March 31, 1942. H. E. LEWIS 2,278,204

APPARATUS FOR PRODUCING A GAS ATMOSPHERE

Filed Jan. 2, 1941 2 Sheets-Sheet 1

Fig. 2.

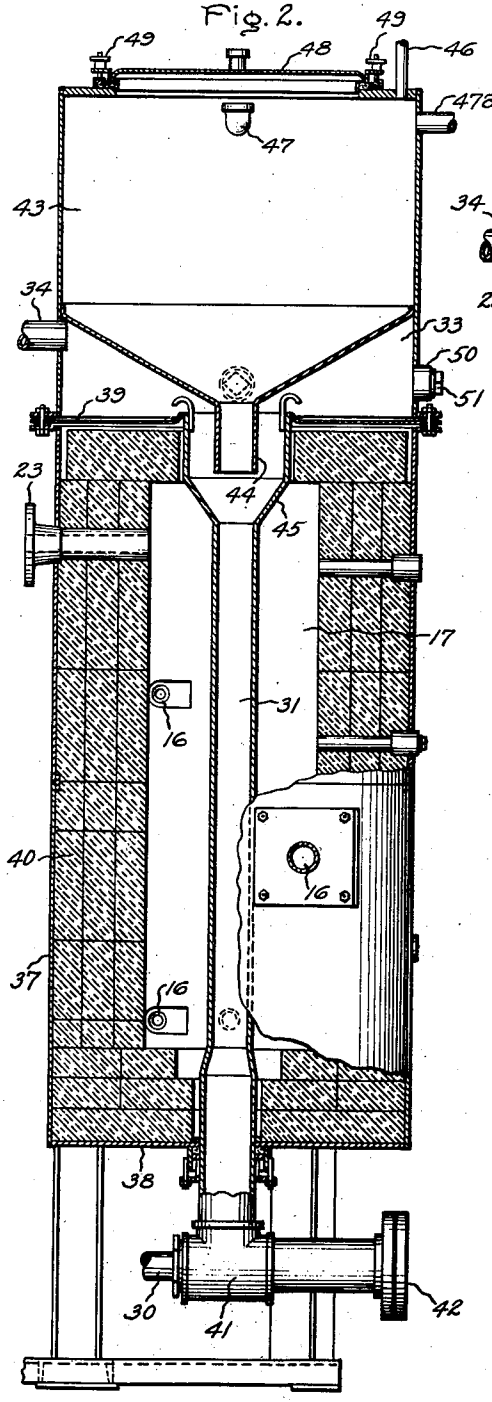


Fig. 3.

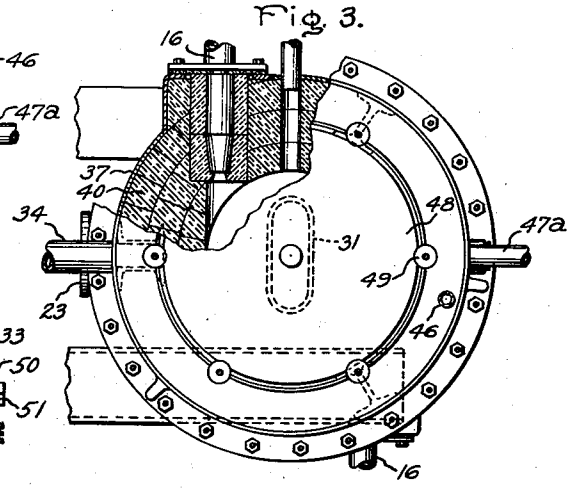
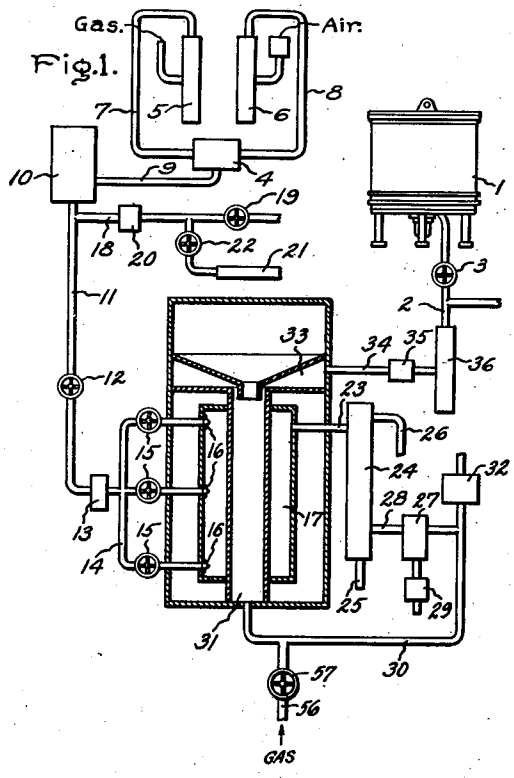


