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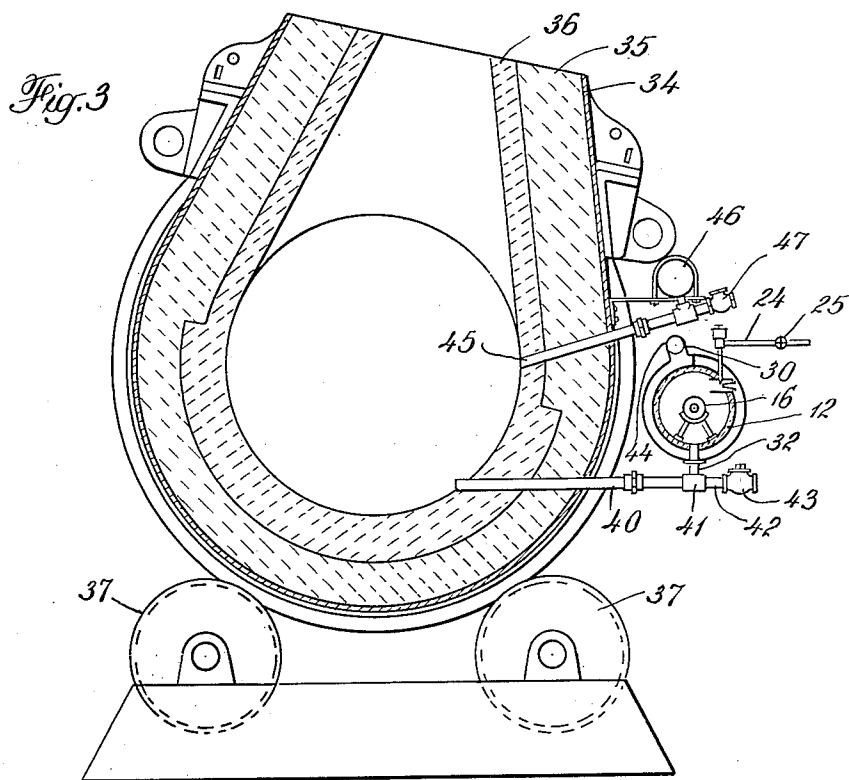
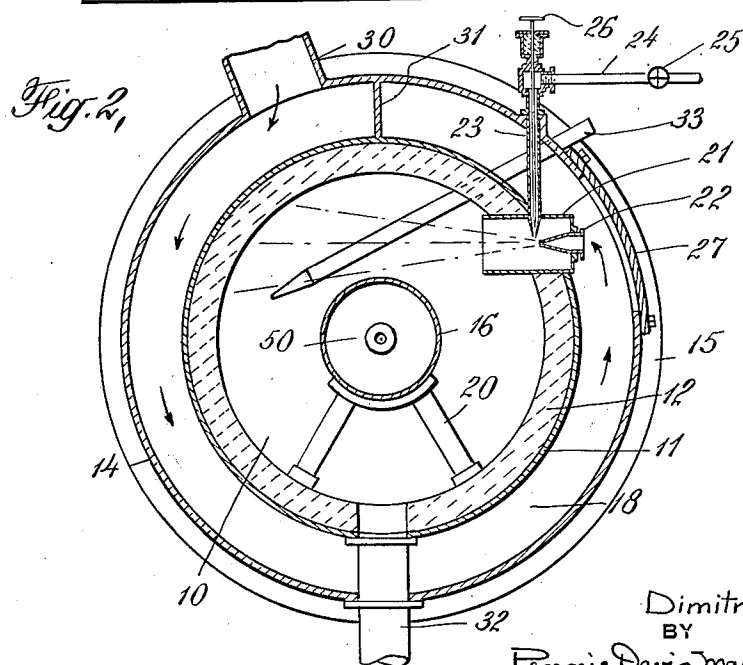
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2,028,946

