

Description

This invention relates generally to gas turbine engines and more particularly to a system for burning gaseous fuels having a range of calorific values.

Fuel systems capable of supplying either all gaseous fuel, all liquid fuel, or a mixture of the two at a preselected ratio have been successfully employed in gas turbine engines. In some instances it is desirable to be able to burn gaseous fuels having a range of calorific values in a gas turbine engine. It can be appreciated that in a place where a more economical fuel, such as a low calorific value fuel in a gas producing area, is available, it would be more economical to arrange the turbine engine to use only the low calorific value fuel to the maximum extent. In most gas producing areas the high calorific value fuel or natural gas can be sold at a profit to a waiting customer, however, the low calorific value fuel is a by-product with little or no market value. Therefore, it is desirable to utilize such low calorific value fuel on site as a fuel. Such fuels, however, are difficult to use in a gas turbine engine. For example, it is very difficult to start a gas turbine engine on low calorific value fuel. Furthermore, the low calorific value of the fuel will necessitate the burning of a greater mass/volume of fuel in order to achieve desired turbine inlet temperature within the turbine engine versus the mass/volume of fuel when burning high calorific value fuel.

A dual fuel system is disclosed, for instance in US-A-2,637,334, of N.E. Starkey. The Starkey patent discloses a dual fuel system where liquid fuel is directed to a manifold and then to a passage in the nozzle and a gaseous fuel is directed to a separate manifold and then to a different passage in the nozzle.

US-A-2,826,038 of James Forrest Shannon et al discloses a gas turbine engine which utilizes a liquid fuel injected into the combustion chamber by a fuel pump and a low calorific value gaseous fuel supplied through a separate duct into the combustion chamber. Shannon et al provides means for diverting a proportion of the pressure air from the combustion chamber and means for converting the energy of the diverted air into useful work, whereby during the supply of low calorific value fuel to the combustion chamber air may be diverted from the combustion chamber in proportion corresponding in mass flow to the additional mass flow of fuel necessary to achieve the desired nozzle temperature.

The primary problems encountered by the prior art systems are firstly, the different fuels have been injected into the combustion chamber through separate passages or ports each connected to the different fuel source. The different calorific value of the fuel and corresponding different mass flow rate required to provide necessary fuel quantities require different fuel injector designs. For example, orifice sizes must be different to supply the quantities of fuel

needed to achieve proper turbine inlet temperatures. If proper fuel injector pressure drop, to control combustion process, is to be maintained. If a fuel injector has been designed for a high BTU fuel, unacceptably high fuel injector pressure drops will occur at the fuel injector when running on low BTU fuel. On the other hand if a fuel injector has been designed to operate on low BTU fuel, very low fuel injector pressure drops will occur when running on high BTU fuel; this could cause combustion driven oscillations resulting in damage to the gas turbine. Secondly, the art teaches that the atomization and mixing of the different fuels within the combustion chamber to provide efficient burning (fuel to air ratio and mixing) and power requirements require controls to provide varied amounts of combustion air. Thirdly, starting a gas turbine engine on low calorific value fuel is very difficult to accomplish. Fourthly, complexity problems are encountered when trying to proportion the combustion air needed to provide the appropriate fuel to air ratio for proper burning when burning the needed mass/volume flow of the relatively low calorific value fuel.

These problems as mentioned above complicate the structures, increase cost and complicate the system design used to burn fuels having a range of calorific values.

CH-A-319366 discloses a method of burning gaseous fuels having a range of calorific values in a combustion chamber of a gas turbine engine and comprising the steps of starting the engine by injecting only a high calorific value gaseous fuel into the combustion chamber through a first fuel supply passage; monitoring an operating parameter (the engine speed) of the engine to determine when a pre-established operating parameter of the engine has been established; injecting a low calorific value gaseous fuel into the combustion chamber when the pre-established parameter of the engine is established, thereby decreasing the quantity of high calorific value gaseous fuel and increasing the quantity of low calorific value gaseous fuel; controllably throttling the high calorific value gaseous fuel through the first fuel supply passage and a second fuel supply passage; and stopping the flow of high calorific value gaseous fuel and thereafter operating the engine on only low calorific value gaseous fuel.

