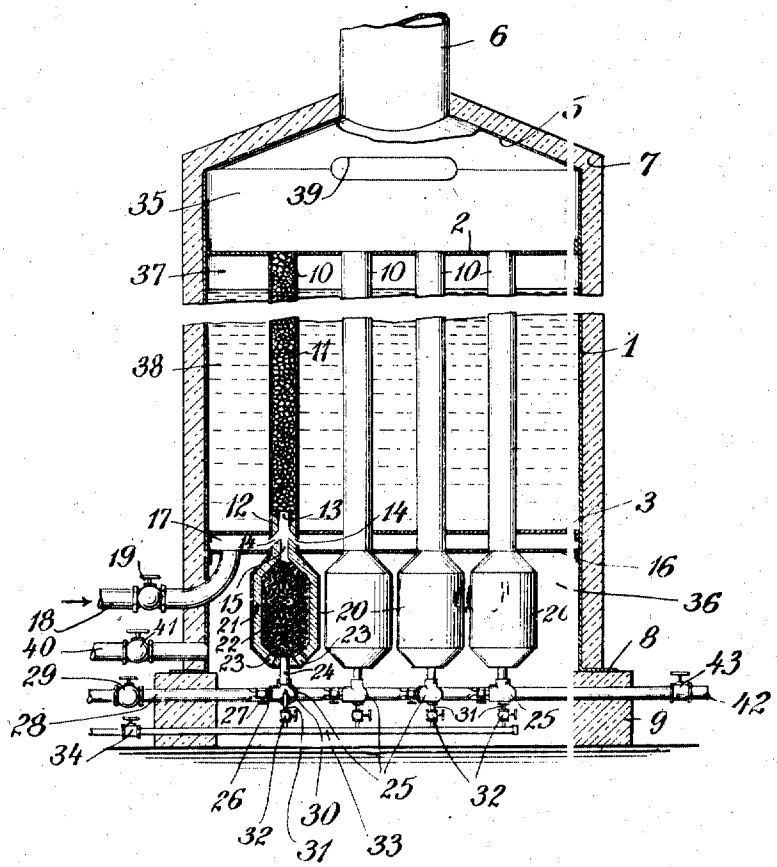
C. ELLIS.

APPARATUS FOR BURNING LIQUID FUEL.

APPLICATION FILED APR. 22, 1912. RENEWED JULY 11, 1916.

1,216,096. Patented Feb. 13, 1917.



WITNESSES

Jessie B. Kay

Albert C. Stengel

Carlton Ellis INVENTOR

BY

Duncan & Duncan ATTORNEYS

UNITED STATES PATENT OFFICE.

CARLETON ELLIS, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO RADIANT HEATING LIMITED, OF ARMLEY, LEEDS, ENGLAND, A CORPORATION OF GREAT BRITAIN.

APPARATUS FOR BURNING LIQUID FUEL.

1,216,096. Specification of Letters Patent. Patented Feb. 13, 1917.

Application filed April 22, 1912, Serial No. 692,288. Renewed July 11, 1916. Serial No. 108,722.

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 Apparatus for Burning Liquid Fuel, of which the following is a specification taken in connection with the accompanying drawing, which forms part of the same.

This invention relates to apparatus for burning oil or other volatile or vaporizable liquid fuel by first gasifying the fuel by heat produced by the burning of a portion thereof, and then mixing the resulting gases and vapors with air in proportions to form an explosive gaseous mixture, and burning the same in a porous and permeable bed of refractory material to which the mixture is supplied at a high velocity. The invention has been made especially with the idea of providing an improved steam boiler or other apparatus for evaporating or heating water or other liquids, and for this purpose the porous and permeable combustion bed in which the explosive gaseous mixture is burned may be formed of a mass of granular refractory material filled into a suitable heating tube which extends through the liquid to be heated, the granular refractory material best filling the tube for a considerable distance beyond the place or zone where combustion takes place so that the hot gases of combustion in passing through the tube will be deflected against its walls, and the whole mass of refractory material within the tube will also be highly heated.

In the accompanying drawing showing in a somewhat diagrammatic way in vertical section an illustrative embodiment of this invention, an upright form of boiler or evaporating apparatus is indicated as being provided with the shell 1 in which suitable tube sheets such as 2, 3 may be arranged in any desired way. The shell may be connected with the smoke-box casing 5 with which a suitable exhaust flue 6 connected to a stack or exhaust fan may be arranged so as to carry off the combustion gases and it is of course desirable to employ suitable lagging or non-conducting packing such as 7 around the shell and connected parts to minimize radiation losses. The shell 1 may, if desired, be provided with a flange or support such as 8 which may rest upon a suitable foundation or support 9, although of course the device may be mounted in any other desired way.