GAS GENERATOR

Filed Nov. 2, 1929

3 Sheets-Sheet 2



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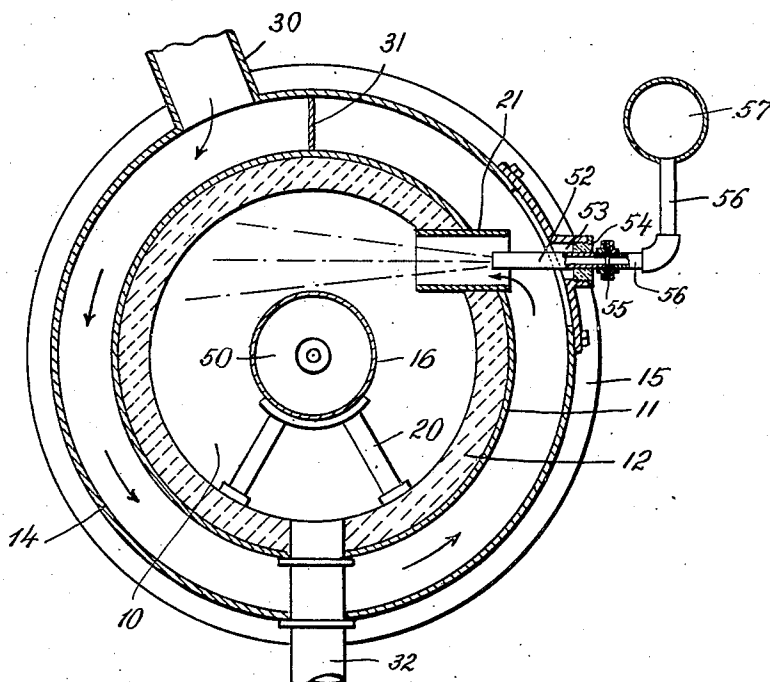
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Fig 2a.



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UNITED STATES PATENT OFFICE

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GAS GENERATOR

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York

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4 Claims. (Cl. 48—62)

This invention relates to gas generators and has for an object the provision of an efficient apparatus for generating industrial gases. More particularly the invention contemplates the provision of an improved apparatus for generating reducing gases for use in metallurgical and similar industries. The invention further contemplates the provision of improved apparatus for generating and utilizing gases.

The heretofore customary type of gas generator is relatively complicated in construction and requires considerable space for its installation. In view of this fact, it is frequently necessary to generate industrial gases at points remote from the points at which they are to be used. The gases are usually stored under slight pressure at some point between the generator and the point of use, and when the operations being conducted require the introduction of the gas under considerable pressure it is necessary to provide an additional compressor or blower. While industrial gases are usually produced at high temperatures, their heat content is dissipated while they are in storage or while they are being conducted from the storage receptacle to the place at which they are to be used. Consequently, not only is considerable heat wasted, but in some types of operations, such, for example, as those involving the introduction of reducing gases into a molten mineral bath, heavy deposition of carbon takes place in the tuyères interfering with the proper operation of the apparatus.

The present invention contemplates the provision of gas generating apparatus which is highly efficient and of relatively simple construction and which may be conveniently disposed immediately adjacent a receptacle or other type of apparatus in which the gas is to be used. The invention further contemplates the provision of improved apparatus for subjecting materials to the action of gases at high temperatures in which gas may be introduced directly from a generator into a receptacle containing the material to be subjected to the action of the gas.

Gas generators constructed in accordance with the present invention are adapted to be utilized in effecting partial combustion of carbonaceous materials and are provided with means for preheating the oxidizing gas. In the preferred form of construction the gas generators are provided with combustion chambers which are surrounded by gas chambers so arranged that the oxidizing gas may be passed around the combustion chamber and be heated by the heat radiated therefrom during its passage into the combustion chamber. The combustion chamber is preferably cylindrical, and it is preferably so mounted that its axis extends horizontally. An outer casing surrounds the cylindrical combustion chamber and is spaced therefrom to provide a gas chamber for the in-

troduction and preheating of the oxidizing gas. A tube may extend axially through the combustion chamber to provide means for igniting the combustible mixture in the first instance, and for providing an additional hot surface for the continuous ignition of the combustible mixture introduced into the combustion chamber.

The combustion chamber may be provided with one or more burners for injecting a mixture of carbonaceous material and oxidizing gas. Burners capable of injecting a mixture of any desired carbonaceous material and any desired oxidizing gas may be provided. Thus, burners capable of injecting a mixture of air and any suitable oil, or burners capable of injecting a mixture of air and powdered coal may be employed.

