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GAS-GENERATOR SYSTEM FOR PRODUCING HEAT-TREATING  
ENVELOPING ATMOSPHERES  
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Fig. 1.

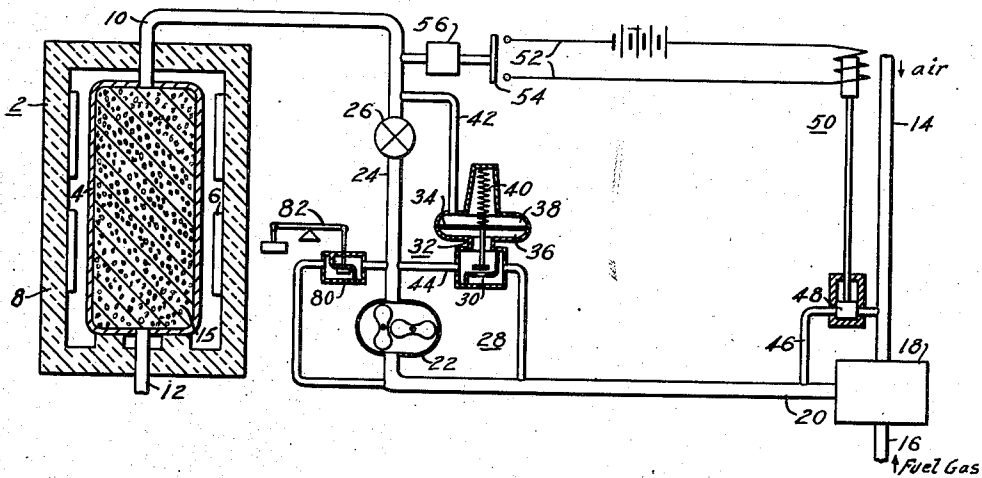
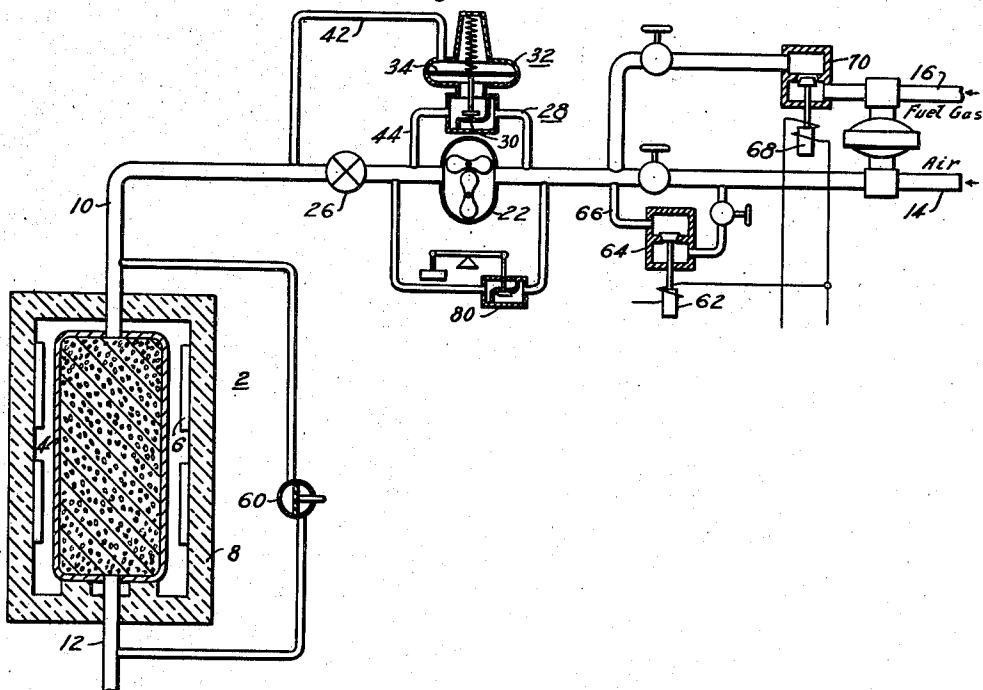


Fig. 2.



