June 1, 1971 E. R. FENSKE ET AL 3,582,281

DETERMINATION AND CONTROL OF A COMPOSITION CHARACTERISTIC WHILE BLENDING A MULTI-COMPONENT COMBUSTIBLE FLUID

Filed May 15, 1970 2 Sheets-Sheet 1

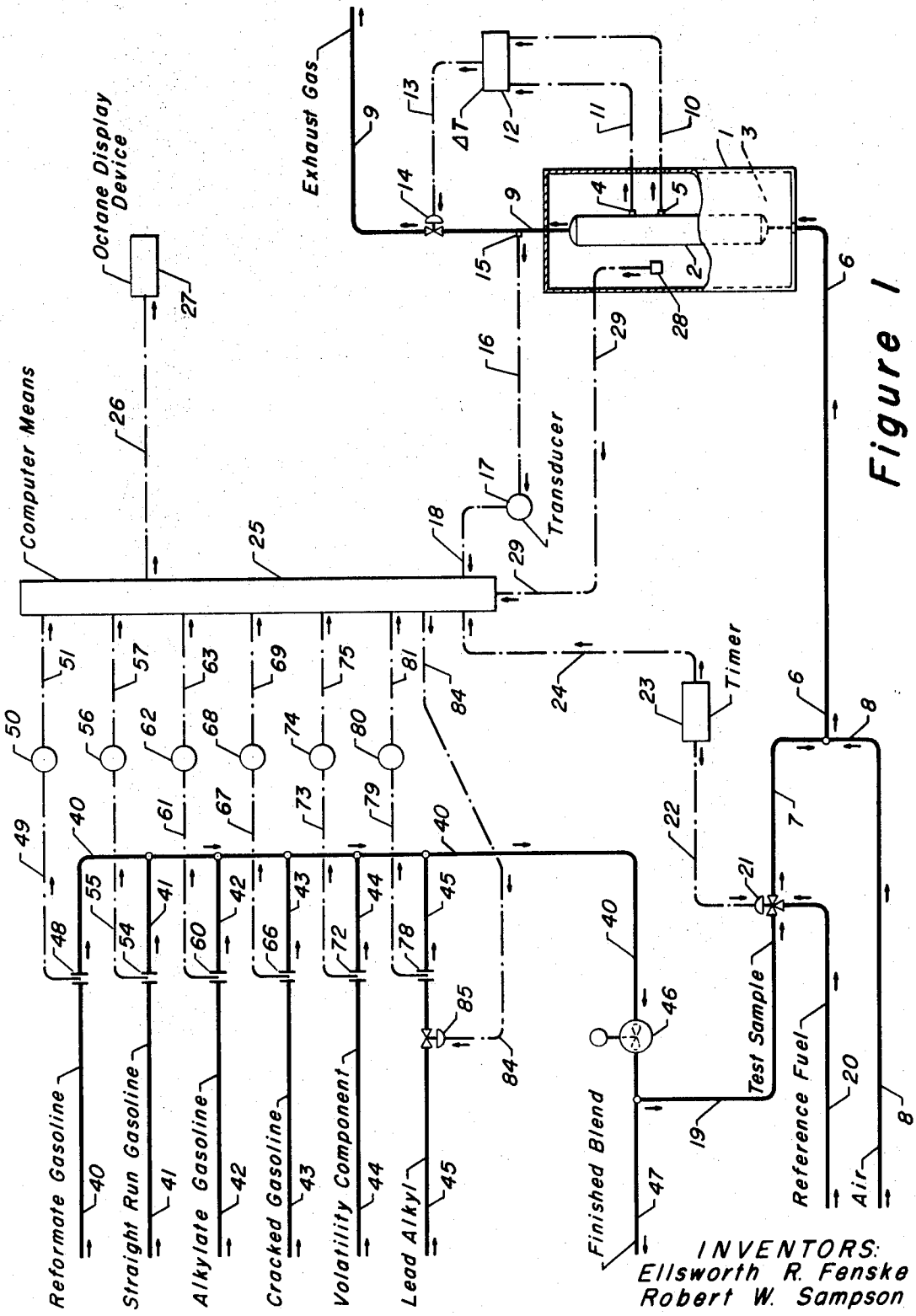


Figure 1

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Filed May 15, 1970 2 Sheets-Sheet 2