The gas generator is preferably provided with observation tubes having sealed end portions extending into the interior of the combustion chamber and open end portions projecting outwardly beyond the outer casing. Such tubes permit the operator to determine the temperature within the combustion chamber by inserting a pyrometer or by observing the color of the heated sealed ends.

The arrangement of gas chamber, combustion chamber, and burners is such that the air supply to all burners may be controlled by a single valve and the supply of oil or other carbonaceous material may be controlled independently at each burner.

In the complete apparatus of the invention the gas generator is mounted on or closely adjacent to a receptacle which is adapted to contain the material to be subjected to the action of the gas. The gas generator is preferably mounted on a wall of the receptacle in such a manner that relatively short conduits or tuyères may be used for providing means of communication between the combustion chamber and the interior of the receptacle. The receptacle may be stationary or it may be mounted for rotary movement through any desired arc, and when the receptacle is mounted for rotary movement the generator is preferably movable therewith. The portions of the tuyères or conduits which are disposed between the gas generator and the outer shell of the receptacle may be covered with insulating material to prevent heat losses, or the gas generator may be so mounted that the exposed portions of the tuyères or conduits are sufficiently short that the heat losses are negligible. This arrangement of gas generator and receptacle permits the introduction of gases into the interior of the receptacle at temperatures and pressures substantially equal to those at which the gases are generated.

In one of the preferred forms of the invention, the apparatus consists of a receptacle adapted to hold a molten mineral bath and mounted for movement about a horizontal axis, a reducing gas

generator mounted on the receptacle, and suitable tuyères providing means of communication between the combustion chamber of the gas generator and the interior of the molten bath receptacle. The tuyères communicate with the interior of the molten bath receptacle below the normal bath level, and additional means may be provided for introducing other fluid or solid reagents into the interior of the receptacle at any desired points.

The apparatus of the invention may be used to particular advantage in the treatment of slags and mattes and similar products resulting from the smelting of ores containing zinc. In the treatment of zinc-bearing materials, the receptacle is preferably a converter similar to those ordinarily used in copper smelting. The converter may be stationary, but it is preferably so mounted that it may be rotated or tilted about a horizontal axis to permit charging and removal of the charge. The gas generator may be mounted on a wall of the converter or it may be separately mounted immediately adjacent the converter and attached thereto merely by means of conduits or tuyères communicating with the combustion chamber and the interior of the converter.

In the treatment of zinc-bearing materials, reducing gas is generated in the gas generator and injected directly into a molten bath of the zinc-bearing material beneath the surface thereof. The gases are introduced into the molten bath at temperatures and pressures substantially equal to those at which they are generated since the heat loss is negligible. Apparatus for treating zinc-bearing materials is preferably provided with auxiliary tuyères for introducing air or other oxidizing gases into the converter at one or more points above the surface of the bath to oxidize any metallic zinc produced, and means are provided for collecting the resulting zinc oxide fumes.

The invention will be better understood from a consideration of the following description in conjunction with the accompanying drawings in which is shown one of the preferred embodiments of the invention, and in which

Fig. 1 is an elevation partly in section of a gas generator constructed in accordance with the invention;

Fig. 2 is a section taken substantially along line 2-2 of Fig. 1;

Fig. 2a is a section similar to Fig. 2, but showing a modification in the burner to permit use of solid fuels; and

Fig. 3 is a sectional elevation of a converter having a gas generator mounted thereon.

The gas generator shown in the drawings is provided with a combustion chamber 10 comprising a metal cylinder 11 lined with a layer of asbestos or other heat insulating and heat refractory material 12 and having its ends sealed by means of circular metal closure plates or discs 13. The longitudinal axis of the combustion chamber extends horizontally. An outer cylindrical metal casing 14 surrounds the combustion chamber 10. The circular closure plates 13 are of greater diameter than the combustion chamber cylinder 11. The outer casing is provided at its ends with flanges 15 which are attached to the peripheral edge portions of the circular closure plates. The combustion chamber cylinder 11 and the outer casing 14 are spaced apart, and an annular air chamber 18 surrounding the combustion chamber is thus provided.

An ignition tube 16 extends longitudinally through the combustion chamber in axial align-

ment therewith. The ignition tube 16 extends through central openings in the closure plates 13 and through stuffing boxes 17 which permit expansion and contraction of the tube. The ignition tube 16 is formed of a suitable heat-resisting alloy. Brackets 20 are provided between the ends of the ignition tube 16 for supporting the tube and preventing sagging when the tube is heated to high temperatures. The ignition tube 16 and the stuffing boxes 17 are removable and the openings in the closure plates 13 are sufficiently large to permit easy access to the interior of the combustion chamber to permit repairs to the lining.