CH-A-290098 discloses a gas turbine engine system comprising at least one fuel injector located in a combustion chamber of a gas turbine engine and having a first fuel supply passage opening at its downstream end into the combustion chamber; a first throttle valve controlling flow through the first fuel supply passage; a chamber connected to the upstream end of the first fuel supply passage; a first control valve interconnecting the chamber, in use, with a source of high calorific value gaseous fuel; a second control valve interconnecting the chamber, in

use, with a source of low calorific value gaseous fuel; and, by implication, means programmed to control the first throttle valve and the first and second control valves in response to a monitoring of an engine parameter so that upon initial start up of the engine, only high calorific value gaseous fuel is supplied to the combustion chamber, and during eventual running only low calorific value gaseous fuel is supplied to the combustion chamber; and according to the invention, such a system is characterised by a second fuel supply passage connected at its upstream end to the chamber and opening at its downstream end into the combustion chamber; by a second throttle valve controlling flow through the second fuel supply passage; by the programmed means also controlling the second throttle valve such that the high calorific value gaseous fuel which is supplied alone to the combustion chamber during the initial start up is supplied through only one of the passages, and the low calorific value gaseous fuel which is supplied alone to the combustion chamber during the eventual running is supplied through both of the passages; and in that the first fuel supply passage of the injector is centrally located and includes a plurality of outwardly directed orifices each of which has a preestablished flow area, and the second fuel supply passage of the injector is coaxially located with respect to the first passage and has a plurality of outwardly directed orifices each of which has a preestablished flow area.

In the accompanying drawings:

Fig. 1 is a schematic view of the system used to burn gaseous fuels having a range of calorific values in the gas turbine engine;

Fig. 2 is an enlarged sectional view taken along lines II-II of Fig. 1; and

Fig. 3 is an enlarged sectional view taken along lines III-III of Fig. 1.

In reference to Fig. 1 a system 10 for burning gaseous fuels having a range of calorific values is shown in combination with a gas turbine engine 12. The engine 12 is of generally conventional design and includes a compressor 14, a power turbine 16, an air supply system 18, a combustion chamber 20, and an ignition system 22.

The system 10 includes a fuel injector 26 located in the combustion chamber 20 and having a first fuel supply passage 28 centrally located therein. The passage 28 has a plurality of outwardly directed orifices 30, best shown in Fig. 3, each having a preestablished flow area opening into the combustion chamber 20. The flow areas of some of the orifices of the first passage are different than the preestablished flow area of other orifices of the first passage to prevent hot spots on the combustion chamber 20 walls. For example, the orifices are divided into a first group of orifices 31 and a second group of orifices 32 having a larger flow area than the first group of the orifices 31. More specifically, when more than one fuel injector

26 is arranged in a circular pattern within the combustion chamber 20, the fuel injected from adjacent fuel injectors into the combustion area in line with or between fuel injectors can cause hot spots. To insure against these hot spots, the second group 32 of the orifices 30 on each fuel injector 26 is made smaller to reduce the fuel flow into the area in line with or between injectors where hot spots could be created. The orifices are arranged in an angular pattern selected to control the combustion process within the combustion chamber 20. The fuel injector 26 also includes a second fuel supply passage 33 coaxially located with respect to the first passage 28. The second fuel supply passage has a plurality of outwardly directed orifices 34, best shown in Fig. 2, each of which has a preestablished flow area opening into the combustion chamber 20. The orifices 34 also include a first group of orifices 35 and a second group of orifices 36 having a larger flow area than the first group of orifice 35 to prevent hot spots from occurring as explained above. In the present application, the combined effective flow area of the orifices of the first fuel supply passage 28 and the combined effective area of the orifices of the second fuel supply passage 33 are substantially equal. In alternative applications, the effective area of the orifices in the first fuel supply passage 28 when compared to the effective area of the orifices of the second fuel supply passage 33 may change and may not be equal. A first throttle valve 37 is connected to the first fuel supply passage 28 by a fuel line 38 and a second throttle valve 40 is connected to the second fuel supply passage 33 by a fuel line 42. The first and second throttle valves 37, 40 are connected to a mixing chamber 44 by lines 46, 48 shut-off valves 50, 52 and lines 54, 56, respectively.