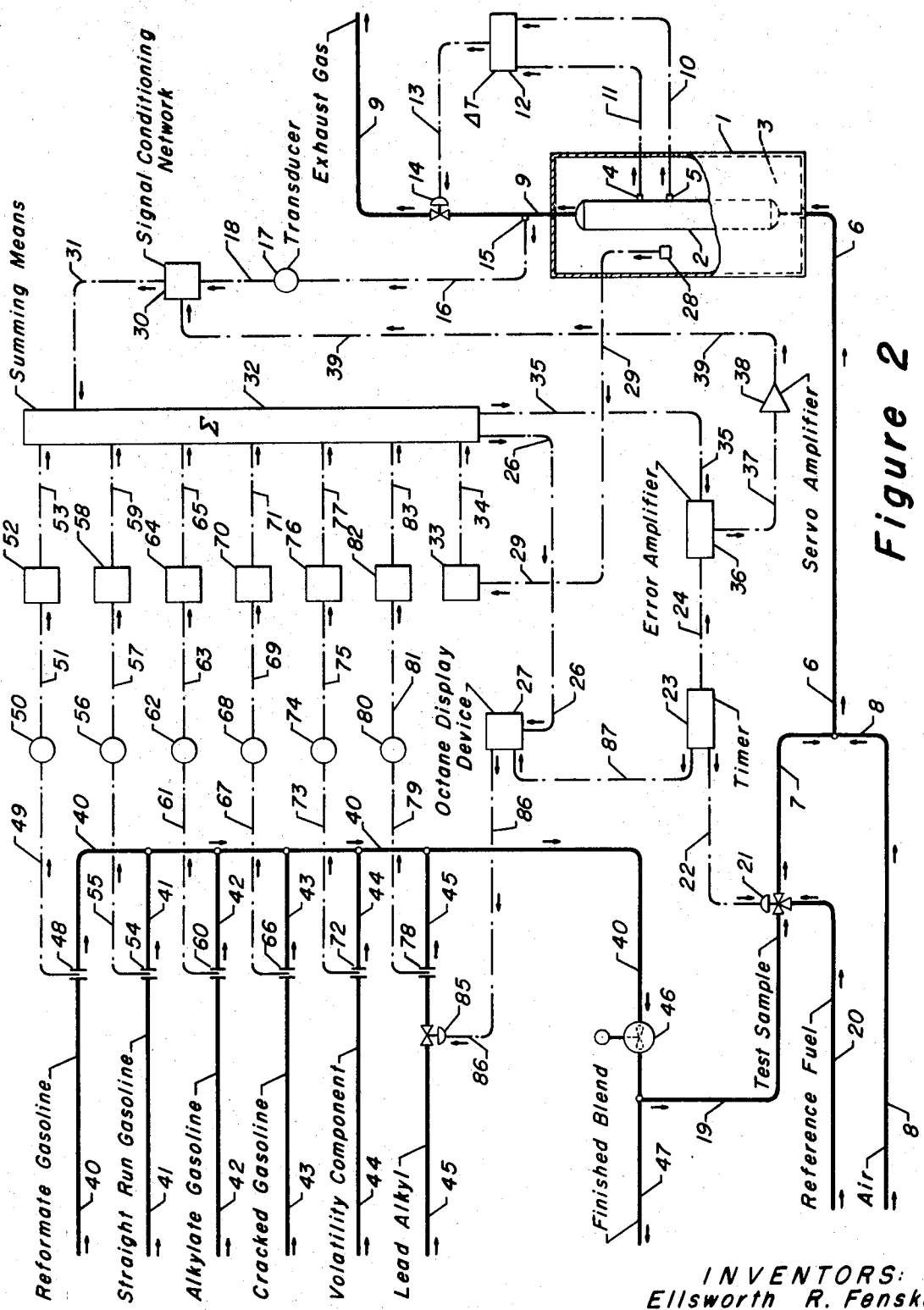


Figure 2

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DETERMINATION AND CONTROL OF A COMPOSITION CHARACTERISTIC WHILE BLENDING A MULTICOMPONENT COMBUSTIBLE FLUID

