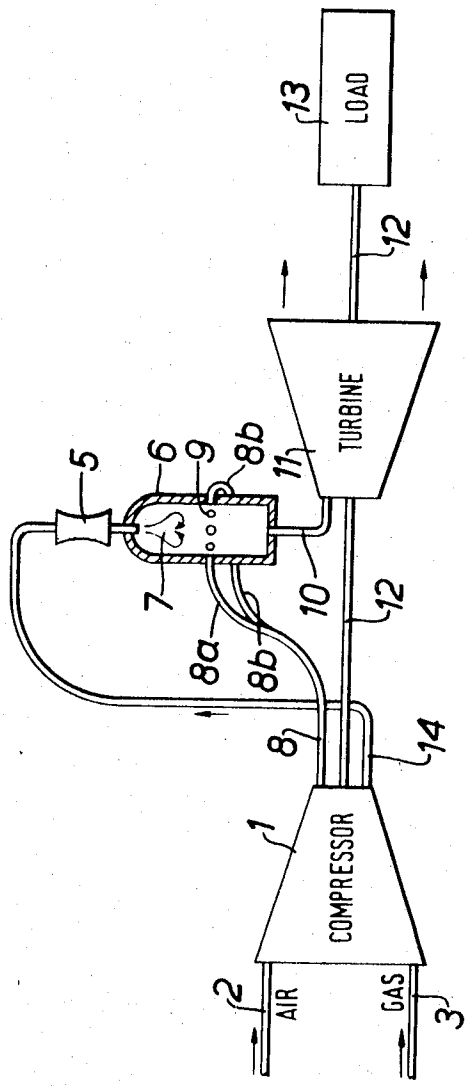
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GAS TURBINE FOR LOW HEATING VALUE GAS

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ABSTRACT OF THE DISCLOSURE

A gas turbine has a compressor, a combustion chamber, and a turbine which drives the compressor and provides additional shaft work, air and low heating value gas being introduced at given circumferentially disposed locations at the compressor intake and being withdrawn at corresponding circumferentially disposed locations at the compressor exhaust, one of said locations at the compressor exhaust providing fuel rich air introduced into and burned in the combustion chamber with additional air from the compressor introduced thereafter, products of combustion from the combustion chamber driving said turbine.

BACKGROUND OF THE INVENTION

An open cycle gas turbine operates on the Brayton cycle in which air is compressed to several atmospheres, heated by combustion of fuel at the higher pressures. The heated air plus products of combustion of the fuel are then expanded to atmosphere, thus producing work to drive the compressor and a surplus in the form of useful power.

For this cycle to operate the fuel must be at a higher pressure than the air in the combustion chamber in order to enter the chamber. If the fuel is initially at atmospheric or any lower pressure, it must be pumped or compressed. Separate compressors for air and fuel gas are normally used. If the gas has a high heating value on a volumetric basis like natural gas ($\approx$1000 B.t.u./ft.^{3}) the compressor is of a tolerably small size. In other cases low heating value gas is to be burned when the compressor size for the fuel becomes excessive. Examples of low heating value gas are sewage gas ($\approx$500 B.t.u./ft.^{3}) and blast furnace gas ($\approx$100 B.t.u./ft.^{3}). A further problem of the use of low heating value gas is that the large volume of fuel gas upsets the normal balance between the volume flow through the compressor and turbine of the gas turbine system. For example, $\approx$⅓ of a cubic foot of natural gas is required for each 14 ft.^{3} of air but 3 ft.^{3} of blast furnace gas would be required. The large volume of low heat value gas can cause the compressor of the gas turbine to surge or stall and can require that the gas turbine system be adjusted to operate on the low heat value gas. The gas turbine then is unable to operate at full efficiency interchangeably.