The mixing chamber 44 is connected to a source of high calorific value gaseous fuel 60 by a fuel line 62, a control valve 64 and a fuel line 65. The mixing chamber 44 is also connected to a source of low calorific value gaseous fuel 66 by a fuel line 68, a control valve 70 and a fuel line 72. The control valves 64 and 70 are conventional electrically operated proportional valves in which the amount of opening is directly proportional to the magnitude of the electrical signal applied thereto.

The system 10 further includes means 74 for selectively controlling the first and second throttle valves 37, 40. The control means 74 includes means 76 for monitoring the engine 12 parameter and means 78 for varying and monitoring the proportion of the high and low calorific value gaseous fuels.

The control means 74 includes a sensor 79 which can be a speed or power sensor and an electronic control mechanism 90 of conventional design which receives input signals in a conventional manner. These signals can be electrical, hydraulic or pneumatic and are converted into standard output signals for use by the control means 74. For example, the sensor

79 is connected to the mechanism 90 with a line 92. The mechanism 90 is also connected to the ignition system 22, the first throttle valve 37, second throttle valve 40, shut-off valves 50, 52 and control valves 64, 70 by conventional feed lines 94, 96, 98, 100, 102, 104, 106, respectively.

Industrial Applicability

The system 10 is used to provide the gas turbine engine 12 with the ability to burn gaseous fuels having a range of calorific values. The gas turbine engine 12 is first started and brought up to rated speed on only the high calorific value gaseous fuel. For example, the control valve 64 is opened to a maximum position, the shut-off valve 50 is opened to a maximum position and the throttle valve 37 is slightly opened. High calorific value gaseous fuel flows from the source of high calorific value gaseous fuel 60 through the connecting line 65, valve 64, line 62, mixing chamber 44, line 54, shut-off valve 50, line 46, throttle valve 37, and line 38 into the first fuel passage 28 of the injector 26, through orifices 30 and into the combustion chamber 20. Air from the air supply system 18 is mixed with the fuel, the ignition system 22 is activated and the engine 12 is started and allowed to accelerate in a conventional manner. Thereafter when the engine is operational at a preestablished operating parameter, approximately 25%-30% of the rated kW output power, the low calorific value gaseous fuel is allowed to mix with the high calorific value gaseous fuel by opening the control valve 70. More specifically in this embodiment as the low calorific value gaseous fuel is mixed with the high calorific value gaseous fuel, the BTU content of the mixed fuel is reduced, the throttle valve 37 opens further to pass the increased mass/volume of fuel demanded by the engine 12 and the fuel pressure at the injector 26 increases. Any further reduction in BTU content is similarly accompanied by further opening of the throttle valve 37 and further increase in fuel pressure at the fuel injector 26. If this process were allowed to continue, the fuel pressure at the injector, due to the increased mass/volume required by the decreasing BTU content of the fuel, will become unacceptably high. To avoid this, at a pre-established level of BTU content of the mixed fuel as determined by relative position of control valves 64, 70, before the fuel pressure at injector 26 becomes excessive, control valve 52 is opened, thus allowing the mixed fuel to flow additionally through the second fuel supply passage 33. With the opening of the second fuel supply passage 33, there is a sudden increase in the mass/volume of fuel flow to the engine 12, the fuel pressure at the injector inlet is considerably reduced and the throttle valves 37, 40 are repositioned towards the closed position to meet the engine fuel requirements. Any further decrease in BTU content is handled by further simultaneous

opening of the throttle valves 37, 40, resulting in increased fuel pressure at the injector inlet. Thus we see that the introduction of the fuel into the second fuel supply passage 33 has considerably widened the operational range of the engine on low BTU fuels. Simultaneous with the opening of the second fuel supply passage 33, the minimum stops of throttle valves 37, 40 are automatically adjusted in accordance with the BTU content of the mixed gas, to prevent the engine 12 from overspeeding in case of a sudden loss of load.

As an alternative to utilizing the relative position of the control valves 64, 70, the relative position of the throttle valve 37 and a signal from the engine sensor 79 together with the ambient temperature and pressure of the air entering the compressor 14 may be used as a preestablished parameter for opening the shut off valve 52 starting the supply of fuel to the second fuel supply passage 33.