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ABSTRACT OF THE DISCLOSURE

In a blending process wherein a plurality of component fluids is continuously introduced into a blending zone producing a combustible fluid mixture, a method and apparatus for continuously determining and controlling a composition characteristic of the combustible fluid mixture, such as the octane rating of a gasoline blend. A sample of the fluid mixture is oxidized in an analyzer comprising a stabilized cool flame generator with a servo-positioned flame front. The position of the flame front is automatically detected and utilized to manipulate a combustion parameter in a manner sufficient to immobilize the flame front regardless of fluctuations in composition characteristic of the fluid sample. Changes in combustion parameter which are required to immobilize the flame front are correlatable with changes in composition characteristic, and means is provided for sensing the manipulated combustion parameter and developing therefrom a condition output signal which is functionally representative of and correlatable with composition characteristic. A suitable reference fuel of known composition characteristic is periodically passed to the analyzer in place of the fluid sample, and means is provided to compensate the condition output signal for any deviation in the signal between apparent reference fuel signal and a signal corresponding to the true known value of reference fuel composition characteristic. Means is also provided for adjusting the condition output signal responsive to analyzer temperature fluctuations and component changes in the blending zone. Thus, the condition output signal is compensated for combustion effects not indicative of composition characteristic, and is thereby rendered functionally representative of and correlatable with the true composition characteristic of the fluid sample of blended product.

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for determining a composition characteristic of a combustible fluid mixture. It further relates to an improvement in the method and apparatus for determining a composition characteristic of a combustible fluid mixture utilizing a stabilized cool flame generator with a servo-positioned flame front. It particularly relates to an improvement in the method and apparatus for determining a composition characteristic of a combustible fluid mixture produced by blending a plurality of component fluids, and for controlling the blending process to produce a mixture having a constant predetermined value of composition characteristic. It more specifically relates to an improved method and apparatus for determining the octane number of a gasoline blend produced from a plurality of blending components, and for controlling the blending operation to produce a gasoline product of constant octane rating.

Those skilled in the art are familiar with the phenomenon of cool flame generation. Briefly, when a mixture of hydrocarbon vapor and oxygen at a composition within the explosion limit is held at conditions of pressure and temperature below the normal ignition point, partial oxidation reactions occur which generally result in the formation of by-products, such as aldehydes, carbon monoxide, and other partially oxidized combustion products. These products are apparently produced via a chain reaction which, it is believed, also produces ions which then in some manner continue the reaction chain. If such a mixture of hydrocarbon vapor and oxygen is isolated and compressed and/or heated so that these chain reactions proceed at significant reaction rates, then "cool flames" are observed within the chamber. The cool flames are characterized as light emissions accompanied by the evolution of relatively minor amounts of heat.

Implicit in this definition is the fact that the phenomenon of cool flame generation is short of total combustion and short of total ignition and explosion. The work of Barusch and Payne in "Industrial and Engineering Chemistry," volume 43, pages 2329–2332, 1951, describes in detail the results which can be obtained from continuous or stabilized cool flames.

Basically, the utilization of this phenomenon in the practice of the present invention is one of manipulating a combustion parameter in a manner sufficient to immobilize the cool flame relative to one end of the combustion chamber. The manipulated combustion parameter is sensed and utilized to develop a condition output signal which is functionally representative of and correlatable with the composition of the fluid being oxidized in the combustion chamber.

A more complete explanation and description of the basic apparatus and basic method for detecting composition characteristics utilizing cool flames is contained in U.S. Pat. 3,463,613, issued on Aug. 26, 1969, to E. R. Fenske and J. H. McLaughlin. The contents of said patent are incorporated herein by reference so that a greater detailed discussion need not be presented in this application. Those skilled in the art are referred directly to the entire teaching contained in said patent for additional and specific details as to the construction of a preferred embodiment of the basic apparatus and method of operation thereof. As will be more fully developed hereinafter, the present invention describes and claims an improvement in the basic method and apparatus disclosed and claimed in said patent.