Fig. 1.



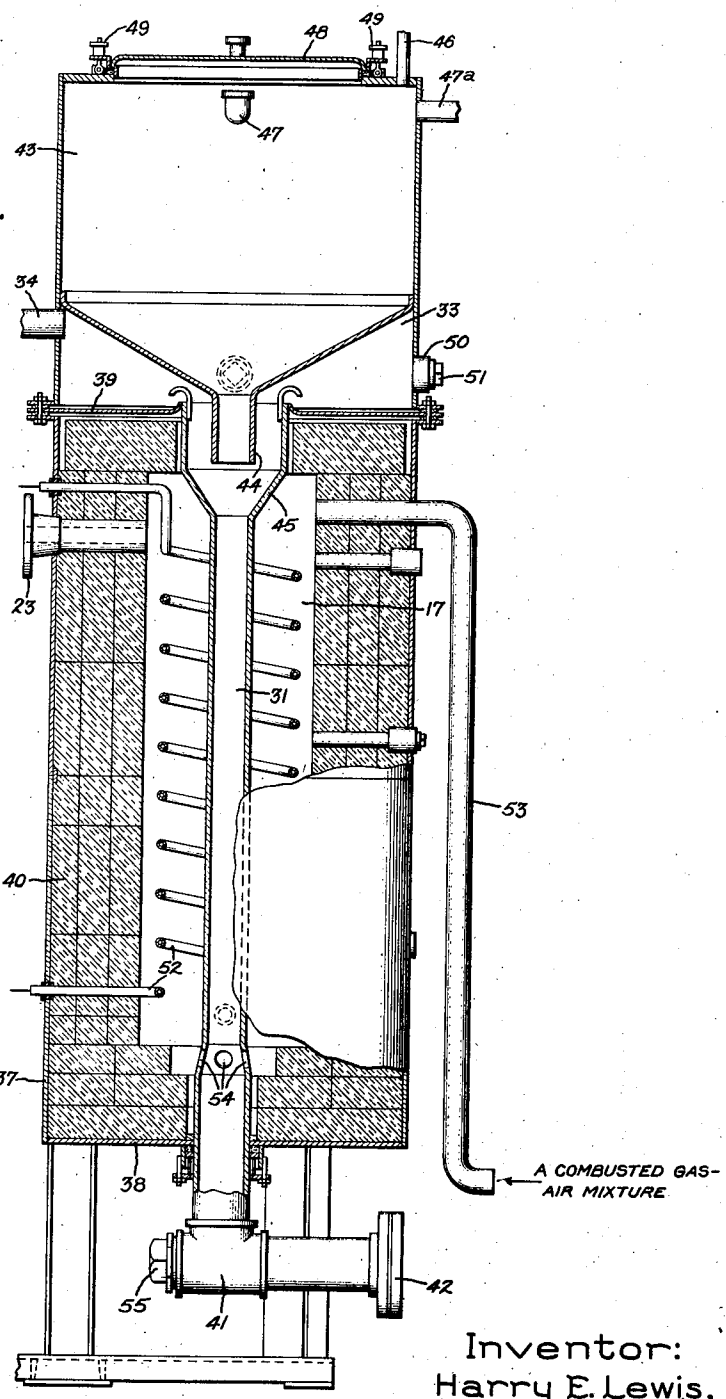
Inventor:
Harry E. Lewis,
by Harry E. Dunham
His Attorney.