A number of burners are mounted in the wall of the combustion chamber adjacent the top. Any desired number of burners may be used. The number of burners provided will depend upon the size of the gas generator and the capacity of each burner. Each burner comprises a casing 21 having an open end portion extending into the combustion chamber. An air inlet nozzle 22 having a restricted discharge opening is mounted in the opposite end wall of the casing 21 with its restricted discharge end directed toward the interior of the combustion chamber. An oil inlet nozzle 23 extends downwardly into the casing 21 to a point adjacent the restricted discharge opening of the air inlet nozzle 22. The oil inlet nozzle 23 is connected by means of a conduit 24 to a source of supply of oil under pressure (not shown). A valve 25 is provided for controlling the flow of oil to each oil inlet nozzle. The oil inlet nozzle is provided with a punching rod 26 for cleaning purposes. The burners are preferably so mounted that a fluid stream issuing from the air inlet nozzle 22 is directed above the ignition tube against the opposite side of the combustion chamber. The outer casing 14 is provided with openings and removable inspection plates 27 adjacent the burners to permit the insertion and removal of the burners.

A single air inlet 30 which may be provided with a suitable control valve communicates with the interior of the air chamber 18 near the top thereof and adjacent the burners. A partition 31 extends longitudinally of the air chamber 18 in contact with the outer casing 14, the combustion chamber cylinder 11, and the closure plates 13. The partition 31 is disposed at the top of the generator between the air inlet 30 and the burners, and it serves to prevent air from passing from the air inlet 30 over the top of the combustion chamber to the burners.

A number of gas discharge outlets 32 communicate with the interior of the combustion chamber and pass through the air chamber 18 to points outside the outer casing 14. Observation tubes 33 extend through the outer casing and combustion chamber and across the ignition tube to points intermediate the lining and ignition tube. The observation tubes are preferably disposed at points between the burners. Each observation tube is sufficiently large to permit the insertion of a pyrometer. The inner end of each tube is sealed.

Fig. 2a, which is similar to Fig. 2, shows a modification in the burner assembly to permit the use of solid fuels. In this modification, the air nozzle 22 and the oil nozzle 23 of the apparatus shown in Fig. 2 have been omitted from the structure. A fuel conduit 52 passes through an opening 53 in the cover plate 27, and projects inwardly toward the combustion chamber 10 through the opening in the combustion chamber

wall 11 provided by the casing 21. The fuel conduit 52 is supported in the opening 53 of the cover plate 27 by means of a plug 54, through a hole in which the fuel conduit extends, and to which the fuel conduit may be rigidly fastened, as by welding. A gas tight joint may thus be obtained. The plug 54 may be threaded and screwed into corresponding threads on the cover plate, or may be otherwise attached thereto.

A plumber's union 55, or other suitable link, connects the outer end of the fuel conduit to one end of an intermediate conduit 56, the other end of the intermediate conduit being connected to a header pipe 57. The header pipe is suitably connected to sources of supply of powdered fuel and air (not shown).

By uncoupling the union 55 and turning the intermediate conduit 56 out of the way, the cover plate 27 may be readily removed for inspection or other purposes.

Fig. 3 shows a combination in which gas generators, constructed in accordance with the invention, may be used to great advantage. In the apparatus shown in Fig. 3 the gas generator is rigidly mounted on the side of a receptacle of the type used as copper converters. The converter comprises an outer metallic shell 34 lined with a layer of suitable heat insulating brick or other material 35 and a layer of heat refractory material, such, for example, as magnesite 36. The converter is mounted on rollers 37 for movement about a horizontal axis. The gas producer is attached to and movable with the converter. The converter is provided with a number of tuyères, as indicated by the numeral 40, which extend through the outer shell and the lining materials and the outer ends of which are attached to the gas discharge conduits 32 of the gas producer. The tuyères 40 are attached to the gas discharge conduits 32 by means of T connections 41. The tuyères 40 enter the converter at points below the normal bath level. Nipples 42 having valves 43 mounted thereon are attached to the T connections 41 in axial alignment with the tuyères 40. The valves 43 may be manipulated to permit the insertion of punching bars for cleaning the tuyères. The air inlet 30 is connected to a header 44 which is suitably connected to a source of supply of air under pressure (not shown). Auxiliary air tuyères 45 extend through the converter shell and lining and communicate with the interior of the converter at points above the normal bath level. The tuyères 45 are connected to a header 46 which communicates with a source of supply of air under pressure (not shown). The tuyères 45 are also provided with valves 47 which may be manipulated to permit the insertion of bars for punching purposes.