One of the difficulties encountered in the method and apparatus disclosed in U.S. Pat. 3,463,612, is concerned with calibration of the apparatus to compensate for combustion effects which are not indicative of composition characteristics of the fluid being analyzed.

For example, it has been found that when the apparatus disclosed in the U.S. Pat. 3,463,613 has been operated on a combustible fluid for a substantial length of time, the apparatus ocassionally begins to produce condition output signals which reflect "aging" of the apparatus. This aging may be introduced due to plugging of preheaters or plugging of a flow diffusor element which is mounted in the interior of the combustion chamber a short distance above the combustion nozzle. Additionally, it has been found that where a leaded gasoline is the combustible fluid being analyzed, deposits of lead oxides within the combustion chamber may introduce combustion effects which are not indicative of the composition characteristic of the gasoline fraction being burned within the chamber.

It has further been discovered that fluctuations in the oxidizer passing into the combustion chamber will introduce combustion effects which will result in a condition output signal containing an error which is not correlatable with the composition characteristics of the fluid being burned within the chamber. For example, the typical oxidizer passing into the combustion chamber is derived from a compressed air system, and the compressed air will contain microscopic quantities of entrained lubricating

oil which have been picked up at the air compressor. Additionally, it has been found upon occasion that a shift in the wind direction will introduce flue gas from nearby furnace stacks so that the air compressor is periodically picking up air containing combustion products. This results in an oxidizer passing into the combustion chamber of the instant analyzer which is not only deficient in oxygen, but which also may contain a considerable proportion of further combustible material such as the carbon monoxide and the unburned hydrocarbons contained in the flue gas.

Furthermore, it is typical in the art to place the combustion analyzer of the instant invention in a local mounting near the product stream which is to be analyzed, and to transmit condition output signals therefrom to the control house in the refinery or chemical plant wherein the apparatus is utilized for monitoring or controlling service. Consequently, the combustion chamber of the apparatus is located out-of-door and is subject to thermal fluctuations due to atmospheric conditions. These fluctuations in atmosperic conditions produce thermal effects within the combustion chamber which are not indicative of the composition characteristic of the fluid being analyzed therein.

Additionally, it is known that the specific nature of the correlation between the condition output signal generated by the apparatus and the actual value of composition characteristic is a function of the actual molecular composition of the fluid being analyzed by the combustion producing the cool flame. For example, where the fluid being analyzed comprises a hydrocarbon mixture, the correlation between the condition output signal and the composition characteristic will be a function of the hydrocarbon fluid composition and the carbon number of the hydrocarbon constituents present therein. Furthermore, the correlation is further influenced by the presence or absence of paraffins, isoparaffins, olefins, diolefins, polyolefins, aromatics, long-chain substituted aromatics, polynuclear aromatics, etc. Thus, as normally operated in commercial practice, the apparatus of the present invention is capable of continuously analyzing a particular type of hydrocarbon blend or sample fluid, and relatively small deviations due to fluctuations in molecular species can be accounted for.

However, where the apparatus of the present invention is utilized in a blending process wherein a plurality of component fluids are blended together in varying proportions to produce fluid mixtures of varying composition characteristics, wide fluctuation in the molecular species contained within the final mixture may result in combustion effects which are not indicative of the true composition characteristic of the resulting blend. For example, in a typical gasoline blending system, blends will be made to produce various qualities of gasoline having different octane ratings and different volatility characteristics from season to season, and even from day to day or hour to hour. Thus where a 98 octane rating is desired, the gasoline blend may be high in reformate gasoline and thereby highly aromatic, and it will typically contain some anti-knock agent such as tetraethyl lead or tetramethyl lead. On the other hand, when a 98 octane rating is desired but reformate gasoline is not always available in a sufficient quantity, the resulting blend may periodically be higher in paraffinic constituents such as straight-run gasoline, and it will then be higher in anti-knock agents. Similarly, at some periods in the blending operation the gasoline blend may contain a substantial amount of isoparaffinic gasoline, such as motor alkylate, and at other periods it may contain none. Furtheromer, the apparatus of the present invention may be utilized in making more than one gasoline blend during a given day, each blend meeting a different specification, and composition effects from blend to blend may introduce deviations in the condition output signal developed by the apparatus which are not actually due to changes in composition characteristic such as octane rating, but which are due to changes in the component distribution of molecular species within the blend sampling being burned to produce the stabilized cool flame.