March 31, 1942. H. E. LEWIS 2,278,204

APPARATUS FOR PRODUCING A GAS ATMOSPHERE

Filed Jan. 2, 1941 2 Sheets-Sheet 2

Fig. 4.



Inventor:
Harry E. Lewis,
by Harry E. Lewis
His Attorney.

Patented Mar. 31, 1942 2,278,204

UNITED STATES PATENT OFFICE

2,278,204

APPARATUS FOR PRODUCING A GAS ATMOSPHERE

Harry E. Lewis, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application January 2, 1941, Serial No. 372,781

4 Claims. (Cl. 23—281)

My invention relates to apparatus for the production of gaseous mixtures, free of carbon dioxide and water vapor, to be used as enveloping atmospheres for materials being subjected to heat treatment, as for example, in the annealing, brazing, etc., of steels and the like.

An object of my invention is to provide an improved apparatus for the production of such mixtures, which apparatus is simple and compact in construction and which is capable of converting a combustible carbonaceous fuel into the desired protective atmosphere with a minimum consumption of raw materials and a maximum thermal efficiency.

Many modern heat treating processes, as applied to steel or the like, require the use of enveloping atmospheres of such composition that no surface change in the steel takes place during treatment. Such atmospheres, when comprising the combustion products of a carbonaceous fuel, usually contain a major proportion of nitrogen in combination with varying amounts of other gases, such as carbon monoxide, carbon dioxide, hydrogen, water vapor, oxygen, and unburned hydrocarbons. Atmospheres completely free of water vapor and carbon dioxide and consisting substantially of carbon monoxide, hydrogen and nitrogen have been found to give desirable results. A particularly useful atmosphere substantially inert with respect to a wide range of steels has been found to be one containing about 20 per cent carbon monoxide, about 2 per cent hydrogen, and the remainder nitrogen. The apparatus of my invention is primarily adapted for the production of such atmospheres from air and combustible carbonaceous materials including fuel gases, coke oven gases, natural gases, butane, propane, etc. By regulating the relative proportions of air and combustible gas, atmospheres containing varying amounts of nitrogen and carbon monoxide with or without the presence of hydrogen, unburned hydrocarbons and the like may easily be obtained.

In accordance with my invention, I provide a combustion chamber in which a mixture of a carbonaceous fuel gas and air is burned, ordinarily to substantially complete combustion, and wherein the heat produced by the burning of the fuel gas-air mixture heats a carbon-filled reaction tube or chamber extending lengthwise through the combustion chamber. Means are provided for removing the products of combustion from the combustion chamber and for suitably treating these products for the removal of part or all of the water vapor therefrom before they are passed through the reactive carbonaceous material in the reaction tube to be converted therein to substantially neutral gaseous atmospheres ideally suited for use in heat-treating processes. Another feature of my invention involves conducting a portion of the gaseous mixture issuing from the reaction tube through a supply of the carbonaceous material ultimately to be introduced into the reaction tube to remove undesirable gases and water vapor therefrom.

Details of the structure will become apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a general schematic arrangement of the apparatus;

Fig. 2 is a view, partially in cross-section, of the unit combustion chamber and reaction chamber;

Fig. 3 is a top view, partly in cross-section, of the unit shown in Fig. 2; and

Fig. 4 is a view, partially in cross-section, of a modified form of the combustion chamber and reaction chamber shown in Fig. 2.