Thus the method of burning gaseous fuels having a range of calorific values in the combustion chamber 20 of the gas turbine engine 12 comprises the steps of starting the engine 12 by injecting only the high calorific value gaseous fuel through the fuel injector 26 into the combustion chamber 20 through the first fuel supply passage 28, monitoring an operating parameter of the engine 12 to determine when the first preestablished operating parameter of the engine 12 has been established; mixing the low calorific value gaseous fuel with the high calorific value gaseous fuel in the mixing chamber 44 when the preestablished operating parameter of the engine 12 is established with the mixing step including the steps of decreasing the quantity of high calorific value gaseous fuel and increasing the quantity of low calorific value gaseous fuel, controllably throttling the mixture of high and low calorific value gaseous fuel through the first fuel supply passage 26 and the second fuel supply passage 33, and stopping the flow of high calorific value gaseous fuel and thereafter operating the engine on only the low calorific value gaseous fuel. The mixing of the low calorific value gaseous fuel with the high calorific value gaseous fuel in the mixing chamber further includes monitoring the position of the control valves 64, 70 to determine when a preestablished heating value of the mixed fuel has been established. Additionally, supplying the fuel to the second fuel supply passage 33 by opening the shut off valve 52 prevents excessive fuel pressure at the fuel injector inlet.

With the invention as disclosed above, the system 10 for burning gaseous fuels having a range of calorific values has overcome the problem of injecting two different fuel through two separate passages or ports into the combustion chamber by providing the mixing chamber 44 in which high and low calorific value gaseous fuels are mixed prior to injection into the combustion chamber 20 through the first and second fuel supply passage 28, 33 in a single injector 26

into the combustion chamber 20. Additionally, excessive fuel pressure at the fuel injector inlet when running on low BTU fuel has been avoided by use of the second fuel supply passage 33. The simplicity of this system has provided low cost and simple structural components. The problem of starting a gas turbine engine 12 when the main source of fuel is a low calorific gaseous fuel has been eliminated by starting on only high calorific value gaseous fuel, mixing the high and low calorific value gaseous fuel in a mixing chamber 44 during an interim change-over phase and subsequently operating the gas turbine engine on only low calorific value gaseous fuel after the mixing operation. The subject system 10 is capable of burning two different calorific value gaseous fuels 60,66 in any proportions by mixing the low and high calorific value fuels outside the combustion chamber. Excessive fuel injector pressure drop or combustion driven oscillations caused by insufficient fuel injector 26 pressure drop has been overcome by providing two separate fuel passages 28,33 in the fuel injector 26; passage 33 can be switched on or off, as required, to maintain proper fuel injector pressure drop.

Claims

1. A gas turbine engine system (10) comprising at least one fuel injector located in a combustion chamber (20) of a gas turbine engine (12) and having a first fuel supply passage (28) opening at its downstream end into the combustion chamber (20); a first throttle valve (37) controlling flow through the first fuel supply passage (28); a chamber (44) connected to the upstream end of the first fuel supply passage (28); a first control valve (64) interconnecting the chamber (44), in use, with a source of high calorific value gaseous fuel; a second control valve (70) interconnecting the chamber (44), in use, with a source of low calorific value gaseous fuel; and means (74) programmed to control the first throttle valve (37) and the first and second control valves (64,70) in response to a monitoring of an engine parameter so that upon initial start up of the engine, only high calorific value gaseous fuel is supplied to the combustion chamber, and during eventual running only low calorific value gaseous fuel is supplied to the combustion chamber; characterised by a second fuel supply passage (33) connected at its upstream end to the chamber (44) and opening at its downstream end into the combustion chamber (20); by a second throttle valve (40) controlling flow through the second fuel supply passage (33); by the programmed means (74) also controlling the second throttle valve (40) such that the high calorific value gaseous fuel which is supplied alone to the combustion chamber during the initial start up is supplied through only one of the passages (28,33), and the low calorific value gaseous fuel which is supplied

alone to the combustion chamber during the eventual running is supplied through both of the passages (28,33); and in that the first fuel supply passage (28) of the injector (26) is centrally located and includes a plurality of outwardly directed orifices (30) each of which has a preestablished flow area, and the second fuel supply passage (33) of the injector (26) is coaxially located with respect to the first passage (28) and has a plurality of outwardly directed orifices (34) each of which has a preestablished flow area.