WITNESSES:

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## UNITED STATES PATENT OFFICE

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GAS-GENERATOR SYSTEM FOR PRODUCING  
HEAT-TREATING ENVELOPING ATMOS-  
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My invention relates to gas-reacting systems for producing a special gaseous atmosphere such as is used for enveloping metal undergoing a heat-treating process. Producing the atmosphere usually involves the reaction, in a heated catalyst, of any suitable combustible fuel-gas and a gas which contains oxygen in some form, for oxidizing the fuel-gas. In the preferred form of my invention, to which, however, I am not limited, the gases are reacted for providing a product-gas utilizable substantially without change for the special atmosphere.

In the production of such a product-gas, the fuel-gas and the air are usually reacted in different relative amounts, preferably first in a ratio in which the amount of free oxygen in the air is insufficient to oxidize all of the carbon in the fuel-gas so that some carbon deposits within the pores of the catalyst, thereby introducing a restriction or resistance to the flow of gas through the catalyst; and then passing a preponderance of an oxidizing gas which consumes the deposited carbon for the purpose of converting the oxidizing gas into a utilizable product-gas, or for reducing the aforesaid gas-flow restriction, or both. Systems of this kind are more fully described in the joint application of C. E. Peck and J. G. Hoop, Serial No. 447,682, filed June 19, 1942, and in the sole application of J. G. Hoop, Serial No. 564,541, filed November 21, 1944, now Patent No. 2,473,525. Other systems of this kind are also known.

In the systems of the aforesaid patent-applications, fuel-gas and air are mixed and combined before delivery to a pumping device which forces the mixture to a gas-generator having a reaction-chamber that includes a porous catalyst bed through which the reacting gases pass. Electrical heating means are provided for heating the catalyst. In these aforesaid systems, the pumping device provides a constant pressure on its output side and the pipe-system between this output side and the gas-generator includes a device for automatically providing a constant rate of flow of inlet gas to the gas-generator. Several automatic regulators are provided, one for the pumping device and one for the constant-flow apparatus.

It is an object of my invention to economize on such apparatus by replacing or eliminating one of the more expensive regulators.

It is another object of my invention to provide a system which will supply a substantially constant flow of gas to a gas-generator having a catalyst bed in which the size of the openings for the flow of gases continually changes and

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thereby alters the pressure drop across the gas-generator or the actual pressure at or near the inlet side of the gas-generator.

Further objects, innovations, combinations and methods of my invention will be discernible from the following description of several embodiments thereof. The description is to be taken in conjunction with the accompanying schematic drawing, in which like numerals represent like parts.

10 In the drawing:

Figure 1 is a view of a system along the lines shown in the aforesaid joint application, but modified in accordance with my invention, and

15 Fig. 2 is a similar view relating to a system such as shown in the aforesaid sole application.

Referring to the drawing, a gas-generator of any suitable type is schematically shown and is indicated in its entirety by the reference numeral 2. A reaction-chamber 4 of any suitable construction is provided inside the gas-generator and is heated by electrical or other heating means 6 supported on the inside of walls 8 of the gas-generator. The reaction-chamber shown comprises an outer gas-tight metallic casing having an inlet pipe 10 and an outlet pipe 12 for the flow of gases, these pipes passing through walls 8. The reaction-chamber 4 is provided with a suitable gas-pervious porous catalyst 15 through which the gas passing through the reaction-chamber is caused to flow.

Referring to Fig. 1, an air supply pipe 14 and a fuel-gas supply pipe 16 are connected to a device 18 which mixes fuel-gas and air to provide a supply gas, having a definite ratio of fuel-gas and air, which flows to a pipe 20 connected to the input side of a constant displacement pump 22. The constant displacement pump 22 delivers the mixture at an increased pressure to a pipe 24 connected to one side of the equivalent of an orifice, which is represented at 26, the other side of this orifice being connected to the inlet pipe 10. The orifice 26 is a flow-controlling or setting device which will provide a constant flow there-through when the differential pressure across it is maintained constant. Suitable valves are available for this purpose including some which are adjustable for providing different constant flow rates for the same differential pressure thereacross.