A pilot burner 50 is removably mounted in the ignition tube 16 and may be utilized for starting the operation of the gas generator. Removable plugs may be provided for closing the ends of the ignition tube when the gas generator is in operation.

In the operation of the apparatus the converter may be charged with the material to be treated, such, for example, as a bath of molten matte containing a zinc compound. For charging and discharging purposes the converter may be tilted to place the charging opening in any desired position.

The operation of the gas generator is started by heating the ignition tube 16 by means of the pilot burner 50. A pilot burner may be inserted in the ignition tube at each end. Heat from

the ignition tube is radiated to and heats the insulating material on the wall of the combustion chamber. Heating is conducted in this manner until the temperature of the combustion chamber wall is at least equal to the ignition temperature of the air and oil mixture to be introduced. Air and oil are then admitted in proper proportions to provide a reducing gas having the desired qualities. The air is heated in passing around the combustion chamber from the air inlet opening in the gas chamber to the air inlet nozzles. The burners admit the air and oil in the form of a mist in which the air and oil are intimately mixed. The intimate mixture of heated air and oil enters the combustion chamber between the heated walls of the ignition tube and the combustion chamber and it is immediately ignited. The resulting gas passes through the tuyères 40 directly into the converter at a temperature substantially equal to that at which it is generated. Proper control of the quantities of air and oil will result in partial combustion of the compounds contained in the oil with the resulting production of a gas mixture containing components in substantially the following proportions by volume:—

	Percent
Carbon monoxide.....	15-18
Hydrogen	4- 6
Methane	3- 5
Illuminants	2- 4
Carbon dioxide.....	4- 5
Nitrogen	72-62

Operation of the generator is conducted in substantially the same manner in case solid fuel is to be used as in the case where oil is the fuel. In such an event a modified burner such as the one illustrated in Fig. 2a is employed.

Powdered coal, or other solid combustible carbonaceous material suspended in a current of air or other oxidizing gas is supplied to the header pipe 57 from a suitable source and from there is blown through the intermediate conduit 56 and the fuel conduit 52 into the interior of the combustion chamber 10. As in the case where oil is used as a fuel, a pilot burner 50 is inserted into the interior of the ignition tube, and the ignition tube, thus heated, causes the ignition of the powdered fuel in the combustion chamber. Air in insufficient quantity to cause complete combustion of the fuel is admitted. Substantially all of the air necessary may be admitted with the powdered fuel as a suspension medium therefor but preferably the least amount of air capable of efficiently transporting the powdered fuel is introduced in this manner, and additional air is admitted through the air inlet opening 30, passed around the combustion chamber 10, and conducted into the combustion chamber through the annular space between the casing 21 and the fuel conduit 52.

The proportion of air and fuel is preferably so regulated that substantially all of the oxygen in the air combines with substantially all of the carbon in the fuel to produce carbon monoxide. In addition, the effluent gas will contain some hydrocarbon gases (distilled from the fuel), considerable quantities of nitrogen (if air is used as the oxidizing gas) and some fine solid particles of ash. Since the effluent hot reducing gases from this generator are primarily intended for use in reducing metals from molten baths, the presence of this solid finely divided ash in the gases will be of no consequence. If, however,

it is desired to produce a clean gas, free from ash, the solid particles may be removed by any conventional apparatus, such as scrubbers, electrostatic precipitators or the like.

5 The gas reducing compounds of the gas mixture reduce the zinc compounds in the molten bath to form metallic zinc which is vaporized. The metallic zinc vapor is oxidized by means of air introduced above the bath through the air inlet tuyères 45. The resulting fume containing zinc oxide issues from the converter through the opening at the top and may be collected in any suitable manner.

10 After the operation of the gas generator has been started, heating by means of pilot burners is discontinued and the open ends of the ignition tube are plugged.