While the gas produced by the apparatus involving my invention may be used for various purposes, I have shown the apparatus in Fig. 1 as supplying a gaseous atmosphere to one or more annealing furnaces, such as furnace 1, of the well known bell type through a supply pipe 2 provided with a control valve 3.

With continued reference to Fig. 1, the complete apparatus used in producing the atmosphere introduced into the furnace may suitably comprise a gas mixer 4 connected to a source of supply of combustible carbon-containing gas, hereinafter referred to as a fuel gas, and air through flow-meters 5 and 6 respectively connected to the mixer by conduits 7 and 8. The gas-air mixture formed in the mixer is conducted through pipe 9 to a compressor 10 adapted to force the compressed mixture through pipe 11 provided with a shut-off valve 12 and a fire check 13 to a header 14 connected through shut-off valves 15 with a plurality of burners 16 mounted in the walls of the combustion chamber proper indicated by numeral 17. A side line 18 provided with bleed-off valve 19 and a fire check 20 connects with pipe 11 and provides means for checking the gas-air ratio without actually operating the complete apparatus. To do this, bleed-off valve 19 is opened and while gas is escaping therethrough the readings on flowmeters 5 and 6 are noted. From these readings, the gas-air ratio may be readily determined. The bleed-off valve line is also shown as having a side arm connected with a lighting torch 21 through

a control valve therefor 22 which torch is used to light the burners 16.

The combustion products formed by burning the fuel gas-air mixture issuing from burner 16 in the combustion chamber are conducted through a pipe 23 into a cooler 24 provided with suitable water inlets and outlets 25 and 26. Most of the moisture contained in the gaseous combustion product is condensed as the gaseous product is cooled by indirect contact with the cooling water. The condensate is separated from the gas mixture in the water separator 27 connected to the cooler by a conduit 28 and is removed from the system through a trap indicated by numeral 29. The cooled partially-dried gas issuing from the separator 27 is conducted through a pipe 30 into the reaction tube 31 extending vertically and longitudinally through the combustion chamber in direct heat interchange relationship therewith.

As the heat generated by the burning of the gas mixture issuing from the burners is not sufficient to maintain the carbonaceous material in the reaction tube at a temperature sufficiently high to react completely with the reducible constituents of all of the cooled combusted gas mixture, it is necessary to remove a portion of the cooled gas from the system prior to its introduction into the reaction tube. This may be suitably accomplished by means of a motor-operated bleed-off control valve broadly indicated by numeral 32 connected to line 30. Means for automatically maintaining a relatively constant temperature within the reaction chamber may also be provided. One such means may comprise a pyrometer (not shown) having its thermocouple positioned in the combustion chamber and suitably connected through relays with the motor-operated bleed-off valve in such a manner that the amount of gas removed from the system through the bleed-off valve is controlled by and depends upon the temperature within the combustion chamber.

If a final atmosphere completely free of hydrogen is desired, it may be found necessary to obtain a more complete removal of water vapor from the combustion products prior to their introduction into the reaction chamber than is possible by use of the water cooler. For this purpose a suitable drying chamber (not shown) containing activated alumina or similar dehydrating agent, may be inserted in line 30 between the water separator 27 and the reaction tube 31. For most purposes, a small percentage of hydrogen in the final atmosphere has been found to have little, if any, undesirable action on the steel being heat treated therein and in such instances the use of such drastic drying agents is unnecessary. Most of the reacted or converted atmosphere issuing from the carbon filled reaction tube and consisting substantially of nitrogen, carbon monoxide and some hydrogen passes through a low velocity settling chamber 33 communicating with the reaction tube wherein the larger particles of carbon dust and ash suspended in the atmosphere settle out from the gas atmosphere before it is conducted through conduit 34 to a filter 35 and flowmeter 36 directly connected through pipe 2 with the annealing furnace 1. The filter 35 serves to remove and retain the remaining finer particles of carbon dust and ash contained in the gas.