Suitable heating tubes or units may be arranged in any desired way in coöperation with the boiler or heating device and as illustrated any desired number of heating tubes 10 may be vertically arranged within the boiler by mounting them within the tube sheets 2 and 3. These heating tubes may be three to five inches or so in internal diameter and long enough to effect the desired cooling of the combustion gases and utilization of the heat thus developed. These heating tubes may be substantially uniformly packed with suitable granular refractory material 11 such as fire clay, magnesite or the like, preferably of substantially uniform size such as lumps between one-half and three-quarter inch mesh, such granular refractory material in the lower part of each tube forming a porous and permeable combustion bed. The granular material may extend upward in the tube as shown to serve as a deflecting, mixing and heating bed to increase the transmission of heat from the tube to the surrounding liquid. The lower end of each tube is preferably provided with a suitable refractory plug such as 12 of fire clay or the like formed with one or more constricted injection passages 13 and also preferably with one or more suitable air inlets 14 through which air may be supplied in any desired way, as for instance from the air box 17 formed between the tube sheet 3 and the auxiliary sheet 16 through which the tubes extend. In this way air forced through the air pipe 18 in amounts governed by the air valve 19 keeps the air box under the desired pressure of six to eight ounces or so and supplies the desired amounts of air through the air inlets so as to mix with and form an explosive gaseous mixture burning within the granular refractory material. By locating this refractory plug 12 substantially at the junction of the heating tube and tube sheet 3 undesirable localized heating at this point is of course minimized. Each of the heating tubes is preferably connected with a suitable combustion or gas forming chamber which may as indicated have the sheet metal casing 20 and a suitable fire clay or other refractory lining 21 while being filled with granular refractory material 22 such as lumps or pieces of fire

clay, magnesite or other suitable refractory material of one-fourth to half inch mesh or so preferably having a decided combustion accelerating action.

These combustion or gas forming chambers may conveniently be arranged within a suitable firing chamber 36 and each combustion chamber may be provided with an injecting pipe such as 24, which may be located substantially in line with the supply passage 15 communicating with the injecting passage and heating tube at the other end of the chamber. This injecting pipe may be supplied in any desired way with a fine spray or jet of oil or oily combustible material, such for instance, as stripped crude petroleum or petroleum distillate, fuel oil or more volatile oil such as petroleum or benzin if desired. In the illustrative arrangement indicated the oil may be supplied under pressure to this injecting pipe through a suitable spraying or other nozzle 30 on the oil pipe 31 connected by means of the valve 32 with the oil line 33. In this way a spray or jet of oil is formed within the injector casing 25 and injecting pipe 24 and if desired a blast of air, steam or other gaseous material may be simultaneously injected thereinto so as to carry the oil into contact with the normally highly heated refractory material within the combustion chamber. The air, steam or other blast may be supplied to the injector casing through the pipe 26 having the regulating valve 27 therein so as to determine the amount of gaseous material supplied through the blast pipe 28 which may if desired have the control valve 29 therein. It is also desirable in some cases to have additional air ports such as 23 formed in the combustion chamber preferably adjacent the injecting pipe and air may be supplied thereto by the air supply pipe 40 which may be provided with the supply valve 41 so as to regulate the amount and pressure of air within the firing chamber which should be maintained under a pressure of 8 to 12 ounces or so. This air serves to cool to a considerable extent the combustion chambers arranged in this firing chamber and the air is thus heated considerably when it passes through the air ports into the combustion chambers for utilization therein.

The apparatus may be started in any suitable way as for instance by forcing coal gas or other combustible gaseous material through the blast line 28 or preferably through the communicating gas line 42 in amounts controlled by the gas valve 43 so that this gas passes into each combustion chamber and heating tube so that it may be ignited by any suitable means inserted through a suitable igniting door or normally closed opening 39 in the smoke-box. The gas flashes back through the granular material so as to burn in the combustion chamber adjacent the injecting pipe in all of the combustion chambers being operated. Additional air may be supplied thereto in any desired way, as for instance by admitting air to the firing chamber by operating the air supply valve 41. In this way the granular refractory material in the combustion chambers is heated to incandescence and then the gas may be cut off and the oil may be regularly supplied to the combustion chambers through the injecting pipes in the manner indicated by opening the oil control valve 34 and also if desired opening the blast valve 29 so as to supply a spray of oil to the highly heated refractory material in the combustion chambers so as to effect sufficient combustion of the oil to maintain the heat of the granular material and also to form an explosive gaseous mixture from the oil and such additional air as may be mixed or incorporated therewith. The oil may thus be cracked and vaporized by the combustion of only a relatively small proportion thereof if desired and may be mixed with additional air supplied thereto as through the air inlets 14 so as to form an explosive gaseous mixture which is injected at high velocity through the injecting passage 13 into the granular refractory material 11 within the heating tube itself. The combustible is here burned under ideal conditions within the interstices or pores of the lumps of highly heated granular material which exert an intense combustion accelerating action so that the heat developed in the refractory material may be utilized by transmission outward through the walls of the tube into the surrounding water or other liquid in the water space 38 of the boiler or evaporator. Any combustion which takes place in the combustion chamber serves not only to maintain the heat of the granular material therein, but also heats the treated combustible material discharged from the combustion chamber through the supply port 15 into the adjacent heating tube so that any sensible heat is utilized in the heating tube while any unconsumed combustible is burned in the slight excess of air or other supporter of combustion preferably supplied in the tube so as to secure high combustion efficiency. The combustion chamber and connected heating tube containing granular refractory material thus form a simple and efficient heating unit for the combustion of fuel oil or other oily material. The water or other liquor in the shell 1 is thus evaporated, the vapor collecting in a suitable steam space such as 37 while the liquor which rapidly circulates upward around the tubes and between the same may descend in the outer portions of the liquor space 38 adjacent the shell.