SUMMARY OF THE INVENTION

This invention solves the problem of operating a gas turbine with low heating value gas. The solution is to compress both air and fuel gas in the same normal gas turbine compressor, but this solution poses several additional problems. When air and fuel are compressed together, there may be a danger of a flash back occurring in the compressor. This can be avoided if the gas-air mixture leaving the compressor passes through a passage where the velocity of the mixture exceeds the flame velocity of the mixture. Alternately, a flame trap may be installed between the compressor and combustion chamber. The system could likely only be used when the gas turbine was up to speed and not during starting when velocities through the system were low, thus, a separate normal fuel for starting would be advisable.

Gas turbine combustion occurs at very weak fuel to air ratios; on natural gas about 25% of stoichiometric. At these weak mixtures if the fuel is mixed with all the air, combustion is difficult. Normal practice is to burn the fuel with a portion of the air, then subsequently, to mix the balance of the air into the combustion products. To achieve this effect with compression of fuel gas and air in a single compressor will require that the fuel gas be concentrated into a portion of the compressor inlet and collected from the compressor outlet where the fuel gas has the highest concentration. The high concentration gas would be fed to the primary zone of the combustor and the air from the compressor with little or no fuel would be supplied to the dilution area of the combustor.

Although compressors of gas turbines are interconnected radially and there is no circumferential separation, air (or gas) being compressed follows a definite path through the machine. In an axial compressor the path is substantial axial but a deviation of several degrees (unlikely to exceed 90°) from inlet to discharge is possible. The flow through a radial flow compressor will also follow a definite path which will permit a concentrated gas mixture to be selected from the compressor outlet if injected locally at the inlet. The above effect only occurs in compressors operating on dynamic principles and does not occur in displacement compressors like screw compressors.

Considering that the gas must be mixed with a portion of the air for combustion, some mixing of gas and air in the compressor is not detrimental. A problem may arise if the gas and air are different in molecular weight or other properties like specific heat which affects compressor performance. In this event some mixing of gas and air before compression may be required for compression to be possible. This does not affect the principle of the invention.

Special construction of the combustion chamber will allow combustion of pre-mixed gas and air, for example, refractory combustion chambers where radiant heating of the incoming air and gas is used. Alternately, a small quantity of higher heating value fuel, oil or gas can be used as pilot fuel to stabilize combustion of the low heat value or pressurized fuel air mixture.

BRIEF DESCRIPTION OF THE DRAWING

The figure is a schematic diagram of a gas turbine jet engine according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Air is introduced into compressor **1** by line **2** and a low value heating gas is introduced into the compressor **1** through line **3**. A fuel gas and mixed air stream is withdrawn from compressor **1** by line **4** and passed through a constriction device **5** to increase its velocity to prevent explosive flash back if the mixture is in the explosive range. Arrows **7** indicate the typical recirculating flame pattern. Pipe **8** withdraws a stream of predominantly air and divides into the pipes **8***a* and **8***b* to introduce the air into the lower end of the combustion chamber **6** through the dilution air holes **9**

Products of combustion leave combustion chamber **6** through duct **10** to enter and expand in turbine **11** driving it. By means of shaft **12** turbine **11** drives compressor **1** and load **13**.

What is claimed is:

1. A gas turbine for use with a low heating value gas comprising, in combination, a compressor having an in-

take and an exhaust, means introducing air into a portion of the intake, means introducing low value heating gas into the intake at a location circumferentially displaced from said means introducing air into said intake, means withdrawing a gas rich air mixture from a circumferential location at the exhaust of said compressor, a combustion chamber, said means withdrawing a gas rich air mixture introducing the gas rich air mixture into the end of said combustion chamber to burn therein, means withdrawing air from said compressor exhaust at a circumferential location displaced from said means withdrawing a gas rich air mixture, said means withdrawing air from said compressor exhaust passing air into said combustion chamber after the end of said combustion chamber, a turbine driving said compressor and providing shaft work, and means conducting products of combustion from said combustion chamber to said turbine driving said turbine.

2. The combination according to claim 1 with the addition of flame arresting means in said means withdrawing a gas rich mixture from said compressor.

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