustion preferably in substantially the proportions required for complete combustion. This may be effected by the use of an injecting nozzle 8 having a valved gas connection to supply combustible gas thereto, from which nozzle the gas is injected under high pressure into a suitable injector which may have the nested petticoat nozzle construction such as 7, whereby air is drawn in by injector action and finally supplied under the desired pressure behind the diaphragm so as to be fed therethrough and normally burned by surface combustion within the outer layer or working face of the diaphragm which is thereby maintained in highly heated incandescent condition. In order to prevent back-heating of the porous refractory diaphragm the dissipation of heat from its rear surface may be promoted by the ribbed construction of the diaphragm and casing and also, if desired, by the use of a cooling liquid chamber, such as 5, by which water or other cooling liquid 6 may be maintained in contact with the diaphragm casing so as to keep the same cool. If desired, the liquid may be supplied continuously or from time to time in amounts required through

the pipe 17 by means of the inlet valve 18 and in some cases it is desirable to utilize the steam or other vapor produced when this liquid is heated in the normal operation of the device and a vapor pipe 10 may supply this vapor through the connecting portion 11 into the oven or heating chamber in amounts regulated by the vapor valve 9 so that if desired this steam may be supplied to the baking oven and the steam roasting of materials effected therein. The steam which is relatively lighter than air or combustion gases under the same temperature conditions tends to fill the upper part of the oven or heating chamber and is finally discharged through one or more suitable vapor outlets such as 20 which may be formed in the lower part of the chamber. The presence of steam or other vapor adjacent the incandescent diaphragm does not interfere with the accelerated surface combustion of the gaseous fuel therein, or with the radiation of heat therefrom to the material in the heating chamber. By this arrangement the diaphragm is not only sufficiently cooled to be maintained in normal operating condition, but steam may be simply and economically produced in connection with the heating or roasting apparatus so as to be available for modifying the oven heats or for steam roasting therein.

Another arrangement is shown in Fig. 2 in which the heating chamber or oven 23 is formed with similar walls 28 provided if desired with air spaces such as 27, a suitable door being provided on the side opposite the diaphragm 3 which may be hinged similarly to the door shown in Fig. 4 but so as to stand in vertical position. As shown more in detail in Fig. 3 the diaphragm 3 which may be provided with integral projections or ribs 4 on its rear face may be formed of porous granules of fire clay or other suitable refractory material cemented together, these granules being preferably of substantially uniform size which is considerably relatively exaggerated in the drawings. Diaphragms of about an inch and a quarter thick and formed of fire clay granules of about uniform sixteenth of an inch size are suitable for many gaseous mixtures such as illuminating gas and the like. The diaphragm may be mounted in connection with a casing 22<sup>a</sup> which may be formed with projections or ribs 42<sup>a</sup> projecting between the diaphragm ribs and connected to the diaphragm support 13<sup>a</sup> of sheet metal or other suitable material by an interposed non-conducting packing 12<sup>a</sup> which may be formed of asbestos cement or other suitable material and readily forced into place so as to give strong mechanical connection between the parts of the diaphragm mounting and at the same time minimize the conduction of heat from the outer face of the diaphragm to the casing forming the gas cham-

ber 24. Explosive mixtures of air and suitable combustible gases may be conveniently supplied to the gas chamber by any suitable injecting devices preferably communicating with the upper part of the gas chamber so that the cooler gases are fed thereto so as to correspondingly cool the upper part of the diaphragm which tends to become somewhat heated by the heat rising from the diaphragm surface and other heated material below. An injecting nozzle 8<sup>a</sup> and injector 7<sup>a</sup> similar to the nozzle 8 and injector 7 of Fig. 1 are shown in this connection for supplying explosive gases through the injecting or supply pipe 14<sup>a</sup> communicating with the upper part of the gas chamber behind the diaphragm to maintain a supply of the explosive mixture in the gas chamber to cause the mixture to flow through the diaphragm so as to burn in the working face of the diaphragm and heat the chamber to the desired extent. In this instance, a suitable air cooling arrangement is shown for minimizing back-heating of the diaphragm, the shell 26 of sheet iron or other material substantially inclosing the diaphragm and gas chamber and forming a cooling chamber 25 in connection therewith to which cool air or other gaseous medium may be supplied as through the cooling pipe 29 preferably communicating with the upper part of this cooling chamber. The circulation of this cooling fluid may be effected in any desired way, as for instance by a suitable flue connection 30 by which this fluid may be withdrawn and discharged into a chimney or flue creating sufficient draft for this purpose when the regulating valve in this flue connection is opened.