The detailed construction of the combustion chamber and reaction chamber or tube is shown more fully in Figs. 2 and 3 wherein the combustion chamber is shown as comprising an outer casing 37 to which are suitably secured the end heads 38 and 39. The casing and end heads are lined with an insulating heat refractory material 40 and the combustion of the fuel gas mixture issuing from burners 16 takes place within the space between the refractory lining and the reaction tube extending lengthwise through the chamber.

In order to obtain a more thorough combustion of the gas-air mixture and a more uniform heating of the reaction tube, the burners extending through the refractory lining are so mounted that the burning mixtures issuing therefrom do not come in direct contact with the reaction tube but rather travel helically around the reaction tube with the combustion products ultimately leaving the combustion chamber through outlet pipe 23.

Preferably the active portion of the reaction tube, i. e., at least that portion subject to the full heating effect of the burning fuel within the combustion chamber, is of a flattened or oval-shaped cross section so that the carbon or coke contained therein is uniformly heated throughout to or above that temperature necessary for the reduction of all of the carbon dioxide and water vapor contained in the gaseous combustion products passing therethrough. Any ash produced during the oxidation of the carbonaceous material collects in the lower portion of the reaction tube and in the T 41 and is intermittently removed therefrom through ash removal door 42 normally kept in a closed position. T 41 is also provided with a reducing connection between the conduit or pipe 30 and the reaction tube 31.

The charge of carbonaceous material such as hardwood charcoal, or other suitable carbonaceous material, in the reaction tube is continually and automatically replenished from a supply of this material in granular form contained in hopper 43 located directly above the reaction tube and connected therewith through the lead-in pipe 44 in the funnel-shaped bottom of the hopper which pipe extends well into the upper flared outlet end 45 of the reaction tube. Preferably the lower end of lead-in pipe 44 extends into the higher temperature zone in the reaction chamber to prevent foreign gases, such as water vapor, from diffusing from the hopper into the effluent gas after the gas has passed from the heated portion of the reaction tube. By the construction described and illustrated the possibility of such diffusion and contamination is positively eliminated as a small portion of the heated reaction products from the reaction tube are continually forced through the tubular bottom portion of the hopper, comprising the hopper lead-in pipe 44, into the supply of carbonaceous material in the hopper and serve to dry thoroughly the material contained therein before being exhausted through exhaust pipe 46.

A dust-free means for introducing additional carbonaceous material into the hopper is also provided. By connecting a suitable exhausting means such as an industrial vacuum cleaner to outlet 47 located near the top of the hopper, the granular carbonaceous material may be drawn into the hopper through pipe 47a suitably connected to a source of supply of the carbonaceous material. Alternatively the carbon may be introduced through the opening in the top of the hopper which opening is normally closed by an air-tight cover 48 normally held in place by suitable fastening devices 49.

The major portion of the reaction products

produced by the reaction between the combustion products and the incandescent carbon pass out of the reaction tube through the passageway formed by the hopper lead-in pipe 44 and the flared end 45 of the reaction tube and into the settling chamber 33 between the funnel-shaped bottom of the hopper and end head 39 where, due to the diminished velocity of the effluent gases, any heavy particles of carbon drop to the bottom of the settling chamber to be periodically removed therefrom through clean-out opening 50 normally closed by plug 51.

Finally, the gas leaving the settling chamber through pipe 34 is freed of the remaining finer carbon particles by passing through filter 35 (Fig. 1) before being introduced into furnace 1.