2. A system according to claim 1, wherein the engine parameter is power and the control means (74) includes a power sensor (79).

3. A system according to claim 1 or claim 2, wherein the control means (74) is programmed so that, between the initial start up and eventual running, the proportion of high calorific value fuel is gradually decreased and the proportion of low calorific fuel is gradually increased.

4. A system according to any one of the preceding claims, wherein the control means (74) includes means (78) for monitoring the proportion of the high and low calorific value gaseous fuels entering the chamber (44).

6. A system according to any one of the preceding claims, wherein the combined flow area of the orifices (30) of the first fuel supply passage (28) and the combined flow area of the orifices (34) of the second fuel supply passage (33) are substantially equal.

6. A system according to any one of claims 1 to 4, wherein the combined flow area of the orifices (30) of the first fuel supply passage (28) and the combined flow area of the orifices (34) of the second fuel supply passages (33) are not equal.

7. A system according to any one of the preceding claims, wherein the preestablished flow area of some of the orifices (30) of the first passage (28) are different from the preestablished flow area of other orifices (30) of the first passage (28).

8. A system according to any one of the preceding claims, wherein the preestablished flow area of some of the orifices (34) of the second passage (33) are different than the preestablished flow area of other orifices (34) of the second passage (33).

9. A system according to any one of the preceding claims, wherein the orifices (34) of the second passage (33) are arranged in an angular pattern substantially the same as an angular pattern of the orifices (30) of the first passage (28).

10. A system according to any one of the preceding claims, further including at least one shut-off valve (50,52) connected between each of the throttle valves (37,40) and the chamber (44).

Patentansprüche

1. Ein Gasturbinenmaschinensystem (10), wel-



into the combustion chamber 20. Additionally, excessive fuel pressure at the fuel injector inlet when running on low BTU fuel has been avoided by use of the second fuel supply passage 33. The simplicity of this system has provided low cost and simple structural components. The problem of starting a gas turbine engine 12 when the main source of fuel is a low calorific gaseous fuel has been eliminated by starting on only high calorific value gaseous fuel, mixing the high and low calorific value gaseous fuel in a mixing chamber 44 during an interim change-over phase and subsequently operating the gas turbine engine on only low calorific value gaseous fuel after the mixing operation. The subject system 10 is capable of burning two different calorific value gaseous fuels 60,66 in any proportions by mixing the low and high calorific value fuels outside the combustion chamber. Excessive fuel injector pressure drop or combustion driven oscillations caused by insufficient fuel injector 26 pressure drop has been overcome by providing two separate fuel passages 28,33 in the fuel injector 26; passage 33 can be switched on or off, as required, to maintain proper fuel injector pressure drop.

Claims

1. A gas turbine engine system (10) comprising at least one fuel injector located in a combustion chamber (20) of a gas turbine engine (12) and having a first fuel supply passage (28) opening at its downstream end into the combustion chamber (20); a first throttle valve (37) controlling flow through the first fuel supply passage (28); a chamber (44) connected to the upstream end of the first fuel supply passage (28); a first control valve (64) interconnecting the chamber (44), in use, with a source of high calorific value gaseous fuel; a second control valve (70) interconnecting the chamber (44), in use, with a source of low calorific value gaseous fuel; and means (74) programmed to control the first throttle valve (37) and the first and second control valves (64,70) in response to a monitoring of an engine parameter so that upon initial start up of the engine, only high calorific value gaseous fuel is supplied to the combustion chamber, and during eventual running only low calorific value gaseous fuel is supplied to the combustion chamber; characterised by a second fuel supply passage (33) connected at its upstream end to the chamber (44) and opening at its downstream end into the combustion chamber (20); by a second throttle valve (40) controlling flow through the second fuel supply passage (33); by the programmed means (74) also controlling the second throttle valve (40) such that the high calorific value gaseous fuel which is supplied alone to the combustion chamber during the initial start up is supplied through only one of the passages (28,33), and the low calorific value gaseous fuel which is supplied

alone to the combustion chamber during the eventual running is supplied through both of the passages (28,33); and in that the first fuel supply passage (28) of the injector (26) is centrally located and includes a plurality of outwardly directed orifices (30) each of which has a preestablished flow area, and the second fuel supply passage (33) of the injector (26) is coaxially located with respect to the first passage (28) and has a plurality of outwardly directed orifices (34) each of which has a preestablished flow area.

