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Brooks et al.

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[54] **SYSTEM FOR SUPPLYING INERT GAS**

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[52] **U.S. Cl.** ..... **23/281**; 23/288 F; 60/276; 60/285; 123/121; 48/DIG. 8

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[58] **Field of Search** ..... 23/288 F, 281; 123/121; 60/276, 285; 48/DIG. 8

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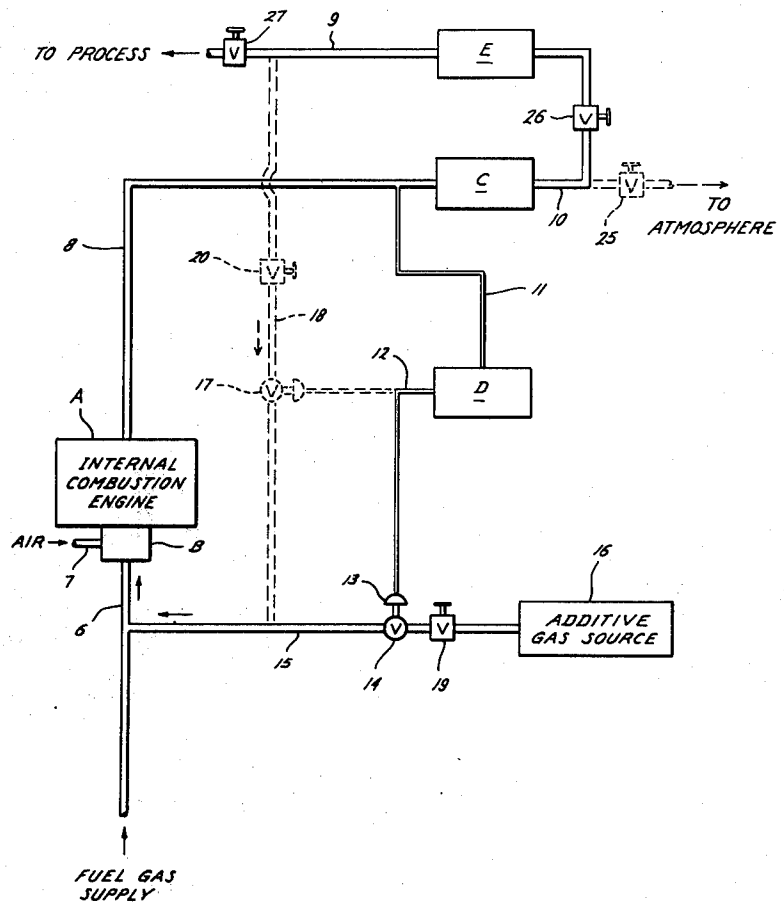
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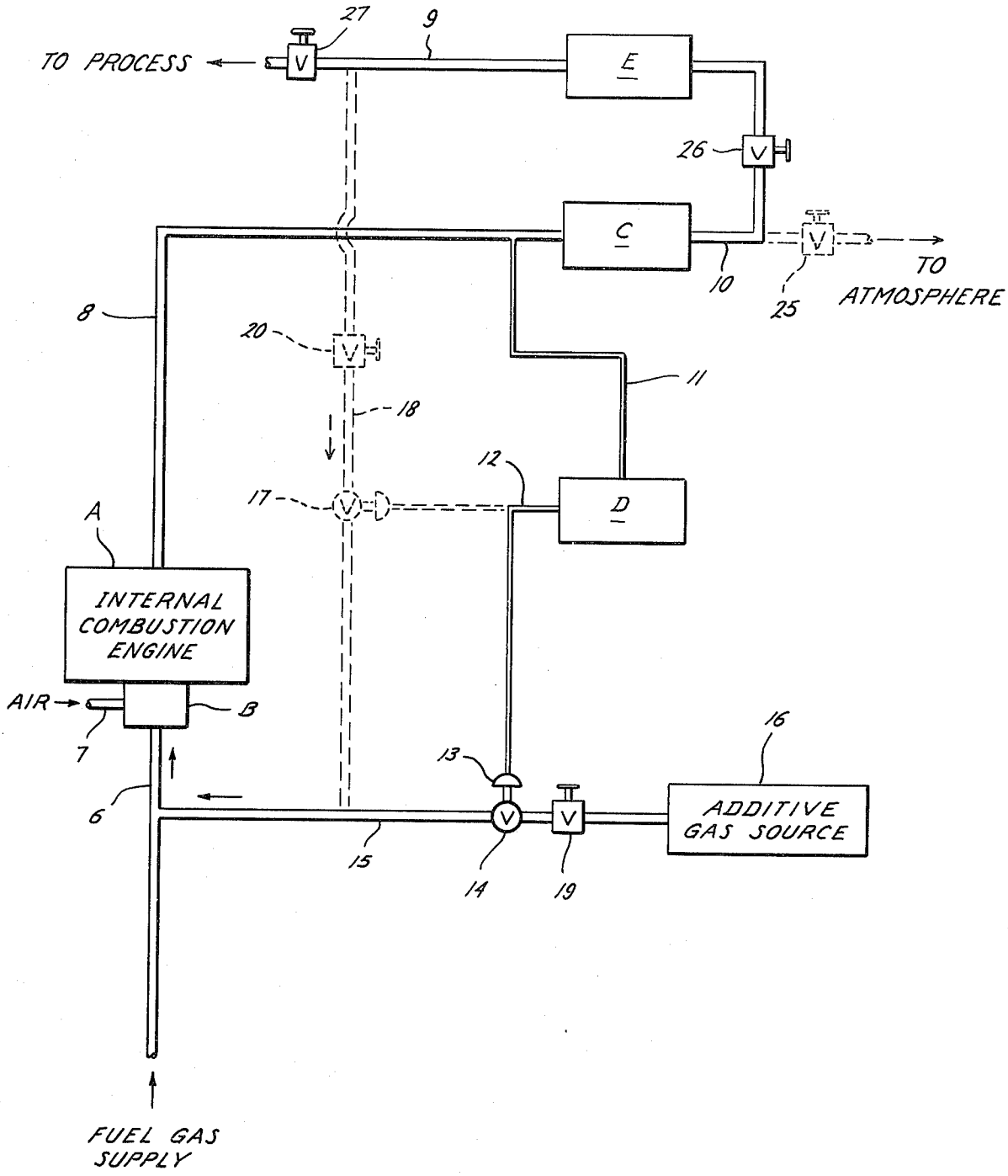
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[57] **ABSTRACT**