Another illustrative arrangement is shown in Fig. 4 as comprising a heating chamber or oven 36 having a door 32 and in which several diaphragms 3 are mounted around the inside of the chamber in connection with cooperating gas chambers 30, 31 and 32. Each gas chamber may as indicated be supplied with an explosive gaseous mixture through the injecting or supply passage 14<sup>b</sup> connecting with the injector 7<sup>b</sup> and nozzle 8<sup>b</sup>. A shell 37 of sheet iron or other material may inclose the gas chambers and diaphragms forming a cooling chamber 35 around the same. The cooling chamber may be provided with a valved outlet 33 and with a valved liquid inlet 34 for the circulation of water or other cooling liquid through this cooling chamber 35. This arrangement may be used for the heating of water for domestic or other purposes, the water operating in the manner described to cool the diaphragms and prevent back-heating there-through.

Such heating apparatus is adapted for use with gaseous or vaporous fuel of various kinds and may be used with good results

where Blau gas or other liquefied or highly compressed gas is available. Such rich combustible gas requires the admixture of a correspondingly large proportion of air for best results and where injector action is relied upon to secure the incorporation of such air the pressure of the gas supplied to the initial injecting nozzle may be varied in such a way as to secure the incorporation of varying amounts of air by injector action. A number of determinations made with a porous refractory diaphragm of this general type having a thickness of about an inch and a quarter and composed of porous fire clay granules of about a sixteenth of an inch diameter cemented together so as to give a high degree of porosity and permeability to the diaphragm gave the following empirical equation:

$$P > .0042B$$

$$P < .018 B$$

where P is the pressure in pounds of the gas supplied to the initial injecting nozzle and B is the number of B. T. U.'s per cubic foot of the gas under normal atmospheric pressure. These formulas seem to give approximate values of the initial gas pressure suitable for proper operation of these diaphragms under conditions insuring the incorporation of ample air and also substantially proper pressures of the combustible gases for normal surface combustion so that undesirable flaming of the diaphragm is avoided.

Having described this invention in connection with a number of illustrative embodiments, forms, proportions, materials, arrangements and methods of operation, to the details of which disclosure the invention is not of course to be limited what is claimed as new and what is desired to be secured by Letters Patent is set forth in the appended claims.

I claim:

1. In gas heating apparatus, an inverted porous refractory diaphragm provided with integral ribs on its rear surface, a metallic casing forming with said diaphragm a gas chamber and having ribs projecting between the ribs on the diaphragm, a supply passage leading to said gas chamber to supply explosive gas thereto, an injector for supplying an explosive gaseous mixture to said passage, and means forming with said casing a cooling liquid chamber to contain cooling liquid in contact with said ribbed casing.

2. In gas heating apparatus, an inverted porous refractory diaphragm provided with projections on its rear surface, a metallic casing forming with said diaphragm a gas chamber and having projections extending between the projections on the diaphragm, a supply passage leading to said gas chamber to supply explosive gas thereto, and means forming with said casing a cooling liquid

chamber to contain cooling liquid in contact with said casing.

3. In gas heating apparatus, an inverted porous refractory diaphragm provided with integral ribs on its rear surface, a metallic casing forming with said diaphragm a gas chamber and having ribs projecting between the ribs of said diaphragm, a supply passage leading to said gas chamber to supply explosive gas thereto, and means forming with said casing a cooling liquid chamber to contain cooling liquid in contact with said casing.

4. In gas heating apparatus, an inverted porous refractory diaphragm provided with projections on its rear surface, a cooling casing forming with said diaphragm a gas chamber and having projecting portions extending toward the rear surface of the diaphragm, a supply passage leading to said gas chamber to supply explosive gas thereto, and means forming with said casing a cooling liquid chamber to contain cooling liquid in contact with said casing.

5. In gas heating apparatus, an inverted porous refractory diaphragm, a metallic casing forming with said diaphragm a gas chamber, a supply passage leading to said gas chamber to supply explosive gas thereto, and means forming with said casing a cooling liquid chamber to contain cooling liquid in contact with said casing.