Having described this invention in connection with illustrative embodiments, forms, proportions, materials, and arrangement of

parts and orders of steps, 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.

1. Apparatus for burning liquid fuel comprising a gas forming chamber containing a filling of granular refractory material, means for injecting liquid fuel and a limited supply of combustion supporter into the filling of refractory material in said chamber to effect partial combustion of the fuel within the chamber and to maintain a vaporizing temperature therein, a combustion bed formed of granular refractory material, a restricted passage leading from the gas forming chamber to the combustion bed, means for supplying air to mix with the gases from the gas forming chamber in proportions to form an explosive gaseous mixture and to cause the explosive gaseous mixture thus formed to enter the combustion bed at a high velocity, and means for controlling the amount of gas burned in the combustion bed by controlling the amount of fuel fed to the gas forming chamber.

2. Apparatus for burning liquid fuel comprising a gas forming chamber containing a filling of granular refractory material, means for injecting liquid fuel and a limited supply of combustion supporter into the filling of refractory material in said chamber to effect partial combustion of the fuel within the chamber and to maintain a vaporizing temperature therein, a porous and permeable combustion bed of refractory material, a restricted passage leading from the gas forming chamber to the combustion bed, means for supplying air to mix with the gases from the gas forming chamber in proportions to form an explosive gaseous mixture and to cause the explosive gaseous mixture thus formed to enter the combustion bed at a high velocity, and means for controlling the amount of gas burned in the combustion bed by controlling the amount of fuel fed to the gas forming chamber.

3. Apparatus for burning liquid fuel comprising a gas forming chamber containing a filling of granular refractory material, means for injecting liquid fuel and a limited supply of combustion supporter into the filling of refractory material in said chamber to effect partial combustion of the fuel within the chamber and to maintain a vaporizing temperature therein, means for supplying gaseous fuel for preliminarily heating the refractory material in said chamber, a porous and permeable combustion bed of refractory material, a restricted passage leading from the gas forming chamber to the combustion bed, means for supplying air to mix with the gases from the gas forming chamber in proportions to form an explosive gaseous mixture and to cause the explosive gaseous mixture thus formed to enter the combustion bed at a high velocity, and means for controlling the amount of gas burned in the combustion bed by controlling the amount of fuel fed to the gas forming chamber.

4. An apparatus for burning liquid fuel comprising a gas forming chamber containing refractory material, means for injecting liquid fuel and a limited supply of combustion supporter into said chamber to effect partial combustion of the fuel within the chamber and to maintain a vaporizing temperature therein, a consuming device for maintaining continuous and localized combustion of an explosive gaseous mixture, an outlet leading from said chamber directly to the consuming device, and means for supplying air to mix with the gases passing through said outlet to form an explosive gaseous mixture moving at a high velocity.

5. Apparatus for burning liquid fuel, comprising a plurality of gas forming chambers containing a porous and permeable filling of refractory material, means for injecting liquid fuel and a limited supply of combustion supporter into the filling of refractory material in each of said chambers to effect partial combustion of the fuel within the chamber and to maintain a vaporizing temperature therein, a plurality of consuming devices each formed to maintain localized and continuous combustion of an explosive gaseous mixture, a restricted passage leading from each gas forming chamber directly to one of the consuming devices, means for supplying air under pressure to mix with the gas passing through each said passage in proportions to form an explosive gaseous mixture, and means for controlling the amount of gas burned in the consuming devices by controlling the amount of fuel fed to the gas forming chamber.

6. Apparatus for burning liquid fuel comprising a plurality of gas forming chambers containing a porous and permeable filling of refractory material, an injecting pipe leading into each said chamber, a fuel supply pipe and a blast pipe connecting with each injecting pipe to supply liquid fuel and gaseous material thereto under pressure, a blast line and a gas line connecting with each said blast pipe, means for supplying air to mix with the gas passing from the gas forming chambers in proportions to form an explosive gaseous mixture, and means for maintaining localized and continuous combustion of the gaseous mixture thus produced.

7. In apparatus for burning liquid fuel, the combination of a gas supplying device comprising means for forming gas from the liquid fuel by heat simultaneously developed by partial combustion of the fuel and means for continuously supplying the liquid fuel

to said gas forming means, with a gas consuming device, a supply connection for the passage of the hot gases from the supply device directly to the consuming device, means for supplying air to mix with the hot gases between the supply device and the consuming device in proportionate amount to form an explosive gaseous mixture, and means for controlling the rate of supply of liquid fuel to the supply device and thereby controlling the amount of heat developed in the consuming device.

CARLETON ELLIS.

Witnesses:
HARRY L. DUNCAN,
JESSIE B. KAY.