The exhaust gases from an internal combustion engine are processed for release to the atmosphere or for delivery to a consuming point, such as a subsurface oil producing formation, by passage through a catalytic converter which reduces or eliminates corrosive, combustible, and other undesirable components of the exhaust. In order to insure the presence in the gases of optimum chemical components for effecting the catalytic reaction, an exhaust analyzer and controller adjusts the supply to the engine of an additive of different BTU value than the main fuel supply.

5 Claims, 1 Drawing Figure




TO PROCESS
27
9
E
26
C
10
25
TO
ATMOSPHERE
8
20
11
18
12
17
D
A
INTERNAL
COMBUSTION
ENGINE
AIR
B
7
6
13
16
ADDITIVE
GAS SOURCE
15
14
19
FUEL GAS
SUPPLY

SYSTEM FOR SUPPLYING INERT GAS

BACKGROUND OF THE INVENTION

Where the exhaust from an internal combustion engine is to be utilized as an inert gas, for instance, supplied through a compressor to a subsurface oil producing formation, it is necessary to render the exhaust essentially free of corrosive, acid-forming and other undesirable components. This has been achieved heretofore by installing in the exhaust duct a catalytic converter containing a catalyst such as platinum or palladium which induces a reduction of the nitrogen oxides and elimination of free oxygen. However, the efficacy of such a converter depends upon the presence in the exhaust of optimum quantities of reducing agents such as carbon monoxide and free hydrogen. The prior art devices for insuring the optimum chemical composition of the exhaust gases for such catalytic conversion have utilized exhaust gas analyzers either to adjust the ratio of fuel and air in the combustible mixture supplied to the engine, or have supplied an additive, as the fuel itself, directly to the catalytic converter. In the first case, proper control of the combustible content of exhaust gases by control of the fuel and air ratio in the mixture supplied to multiple carburetors or mixing valves is not feasible. In the latter case, close control of the exhaust constituents has not been achieved.