6. In gas heating apparatus, an inverted porous refractory diaphragm in such position that the rising heat tends to heat the inner portions of said diaphragm, a gas chamber cooperating with said diaphragm, a connected supply passage to supply explosive gas thereto, a cooling chamber cooperating with said gas chamber and diaphragm, and cooling fluid in said cooling chamber to cool said gas chamber and diaphragm and minimize back-heating or backfiring of said diaphragm.

7. In gas heating apparatus, a porous refractory diaphragm in such position that the rising heat tends to heat said diaphragm, a gas chamber cooperating with said diaphragm to supply explosive gas thereto, a cooling chamber cooperating with said gas chamber and diaphragm, and cooling fluid in said cooling chamber to cool said gas chamber and diaphragm and minimize back-heating or backfiring of said diaphragm.

8. In gas heating apparatus, a porous refractory diaphragm provided with ribs on its rear surface, a metallic casing forming with said diaphragm a gas chamber and having ribs projecting between the ribs on said diaphragm, a supply passage connected to said casing to supply explosive gases to the gas chamber between said casing and diaphragm, and means forming with said casing a cooling chamber to contain cooling

liquid in contact with said casing to minimize back-heating or back-firing of said diaphragm.

9. In gas heating apparatus, a porous refractory diaphragm provided with ribs on its rear surface, a metallic casing forming with said diaphragm a gas chamber and having ribs, a supply passage connected to said casing to supply explosive gases to the gas chamber between said casing and diaphragm, and means forming with said casing a cooling chamber to contain cooling fluid in contact with said casing to minimize back-heating or back-firing of said diaphragm.

10. In gas heating apparatus, a porous refractory diaphragm, a metallic casing forming with said diaphragm a gas chamber, a supply passage connected to said casing to supply explosive gases to the gas chamber between said casing and diaphragm, and means forming with said casing a cooling chamber to contain cooling fluid in contact with said casing to minimize back-heating or back-firing of said diaphragm.

11. In a gas heating apparatus, a porous refractory diaphragm, a metallic wall adjacent the rear face of the diaphragm and providing a gas chamber between it and the diaphragm, a supply passage leading to said gas chamber for supplying explosive gaseous mixture thereto, and means for abstracting heat from the rear of the diaphragm through said metallic wall of the gas chamber.

12. In a gas heating apparatus, a porous refractory diaphragm, a metallic wall adjacent the rear face of the diaphragm and providing a gas chamber between it and the diaphragm, one of said members having projecting parts extending toward the face of the other of said members, a supply passage leading to said gas chamber for supplying explosive gaseous mixture thereto, and means for dissipating heat from said metallic wall.

13. In a gas heating apparatus, a porous refractory diaphragm, a metallic wall adjacent the rear face of the diaphragm and providing a gas chamber between it and the

diaphragm, and means for causing a cooling fluid to flow against said metallic wall.

14. In a gas heating apparatus, a porous refractory diaphragm, a metallic wall adjacent the rear face of the diaphragm and providing a gas chamber between it and the diaphragm, and means for maintaining a cooling liquid against said metallic wall.

15. In a gas heating apparatus, a porous refractory diaphragm, means for maintaining a supply of an explosive gaseous mixture against the rear face of the diaphragm to flow through the diaphragm to burn at the outer face thereof, and means for abstracting heat from the rear face of the diaphragm.

16. In a gas heating apparatus, a porous refractory diaphragm, means for maintaining a supply of an explosive gaseous mixture against the rear face of the diaphragm to flow through the diaphragm to burn at the outer face thereof, means providing a heat absorbing surface adjacent the rear face of the diaphragm, and means for dissipating heat from said surface.

17. In a gas heating apparatus, a porous refractory diaphragm, means for maintaining a supply of an explosive gaseous mixture against the rear face of the diaphragm to flow through the diaphragm to burn at the outer face thereof, means providing a heat absorbing surface adjacent but out of contact with the rear face of the diaphragm, and means for dissipating heat from said surface.

18. In a gas heating apparatus, a porous refractory diaphragm, means for maintaining a supply of an explosive gaseous mixture against the rear face of the diaphragm to flow through the diaphragm to burn at the outer face thereof, means providing a heat absorbing surface adjacent but out of contact with the rear face of the diaphragm, and means providing a flowing fluid for dissipating heat from said surface.

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