50 The constant displacement pump 22 has a capacity which is more than that required for the maximum flow expected to be delivered to the gas-generator, the difference between the output of the pump and the actual demand being recirculated through a branch pipe-system 28 con-

nected across the inlet and outlet of the pump. The pipe-system 28 includes a valve 30 of a flow-controller regulator 32.

The regulator 32 may be of any suitable type for operating the valve 30 to a degree dependent upon the differential pressure across it, and is here shown as comprising a flexible diaphragm 34 dividing the regulator into a higher-pressure chamber 36 and a lower-pressure chamber 38. The diaphragm is biased downwardly by any suitable biasing means such as, for example, an adjustable spring 40. The valve 30 is opened or closed in accordance with the displacement of the diaphragm 34.

One side of the diaphragm 34, exposed in the chamber 38, is subjected, through a pipe 42, to the pressure at the outlet of the orifice 26 or in the pipe 10; while the other side of the diaphragm, exposed in the chamber 36, is subjected to the pressure at the outlet of the pump 22, or in the pipe 24, through a pipe connection 44 of the branch pipe-system 28.

The system of Fig. 1 also includes a branch air-pipe connection 46, between the pipes 14 and 20, controlled by a normally closed valve 48 operable to open position when a solenoid 50 is energized. The solenoid 50 is in a normally open circuit 52 which is closed when normally open contacts 54 are operated to closed position by a pressure-responsive device 56. The pressure-responsive device can be considered to maintain the contacts 54 open when the gas-pressure in the inlet pipe 10 is below a predetermined value or range of values and to close the contacts 54 when the gas-pressure rises above that value or range.

In the operation of the system of Fig. 1, a mixture of air and gas is pumped to the gas-generator. Assuming that the gas-pressure in the inlet pipe 10 is below that required to close the contacts 54, the relative amounts of fuel-gas and air are such that carbon will be separated from the reacting gases and deposited in the pores of the catalyst, causing an increase in pressure in the inlet pipe 10. As the pressure increases, the diaphragm 34 tends to close the valve 30 for restricting the flow of gas through the branch pipe-system 28 so that the pressure at the outlet of the pump tends to increase. This increased pressure manifests itself on the underside of the diaphragm 34 and tends to balance the increased pressure in the pipe 10 so that the pressure across the flow-determining orifice 26 tends to remain constant. When the pressure in the inlet pipe 10 reaches a value sufficient to close the contacts 54, the solenoid 50 is energized and causes the valve 48 to open. A preset additional supply of air is accordingly fed to the pump 22 so that the mixture supplied to the gas-generator contains a preponderance of oxidizing gas for consuming carbon deposited in the reaction chamber. As the carbon is being consumed, the gas-pressure in the inlet pipe 10 decreases, but the flow remains substantially constant because the regulator 32 automatically controls or adjusts the valve 30 for maintaining a constant difference of gas-pressure between the pipes 24 and 10 and consequently across the flow-determining device 26.

When the pressure in the pipe 10 decreases to the proper value, the contacts 54 open and the original conditions are restored, with the inlet supply to the gas-generator such as to cause carbon to be again deposited in the catalyst. Consequently, the operation of the apparatus changes

in turn from a condition in which carbon is deposited to one in which carbon is consumed.

My invention is not necessarily limited to a system such as described but can be applied to any general system of the type involved; and as indicative of this flexibility I have shown in Fig. 2 another system modified in accordance with my invention. In this system, the differential pressure between the inlet pipe 10 and outlet pipe 12 of the gas-generator controls a pressure responsive device 60 which controls one or more electric circuits. Included in the electric circuits are a solenoid 62 for a normally-closed valve 64 in a branch supply 66 for increasing the relative amount of air supplied to the gas-generator; and a solenoid 68 for a normally-open valve 70 controlling the supply of fuel-gas.