SUMMARY OF THE INVENTION

Accordingly it is an object of the present invention to provide an improved method and apparatus for analyzing a combustible fluid mixture.

It is another object of the present invention to provide an improved method and apparatus for determining a composition characteristic of a combustible fluid mixture in a stabilized cool flame generator with a servo-positioned flame front.

It is a further object of the present invention to provide a method and apparatus for determining a composition characteristic of a combustible fluid mixture produced by blending a plurality of component fluids, and for controlling the blending process to produce the mixture at a constant predetermined value of composition characteristic.

It is a particular object of the present invention to provide an improved method and apparatus for determining the octane rating of a gasoline blend produced from a plurality of blending components, and for controlling the blending operation to produce a gasoline blend having a constant octane rating.

Therefore in its method aspects, a broad embodiment of the present invention provides a method for detecting a composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids which comprises: (a) introducing a sample stream of said fluid mixture and a stream of oxygen-containing gas into one end of a combustion zone including an induction section maintained at elevated temperature; (b) partially oxidizing said sample stream in said combustion zone under conditions sufficient to generate and maintain therein, a cool flame characterized by a relatively narrow well-defined flame front spaced from said one end; (c) sensing the position of said flame front relative to said one end, and developing therefrom a control signal; (d) utilizing said control signal to adjust a combustion parameter selected from the group consisting of combustion zone pressure, induction section temperature, sample stream flow rate, and oxygen-containing gas stream flow rate, in a manner sufficient to immobilize said flame front relative to said one end regardless of fluctuations in the composition characteristic of said sample stream; (e) sensing the adjusted parameter and developing a parameter signal responsive to changes in said composition characteristic; (f) developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; and, (g) passing said parameter signal and said component signal into signal conditioning means, and producing therefrom a condition output signal functionally representative of the composition characteristic of said sample stream of fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture.

Furthermore, in its method aspects, an additional broad embodiment of the present invention provides a method for detecting a composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids which comprises: (a) introducing a sample stream of said fluid mixture and a stream of oxygen-containing gas into one end of a combustion zone including an induction section maintained at elevated temperature; (b) partially oxidizing said sample stream in said combustion zone under conditions sufficient to generate and maintain therein, a cool flame characterized by a relatively narrow well-defined flame front spaced from said one end; (c) sensing the position of said flame front relative to said one end, and developing therefrom a control signal; (d) utilizing said control signal to adjust

a combustion parameter selected from the group consisting of combustion zone pressure, induction section temperature, sample stream flow rate, and oxygen-containing gas stream flow rate, in a manner sufficient to immobilize said flame front relative to said one end regardless of fluctuations in the composition characteristic of said sample stream; (e) sensing the adjusted parameter and developing a first parameter signal responsive to changes in said composition characteristic; (f) developing a first component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; (g) passing said first parameter signal and said first component signal into signal conditioning means, and producing therefrom a first condition output signal functionally representative of the composition characteristic of said sample stream of fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture; (h) periodically isolating said sample stream from said combustion zone, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said zone in a manner sufficient to continue the generation of said immobilized flame front, (i) sensing the adjusted parameter during the period of isolation and passing a second parameter signal into said signal conditioning means, said second parameter signal being functionally representative of the apparent composition characteristic of said reference fuel; (j) comparing said second parameter signal with a reference value of parameter signal functionally corresponding to the actual known value of composition characteristic of said reference fuel; (k) adjusting said signal conditioning means in a manner sufficient to produce a second condition output signal which is compensated to reflect the elimination of the difference between said second parameter signal and said reference value parameter signal, and which is thereby functionally representative of the actual known composition characteristic of said reference fuel; and, (l) periodically isolating said reference fuel stream from said combustion zone while retaining the signal conditioning adjustment of step (k), and simultaneously passing said fluid sample stream into said zone in a manner sufficient to maintain said flame front, whereby said signal conditioning means receives a third parameter signal and a second component signal representative of the relative amount of said first component fluid, and said signal conditioning means therefrom develops a third condition output signal compensated for combustion effects not indicative of composition characteristic, and said third condition output signal is thereby functionally representative of the actual composition characteristic of said sample stream.