2. A system according to claim 1, wherein the engine parameter is power and the control means (74) includes a power sensor (79).

3. A system according to claim 1 or claim 2, wherein the control means (74) is programmed so that, between the initial start up and eventual running, the proportion of high calorific value fuel is gradually decreased and the proportion of low calorific fuel is gradually increased.

4. A system according to any one of the preceding claims, wherein the control means (74) includes means (78) for monitoring the proportion of the high and low calorific value gaseous fuels entering the chamber (44).

5. A system according to any one of the preceding claims, wherein the combined flow area of the orifices (30) of the first fuel supply passage (28) and the combined flow area of the orifices (34) of the second fuel supply passage (33) are substantially equal.

6. A system according to any one of claims 1 to 4, wherein the combined flow area of the orifices (30) of the first fuel supply passage (28) and the combined flow area of the orifices (34) of the second fuel supply passages (33) are not equal.

7. A system according to any one of the preceding claims, wherein the preestablished flow area of some of the orifices (30) of the first passage (28) are different from the preestablished flow area of other orifices (30) of the first passage (28).

8. A system according to any one of the preceding claims, wherein the preestablished flow area of some of the orifices (34) of the second passage (33) are different than the preestablished flow area of other orifices (34) of the second passage (33).

9. A system according to any one of the preceding claims, wherein the orifices (34) of the second passage (33) are arranged in an angular pattern substantially the same as an angular pattern of the orifices (30) of the first passage (28).

10. A system according to any one of the preceding claims, further including at least one shut-off valve (50,52) connected between each of the throttle valves (37,40) and the chamber (44).

Patentansprüche

1. Ein Gasturbinenmaschinensystem (10), wel-



ches folgendes aufweist: mindestens eine Brennstoffeinspritzvorrichtung angeordnet in einer Verbrennungskammer (20) der Gasturbinenmaschine (12) und mit einem ersten Brennstoffversorgungsdurchlaß (28), der sich an seinem stromabwärtsgelegenen Ende in die Verbrennungskammer (20) öffnet; ein erstes Drosselventil (37), welches den Fluß durch den ersten Brennstoffversorgungsdurchlaß (28) steuert; eine Kammer (44) verbunden mit dem stromaufwärtsgelegenen Ende des ersten Brennstoffversorgungsdurchlaßes (28); ein erstes Steuerventil (64), welches im Gebrauch die Kammer (44) mit einer Quelle eines hohen Kalorienwert besitzenden gasförmigen Brennstoffs verbindet; ein zweites Steuerventil (70), welches im Gebrauch die Kammer (44) mit einer Quelle eines niedrigen Kalorienwert besitzenden gasförmigen Brennstoffs verbindet; und Mittel (74) programmiert zur Steuerung des ersten Drosselventils (37) und der ersten und zweiten Steuerventile (64, 70) infolge einer Überwachung eines Maschinenparameters derart, daß beim anfänglichen Starten der Maschine nur gasförmiger Brennstoff mit einem hohen Kalorienwert an die Verbrennungskammer geliefert wird, und daß während des schließlichen Laufens nur gasförmiger Brennstoff mit einem niedrigen Kalorienwert an die Verbrennungskammer geliefert wird; gekennzeichnet durch: einen zweiten Brennstoffversorgungsdurchlaß (33) verbunden an seinem stromaufwärtsgelegenen Ende mit der Kammer (44) und sich an seinem stromabwärts gelegenen Ende in die Verbrennungskammer (20) öffnend; ein zweites Drosselventil (40), welches den Fluß durch den zweiten Brennstoffversorgungsdurchlaß (33) steuert; wobei die programmierten Mittel (74) auch das zweite Drosselventil (40) derart steuern, daß der einen hohen Kalorienwert besitzende gasförmige Brennstoff, der allein an die Verbrennungskammer während des anfänglichen Startens geliefert wird nur durch eine der Durchlässe (28, 33) geliefert wird, und daß der einen niedrigen Kalorienwert besitzende gasförmige Brennstoff, der allein zu der Verbrennungskammer während des schließlichen Laufens durch die beiden Durchlässe (28, 33) geliefert wird; und ferner dadurch gekennzeichnet, daß der erste Brennstoffversorgungsdurchlaß (28) der Einspritzvorrichtung (26) mittig angeordnet ist und eine Vielzahl von nach außen gerichteten Zumeßöffnungen (30) aufweist, deren jede eine vorher festgelegte Strömungsfläche besitzt, und wobei der zweite Brennstoffversorgungsdurchlaß (33) der Einspritzvorrichtung (26) koaxial angeordnet ist bezüglich des ersten Durchlaßes (28) und eine Vielzahl von nach außen gerichteten Zumeßöffnungen (34) besitzt, deren jede eine vorher festgelegte Strömungsfläche aufweist.