When the differential pressure across the gas-generator goes above a predetermined value, because of carbon deposited in the catalyst, the device 60 operates to cause the solenoid 62 to be energized, opening the branch supply 66 for increasing the flow of air in the inlet-supply to the gas-generator. The pressure-responsive device 60 may also control apparatus for energizing the solenoid 68 momentarily. When the solenoid 68 is energized, the valve 70 completely or substantially entirely closes off the flow of fuel-gas so that a pure air-shot flows to the gas-generator.

With the valves 64 and 70 open, a relatively leaner mixture of fuel-gas and air is supplied having a slight preponderance of oxidizing gas for consuming carbon deposited in the catalyst. With valve 64 open and valve 70 closed, the supply to the gas-generator has a greater preponderance of oxidizing gas for consuming carbon in the catalyst.

In the apparatus disclosed, the pump is automatically loaded in accordance with the load which it must force through the gas-generator. When the gas-generator is relatively free from carbon, the low load pressure permits the pump output pressure to decrease and vice versa. Since, however, the output pressure of the pump may tend to increase continuously when the flow of the gas-generator is, for example, closed off, it is desirable to provide a normally closed relief valve in the system operable for relieving the pressure of the pump under such circumstances. To this end, a normally closed relief valve 80 is provided controlled by a regulator 82 responsive to the pressure across the pump and set to open the valve 80 when the pressure rises to a value somewhat above that resulting from the maximum opposition to gas flow expected from the gas-generator.

The relief valve device not only protects the system against excessive high pressure, but also operates to protect the system against abnormally high suction at the inlet end of the pump.

While I have described my invention in connection with preferred forms thereof, it is obvious that it is of more general application in atmosphere producing systems of the type described, involving a fuel-gas and any oxidizing gas, which may be other than air, for oxidizing the fuel-gas to different extents, depending on operating conditions.

I claim as my invention:

1. A system of a type described for producing a special atmosphere adapted to be used in heat-treating, comprising the combination with a gas-generator having a gas-pervious porous catalyst, a plurality of gas-supply means for different gases to be delivered to said gas-genera-

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tor in relatively different amounts, operable means operable for determining the relative amounts of said gases to be delivered to said gas-generator, and means responsive to resistance to gas-flow through said gas-generator for changing the relative amounts of said gases deliverable to said gas-generator; of means for conveying the relative amounts of said gases, as determined by said operable means, to said gas-generator, comprising a pump, a branch pipe-system including a variable flow-controlling device therein, by-passing said pump, a pipe-connection from the output side of said pump to said gas-generator, said pipe-connection including a separate orifice means, and a separate regulator connected by separate tubular pipes across said orifice means so as to be responsive to the pressure drop directly across said separate orifice means, said regulator having associated therewith means arranged to vary said flow-controlling device for providing a substantially constant gas-flow to said gas-generator.

2. A system of a type described for producing a special atmosphere adapted to be used in heat-treating, comprising the combination with a gas-generator having a gas-pervious porous catalyst, a plurality of gas-supply means for different gases to be delivered to said gas-generator in relatively different amounts, operable means op-

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erable for determining the relative amounts of said gases to be delivered to said gas-generator, and means responsive to resistance to gas-flow through said gas-generator for changing the relative amounts of said gases deliverable to said gas-generator; of a pipe line connected to said gas-supply means for conveying the relative amounts of said gases, as determined by said operable means, to said gas-generator, comprising a pump, a branch pipe-system including a variable flow-controlling device therein, by-passing only said pump, a pressure-responsive regulator means having means associated therewith constructed and arranged to operate said flow-controlling device, said pipe line including a pipe connection from the output side of said pump to said gas-generator, said pipe connection including a separate orifice device, and separate pipes connecting the different sides of said regulator across said orifice.

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