In addition, in its apparatus aspects, a broad embodiment of the present invention provides a composition analyzer for detecting a composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids, which comprises in combination: (a) a combustion chamber, including an induction section; (b) means for generating within said combustion chamber, a cool flame characterized by a relatively narrow well-defined flame front, utilizing as fuel therefor said combustible fluid mixture to be analyzed, said generating means including means passing a stream of said fluid mixture and a stream of oxidizer into said combustion chamber; (c) means sensing the physical position of said flame front within said combustion chamber; (d) control means coupled to said position sensing means, and adapted to adjust a combustion parameter selected from the group consisting of combustion pressure, induction section temperatrue, fluid stream flow rate, and oxidizer stream flow rate in a manner sufficient to immobilize said flame front in a constant physical position relative to said combustion chamber; (e) means sensing the adjusted parameter and developing a parameter output signal which is functionally representative of the composition characteristic of said fluid stream; (f) means developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; and, (g) signal conditioning means receiving said parameter output signal and said component signal, and producing therefrom a condition output signal which is functionally representative of and correlatable with said composition characteristic of the combustible fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture.

Still further, in its apparatus aspects, a broad embodiment of the present invention provides a composition analyzer for detecting a composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids which comprises in combination: (a) a combustion chamber, including an induction section; (b) means for generating within said combustion chamber, a cool flame characterized by a relatively narrow well-defined flame front, utilizing as fuel therefor said combustible fluid mixture to be analyzed, said generating means including means passing a stream of said fluid mixture and a stream of oxidizer into said combustion chamber; (c) means sensing the physical position of said flame front within said combustion chamber; (d) control means coupled to said position sensing means, and adapted to adjust a combustion parameter selected from the group consisting of combustion pressure, induction section temperature, fluid stream flow rate, and oxidizer stream flow rate in a manner sufficient to immobilize said flame front in a constant physical position relative to said combustion chamber; (e) means sensing the adjusted parameter and developing a parameter output signal which is functionally representative of the composition characteristic of said fluid stream; (f) means developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; (g) signal conditioning means receiving said parameter output signal and said component signal; (h) condition signal generating means within said signal conditioning means producing a condition output signal functionally representative of said composition characteristic; (i) means periodically isolating said fluid stream from said flame generating means, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said flame generating means in a manner sufficient to continue the generation of said immobilized flame front; (j) means passing to said signal conditioning means, a timing signal indicative of the passage of reference fuel to said flame generating means; (k) comparison means within said signal conditioning means, responsive to said timing signal, adapted to compare the condition output signal generated due to reference fuel flame front with a reference value signal functionally corresponding to the actual known value of composition characteristic of said reference fuel, and therefrom developing a comparison signal; (l) adjusting means within said signal conditioning means, responsive to said comparison signal, and adapted to adjust said condition signal generating means to compensate for deviations between the condition output signal generated due to reference fuel flame front and said reference value signal; and, (m) means for retaining said adjustment to said condition signal generating means when said isolation period is ended and said fluid stream is returned to said flame generating means in place of said reference fuel, whereby the condition output signal generated by said fluid stream flame front is compensated for combustion effects not indicative of composition characteristic, and said condition output signal is thereby functionally representative of and correlatable with the actual com-

position characteristic of said combustible fluid mixture.