When removal of zinc from a bath has been completed, the converter is tilted to discharge the remaining material and another charge is provided. During the charging and discharging operations the operation of the gas generator may be suspended by cutting off the supply of air and oil. If the discharging and charging operations are conducted rapidly, the gas generator will be sufficiently hot to resume operation without requiring reheating by means of pilot burners. If desired the temperature of the gas generator may be maintained by means of a pilot burner while the reducing operations are suspended.

15 The progress of the heating of the interior of the combustion chamber may be determined through the observation tubes. In starting the operation of the gas generator, small amounts of the oil and air mixture may be introduced when the inner ends of the observation tubes are at a red heat. When the observation tubes become bright red, heating by means of the pilot burner may be discontinued and the gas generator may then be operated at full capacity. Since all of the air inlet nozzles communicate with the interior of the air chamber the supply of air to the burners is uniform. The oil is regulated by means of an individual valve at each burner until the desired temperature in the combustion chamber is obtained. This may be determined by means of a pyrometer inserted in one of the observation tubes or merely by the appearance of the inner ends of the observation tubes which may be observed through the outer open ends.

20 The oil and air mixture introduced is ignited instantly and because of the rapid whirling motion between two highly heated surfaces the oil mist is rapidly gasified.

25 The provision of an air chamber surrounding the combustion chamber not only serves to permit preheating of the oxidizing gas but also permits the use of a relatively thin refractory lining for the combustion chamber because of the cooling effect of the gas passing through the air chamber.

Gas generators constructed in accordance with the invention have been successfully operated with a number of commercial fuel oils including some of the relatively heavy oils such, for example, as 18° Bé, California fuel oil. Heavy oils require higher temperatures and greater amounts of air than the light oils, and the resulting gases are therefore relatively more dilute. The operating temperature range for heavy oils is about 750° C. to 900° C., and, for light oils, a minimum temperature of about 650° C. is used. In using heavy oils, the addition of steam at the rate of about one gallon of water to ten gallons of oil is advantageous.

Gas generators constructed in accordance with the invention are of simple and sturdy construction and easily operated and controlled. Few parts are required and the complete structure is relatively small and requires little space for its installation. Operations may be quickly started or discontinued, and the provision of a single air control valve permits easy control of the operations. Owing to the fact that the oxidizing gas may be highly preheated, a high temperature flame of intense reducing power may be obtained.

I claim:

1. A gas generator comprising an annular combustion chamber, an annular preheating chamber surrounding said combustion chamber, one or more burners mounted on a wall of the combustion chamber within the walls of the preheating chamber and providing means of communication between the preheating chamber and the combustion chamber, means for introducing combustible carbonaceous material into the combustion chamber adjacent the burners, and means for introducing an oxidizing gas into the preheating chamber.

2. A gas generator comprising three cylindrical members so arranged as to provide an outer preheating chamber an intermediate combustion chamber and an inner ignition tube, one or more burners mounted on a wall of the combustion chamber within the walls of the preheating chamber and providing means of communication between the preheating chamber and the combustion chamber, means for introducing combustible carbonaceous material into the combustion chamber adjacent the burners, means for introducing an oxidizing gas into the preheating chamber, and means for conducting the gaseous products of combustion from the interior of the combustion chamber to a point of use.

3. A gas generator comprising three cylindrical members so arranged as to provide an outer preheating chamber, an intermediate combustion chamber and an inner ignition tube, one or more burners mounted on a wall of the combustion chamber within the walls of the preheating chamber and providing means of communication between the preheating chamber and the combustion chamber, means for introducing oil into the combustion chamber adjacent the burners, means for introducing an oxidizing gas into the preheating chamber, and means for conducting the gaseous products of combustion from the interior of the combustion chamber to a point of use.

4. A gas generator comprising three cylindrical members so arranged as to provide an outer preheating chamber, an intermediate combustion chamber and an inner ignition tube, one or more burners mounted on a wall of the combustion chamber within the walls of the preheating chamber and providing means of communication between the preheating chamber and the combustion chamber, means for introducing powdered coal into the combustion chamber adjacent the burners, means for introducing an oxidizing gas into the preheating chamber, and means for conducting the gaseous products of combustion from the interior of the combustion chamber to a point of use.