In a modification of my invention auxiliary heating means may be provided in combustion chamber 17 in the form of suitable electric heating elements mounted on the inner walls of the refractory lining 37 or coiled around the reaction tube 31. In this connection, as is shown in Fig. 4, these electric heating elements 52 connected to a suitable source of electrical power (not shown) may also serve as the sole heating means for the contents of the reaction tube 31 and in such a modification of the invention the combusted gas mixture introduced into the lower end of the reaction tube may be that produced, for example, in the apparatus shown and described in Hotchkiss Patent 2,085,587 preheated if desired by being introduced into chamber 17 through pipe 53, passed through the chamber 17 and introduced directly therefrom into the reaction tube through holes 54 in the reaction tube near the lower end of the combustion chamber 17. With such modification inlet pipe 30 (Fig. 2) is replaced by a plug 55 and all of the remaining novel features of my invention including the compact highly efficient arrangement of the hopper, settling chamber and reaction tube are, of course, retained. Small amounts of a gas rich in carbon, such as propane, may be introduced through pipe 56 (Fig. 1) provided with valve 57 into the gas mixture entering the reaction tube, which gas will serve as an additional source of carbon for the reduction of the carbon dioxide and other reducible constituents of the mixture in the reaction tube.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an apparatus for the production of protective gaseous atmospheres, a reaction tube having a gas inlet and outlet and adapted to contain a granular carbonaceous material, means for heating said reaction tube, means for introducing an additional supply of carbonaceous material into said reaction tube, said supply means comprising a hopper having an outlet extending into the heated zone of said reaction tube through the gas outlet thereof, a settling chamber positioned below said hopper and around the outlet from said hopper, and means for conducting the major portion of the gaseous products formed in the reaction tube to said settling chamber.

2. Apparatus for producing a gaseous atmosphere comprising a vertical inner reaction tube adapted to hold a charge of carbonaceous material, an outer combustion chamber surrounding and in heat-interchange relationship with said reaction tube, one or more burners mounted in the walls of said combustion chamber, means for conducting gaseous combustion products from said combustion chamber to the lower end of said reaction tube, means for removing spent carbonaceous material from the lower end of said reaction tube, a hopper adapted to hold a supply of carbonaceous material located above said reaction tube and having an outlet extending into the upper end thereof, a settling chamber between said hopper and said combustion chamber, the said reaction tube, hopper, outlet, and settling chamber being so constructed and arranged that a major portion of the gaseous reaction products issuing from the upper end of said reaction tube enters the settling chamber and a minor portion enters the hopper through the outlet thereof, and means for conducting the gaseous reaction products from said settling chamber to a point of use.

3. Apparatus for producing a gaseous atmosphere comprising a metal casing having end heads and a refractory lining forming a vertical combustion chamber, one or more burners adapted to introduce a combustible mixture of gas and air into said combustion chamber mounted along the walls of said combustion chamber so that the combustible gaseous mixtures issuing therefrom enter tangentially into the combustion chamber and pass helically therethrough during combustion, a flattened tubular reaction chamber extending longitudinally through said combustion chamber in heat-interchange relationship therewith, means for conducting gaseous products of combustion from said combustion chamber to the lower end of said reaction chamber, a hopper adapted to hold a supply of carbonaceous material for said reaction chamber, said hopper having a funnel-shaped outlet partially extending into the upper end of said reaction chamber and adapted to conduct a portion of the gaseous products from said reaction chamber through said hopper, a settling chamber between said hopper and said combustion chamber communicating with said reaction chamber to receive the remaining portion of the gaseous products issuing therefrom, and means for conducting the gaseous products from said settling chamber to a point of use.

4. In an apparatus for producing gaseous atmospheres, a vertically arranged combustion chamber, a plurality of burners mounted in the walls of said combustion chamber, a reaction chamber comprising a tubular member of oval cross section extending longitudinally and centrally through said combustion chamber and adapted to hold a mass of carbonaceous material, said reaction chamber having a gas inlet end and a flared outlet end, a hopper above said reaction chamber adapted to hold a supply of carbonaceous material, a settling chamber below said hopper, said hopper having a funnel-shaped bottom portion extending into the outlet end of said reaction chamber and cooperating with said flared outlet end of said reaction chamber to form a passageway between said reaction tube and said settling chamber, means for conducting combustion products from said combustion chamber to the inlet end of said reaction chamber, and means for conducting gaseous products from said settling chamber to a point of use.

HARRY E. LEWIS.