2. System nach Anspruch 1, wobei der Maschinenparameter die Leistung ist, und wobei die Steuermittel (74) einen Leistungsfühler (79) aufweisen.

3. System nach Anspruch 1 oder 2, wobei die

Steuermittel (74) derart programmiert sind, daß zwischen dem anfänglichen Starten und dem schließlichen Laufen die Proportion des einen hohen Kalorienwert besitzenden Brennstoffs allmählich verringert wird und die Proportion des einen niedrigen Kalorienwert besitzenden Brennstoffs allmählich erhöht wird.

4. System nach einem der vorhergehenden Ansprüche, wobei die Steuermittel (74) Mittel (78) aufweisen, um die Proportion der den hohen und niedrigen Kalorienwert besitzenden gasförmigen Brennstoffe, die in die Kammer (44) eintreten zu überwachen.

6. System nach einem der vorhergehenden Ansprüche, wobei die kombinierte Strömungsfläche der Zumeßöffnungen (30) des ersten Brennstoffversorgungsdurchlaßes (28) und die kombinierte Strömungsfläche der Zumeßöffnungen (34) des zweiten Brennstoffversorgungsdurchlaßes (33) im wesentlichen gleich sind.

6. System nach einem der Ansprüche 1 bis 4, wobei die kombinierte Strömungsfläche der Zumeßöffnungen (30) des ersten Brennstoffversorgungsdurchlaßes (28) und die kombinierte Strömungsfläche der Zumeßöffnungen (34) der zweiten Brennstoffversorgungsdurchlässe (33) nicht gleich sind.

7. System nach einem der vorhergehenden Ansprüche, wobei die vorher festgelegte Strömungsfläche einiger der Zumeßöffnungen (30) des ersten Durchlaßes (28) sich unterscheiden von der vorher festgelegten Strömungsfläche der anderen Zumeßöffnungen (30) des ersten Durchlaßes (28).

8. System nach einem der vorhergehenden Ansprüche, wobei die vorher festgelegte Strömungsfläche einiger der Zumeßöffnungen (34) des zweiten Durchlaßes (33) unterschiedlich sind von der vorher festgelegten Strömungsfläche der anderen Zumeßöffnungen (34) des zweiten Durchlaßes (33).

9. System nach einem der vorhergehenden Ansprüche, wobei die Zumeßöffnungen (34) des zweiten Durchlaßes (33) in einem Winkelmuster angeordnet sind, welches im wesentlichen das gleiche ist wie ein Winkelmuster der Zumeßöffnungen des ersten Durchlaßes (28).

10. System nach einem der vorhergehenden Ansprüche, wobei ferner mindestens ein Abschaltventil (50, 52) zwischen die Drosselventile (37, 40) und die Kammer (44) geschaltet ist.