Accordingly, it is an object of the present invention to provide a system for rendering the exhaust gases from an internal combustion engine continuously at the optimum composition for maximum catalytic conversion even where multiple carburetors are used.

Another object is to provide an improved system for insuring closer control of the catalytically converted gases in the exhaust system from an internal combustion engine.

SUMMARY OF THE INVENTION

In accordance with the present invention the exhaust gases from an internal combustion engine are directed, as heretofore, through a catalytic converter. In order to improve the converter action, an exhaust gas analyzer is utilized to control the BTU value of the fuel supply to the engine, by adding to the intake fuel controlled proportions of a gas having a substantially different BTU than the main fuel gas. Greater BTU additive gas will be used where the fuel gas has an abnormally low BTU value (for example, less than about **900** BTU per cu. ft.) and lower BTU additive gas will be used where the fuel gas exceeds normal BTU values (for example, above **1000** BTU per cu. ft.). For intermediate value fuel gas (between about **900** and **1000** BTU per cu. ft.) either higher or lower BTU additive gas may be used with a corresponding adjustment of the carburetor or fuel mixing valves.

In the accompanying drawing, the FIGURE is a schematic representation illustrating an exemplary form of the apparatus.

DETAILED DESCRIPTION OF THE FIGURE

An internal combustion engine A, preferably of the reciprocating type, is equipped with carburetion or mixing valve equipment B for properly mixing fuel and air constituents introduced through piping **6** and **7** for supply to the firing chambers. Where the apparatus is utilized in the oilfields, the fuel supply may be natural gas which generally is present and available. The exhaust line **8** leads from the engine exhaust manifold to a conventional catalytic converter C containing a suitable catalytic agent, such as platinum or palladium, over which the exhaust is directed for eliminating corrosive oxides of nitrogen and other undesirable materials. The treated exhaust may then be supplied through line **10,** valve **26,** compressor E and line **9** to a process or consuming point, such as a water sweetening plant (for removal of gases such as H_2S) or a subsurface oil-producing formation. Alternatively, the inert gas from the converter may be discharged to the atmosphere through line **10** and valve **25.**

A portion of the exhaust is bypassed as at **11** to an exhaust gas analyzer D, also of conventional design, for instance, a thermal conductivity type. The exhaust gas analyzer is adapted to respond to the chemical composition of the exhaust gas. Responses from the analyzer, delivered through a pneumatic or electrical line **12,** energize the actuator **13** of an automatic valve **14** in a line **15** leading from a source of additive gas **16** to the main fuel supply line **6** and thence to the engine carburetion system. Alternatively, the additive gas may be introduced into the intake manifold downstream of the carburetion system.

As another alternative, pneumatic line **12** may control an automatic valve **17** in a connection **18,** shown dotted, between discharge duct **9** and line **15** and thence to the engine intake permitting a portion of the produced, essentially zero BTU inert gas to be used as the additive gas. Manual valves **19** and **20** are provided in lines **15** and **18.** In those embodiments where the exhaust is released to the atmosphere, the compressor E will be employed to raise the exhaust gas pressure only enough to permit flow through connection **18** through line **15** to intake line **6.**

OPERATION

The purpose of the additive supplied, either through line **15, 6** or line **18, 15, 6** is to adjust the BTU value of the engine intake mixture so that the components of the exhaust in duct **8** will be optimum for action of the catalytic converter as explained above. Where fuel gas has an intermediate BTU value (about **900** to **1000** BTU per cu. ft.) a lower BTU additive gas may be used and when the fuel gas has a high BTU value (above about **1000** BTU per cu. ft.) the additive gas should be an inert gas or a gas with a lower BTU value than that of the main supply gas. With the use of such low BTU or inert additive gas, the carburetor is initially adjusted without the additive gas to provide a rich fuel mixture so as to produce an excess of combustible gases as carbon monoxide and hydrogen in the exhaust over the amount required for efficient operation of the catalytic converter (about **2–4%**). The amount of excess caarbon monoxide and hydrogen in the exhaust before the introduction of the additive is not critical but it should be sufficiently in excess of the desired amount to be certain that a sufficient amount will always be available with normal fluctuations in the BTU value of the fuel supply.