Revendications

1. Système de turbomoteur à gaz (10) comprenant au moins un injecteur de combustible situé dans une chambre de combustion (20) d'un turbomoteur à gaz (12) et ayant un premier passage d'alimentation en combustible (28) débouchant au niveau de son extrémité aval dans la chambre de combustion (20);



une première soupape d'étranglement (37) régulant l'écoulement à travers le premier passage d'alimentation en combustible (28); une chambre (44) reliée à l'extrémité amont du premier passage d'alimentation en combustible (28); une première soupape de commande (64) reliant la chambre (44), en fonctionnement, à une source de combustible gazeux à haut pouvoir calorifique; une seconde soupape de commande (70) reliant la chambre (44), en fonctionnement, à une source de combustible gazeux à faible pouvoir calorifique; et des moyens (74) programmés pour commander la première soupape d'étranglement (37) et les première et seconde soupapes de commande (64,70) en réponse à un contrôle d'un paramètre du moteur de sorte que, lors de la mise en route initiale du moteur, seul du combustible gazeux à haut pouvoir calorifique est fourni à la chambre de combustion et, pendant le fonctionnement ultérieur, seul du combustible gazeux à faible pouvoir calorifique est fourni à la chambre de combustion; caractérisé par un second passage d'alimentation en combustible (33) relié, au niveau de son extrémité amont, à la chambre (44) et débouchant, au niveau de son extrémité aval, dans la chambre de combustion (20); par une seconde soupape d'étranglement (40) régulant l'écoulement à travers le second passage d'alimentation en combustible (33); par les moyens programmés (74) commandant également la seconde soupape d'étranglement (40) de sorte que le combustible gazeux à haut pouvoir calorifique, qui est fourni seul à la chambre de combustion au cours de la mise en route initiale, soit fourni à travers un seul des passages (28,33), et que le combustible gazeux à faible pouvoir calorifique, qui est fourni seul à la chambre de combustion au cours du fonctionnement ultérieur, soit fourni à travers les deux passages (28,33); et en ce que le premier passage d'alimentation en combustible (28) de l'injecteur (26) est situé en un emplacement central et comprend une multiplicité d'orifices dirigés vers l'extérieur (30) dont chacun a une section d'écoulement pré-établie, et le second passage d'alimentation en combustible (33) de l'injecteur (26) est disposé coaxialement par rapport au premier passage (28) et présente une multiplicité d'orifices dirigées vers l'extérieur (34) dont chacun a une section d'écoulement pré-établie.

2. Système selon la revendication 1, dans lequel le paramètre du moteur est l'énergie et les moyens de commande (74) comprennent un détecteur d'énergie (79).

3. Système selon la revendication 1 ou la revendication 2, dans lequel les moyens de commande (74) sont programmés de sorte que, entre la mise en route initiale et le fonctionnement ultérieur, la proportion de combustible à haut pouvoir calorifique soit diminuée progressivement et la proportion de combustible à faible pouvoir calorifique soit augmentée progressivement.

4. Système selon l'une quelconque des revendications précédentes, dans lequel les moyens de commande (74) comprennent des moyens (78) destinés à contrôler la proportion de combustibles gazeux à haut et à faible pouvoir calorifique pénétrant dans la chambre (44).

5. Système selon l'une quelconque des revendications précédentes, dans lequel la section d'écoulement combinée des orifices (30) du premier passage d'alimentation en combustible (28) et la section d'écoulement combinée des orifices (34) du second passage d'alimentation en combustible (33) sont sensiblement égales.

6. Système selon l'une quelconque des revendications 1 à 4, dans lequel la section d'écoulement combinée des orifices (30) du premier passage d'alimentation en combustible (28) et la section d'écoulement combinée des orifices (34) du second passage d'alimentation en combustible (33) ne sont pas égales.

7. Système selon l'une quelconque des revendications précédentes, dans lequel la section d'écoulement pré-établie de certains des orifices (30) du premier passage (28) est différente de la section d'écoulement pré-établie d'autres orifices (30) du premier passage (28).

8. Système selon l'une quelconque des revendications précédentes, dans lequel la section d'écoulement pré-établie de certains des orifices (34) du second passage (33) est différente de la section d'écoulement pré-établie d'autres orifices (34) du second passage (33).

9. Système selon l'une quelconque des revendications précédentes, dans lequel les orifices (34) du second passage (33) sont disposés suivant une configuration angulaire sensiblement identique à la configuration angulaire des orifices (30) du premier passage (28).

10. Système selon l'une quelconque des revendications précédentes, comprenant en outre au moins une soupape d'arrêt (50,52) reliée entre chacune des soupapes d'étranglement (37,40) et la chambre (44).