Inert or low BTU gas additives may be supplied from the additive gas source **16** through manual valve **19** and past the automatic control valve **14.** In the alternative, the produced inert gas in line **9** may itself be supplied to the carburetor or mixing valve of the internal combustion engine to reduce the combustibles in the exhaust gas to the desired amount for proper operation of

the catalytic converter. When inert gas is supplied to a consuming point or process, the alternate supply of inert gas may be obtained by opening manual valve **20** and the inert gas will then be supplied to the fuel system through automatic control valve **17.** Manual valves **19** and **25** will be closed at this time.

When the produced inert gas is used as an alternate supply of fuel additive gas and the remainder of the produced inert gas is discharged to the atmosphere, manual valves **20** and **25** will be open and valves **19** and **27** will be closed. As previously noted, in this case the compressor E will then be employed only to raise the exhaust gas pressure sufficiently to permit flow through line **18,** valve **20** and line **15** to the engine intake **6.** During such operation automatic control valve **17** will control the supply of the inert gas to the fuel mixture.

Valve **26** is provided to illustrate an embodiment in which compressor E would not be used and the entire production of inert gas would be discharged through manual valve **25** to the atmosphere. Such circumstance would normally occur when the catalytic converter is used to reduce the undesirable corrosive or combustible components of the exhaust gas for discharge to the atmosphere and the source **16** is used for the additive gas supply.

Source **16** may be used to store a supply of gas of lesser or greater BTU value than the main gas supply. A gas having a greater BTU value than that of normally available natural gas would include, for example, an LPG (liquified petroleum gas) such as butane or propane. Such a high BTU gas may be used if the fuel gas has an intermediate BTU value (about **900–1000** BTU per cu. ft.) and such greater BTU additive will be used if the fuel gas has a relatively low BTU value (below about **900** BTU per cu. ft.). In such case, of course, the carburetor or fuel mixing valve will be adjusted to a lean mixture as evidenced by a low proportion of combustibles in the exhaust gas, normally less than **2** percent, before the additive is introduced into the fuel supply. The rich additive gas is then introduced as in the case of the lean additive gas by opening manual valve **19** and controlling the desired proportion supplied to the carburetor system by the operation of automatic valve **14.**

We have found that the system herein disclosed and claimed insures the supply of an exceptionally uniform composition of exhaust gases, particularly as to reductants, to the catalytic converter, with the result that the main fuel gas supply may be controlled as necessary for proper engine operation and also for continuing uniform supply of inert gas to the consuming point. Various features may be modified as will occur to those skilled in the art, and the exclusive use of all modifications as come within the scope of the appended claims is contemplated.

We claim:

1. In an apparatus for the production of an inert gas by the conversion of exhaust gas from an internal combustion engine said apparatus having a source of hydrocarbon fuel of predetermined BTU value connected to said engine by a fuel supply means, and exhaust duct means connected to said engine to convey the exhaust gases therefrom; and a catalytic converter provided in said duct means for reacting the exhaust gases over a catalyst of the group consisting of platinum and palladium, the improvement comprising:

a. Exhaust gas analyzing means connected to said duct means between said engine and said converter to sample and respond to the chemical composition of the exhaust gas;

b. A source of fuel additive of BTU value differing from that of the hydrocarbon fuel;

c. A connection between said latter source of fuel additive and said fuel supply means;

d. A valve controlling said connection; and

e. An operative connection between said analyzing means and said valve for adjusting the quantity of fuel additive admixed with said hydrocarbon fuel supplied to the engine in proportions which will maintain the combustibles in the exhaust gas at a level sufficient for efficient operation of the catalytic converter.

2. Inert gas generating apparatus as described in claim **1** in which said source of fuel additive is adapted to supply to the engine a fuel additive comprising a liquefied petroleum gas of greater BTU value than the BTU value of the gas delivered by said fuel supply means.

3. Inert gas generating apparatus as described in claim **1** in which said source of fuel additive comprises a communication with said exhaust duct downstream of the catalytic converter.

4. Inert gas generating apparatus as described in claim **1** wherein a compressor is connected to said exhaust duct downstream from said converter, and a discharge conduit is connected to said compressor to carry said inert gas from said compressor to a consuming point.

5. Inert gas generating apparatus as described in claim **1** wherein a discharge conduit is connected to said catalytic converter to release said inert gas to the atmosphere.

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