In essence therefore, the present invention provides a method and apparatus which determines the composition characteristic of a combustible fluid mixture by oxidizing the fluid in a stabilized cool flame generator with a servo-position flame front to develop a condition output signal which is compensated for fluctuations in the relative proportion of component fluids passing into the blending system which produces the mixture, and which is periodically recalibrated to compensate for deviations in condition output signal generated by a reference fuel of known composition characteristic. Furthermore as shall be set forth hereinafter, the condition output signal is compensated for temperature fluctuations occurring within the inventive apparatus. In this manner then, the condition output signal is continuously compensated for combustion effects which are not indicative of composition characteristic, and the condition output signal is thereby rendered functionally representative of and correlatable with the true composition characteristic of the combustible fluid blend being analyzed. Thus as shall be set forth more fully hereinafter, the apparatus of the present invention is readily adaptable for controlling the blending process to produce a final product having a constant predetermined value of composition characteristic, such as octane number in a gasoline blending operation.

As used herein, the term "composition characteristic" does not refer to a compound by compound analysis of the type presented by instruments such as mass spectrometers or vapor phase chromatographs. Rather, the composition characteristic is represented by a continuous, or substantially continuous, output signal which is responsive to and indicative of the fluid composition, and which is more specifically, empirically correlatable with one or more conventional composition identifications or specifications. For example, when the fluid to be analyzed is a hydrocarbon composition, the composition characteristic which is represented by the condition output signal may be a conventional identification or specification such as the Reid Vapor Pressure, ASTM or Engler distillation, initial boiling point, end boiling point, etc. In particular, when the fluid being analyzed comprises gasoline boiling range hydrocarbon, the composition characteristic which is functionally represented by the condition output signal will typically comprise a knock characteristic such as research octane number or motor octane number.

As used herein, the terms "output signal," "condition output signal" and "parameter signal" are to be construed in their most meaningful sense and include analog signals of all types, such as amplitude-modulated, phase-modulated, or frequency-modulated electrical signal or pressure signals by conventional pneumatic transmission media, as well as digital representations thereof. These terms are further intended to include simple mechanical motion or displacement of a transducer member (whether or not mechanically, electrically, or pneumatically coupled to a physical display means, such as an indicating arm, recorder pin, or digital display board) including by way of illustration, the expansion or contraction of a Bourbon tube, pressure spiral or helix, the displacement of a bellows-flapper, nozzle-diaphragm, or differential transformer-core assembly, the movement of a bimetallic temperature responsive element, the motion of a slider of a self-balancing potentiometer, etc.

The condition output signal may be transmitted without physical display directly to reset a final control unit, such as a diaphragm motor valve or a sub-control loop in a cascade system. More commonly, however, the condition output signal will pass to a readout device which will comprise or will be coupled to an indicating or recording means, the scale or chart of which may be calibrated in terms of the desired identifying composition characteristic of the fluid sample, such as octane number, initial boiling point, 90% boiling point, vapor pressure, and the like.

In the practice of this invention the location of the cool flame front is, preferably, determined by temperature sensing devices, such as a pair of axially spaced thermocouples fixed at a known distance from one end of the combustion zone and at a known and fixed distance from each other, e.g. one (1) inch. As will be more fully developed hereinbelow, the signal developed by the thermocouple means activates appropriate control means for adjusting a combustion zone parameter or condition so as to immobilize the cool flame front at a position generally between the two spaced thermocouples. A most satisfactory combustion condition which can be used as the control means is the combustion zone pressure.

Test samples which can be continuously analyzed by this invention include normally gaseous and normally liquid combustible chemicals. In a particularly preferred embodiment, the test samples comprise hydrocarbon-containing mixtures. These mixtures typically comprise at least one hydrocarbon containing from 1 to about 22 carbon atoms per molecule in admixture with one or more non-hydrocarbons such as hydrogen, nitrogen, carbon monoxide, carbon dioxide, water, and hydrogen sulfide. Alternatively, these mixtures will comprise at least two different hydrocarbons containing from 1 to about 22 carbon atoms per molecule. The upper limit on carbon number is fixed generally by the preferred operational procedure whereby the test sample and the reference fuel sample are vaporized in an air stream under combustion conditions without undergoing any substantial thermal decomposition prior to the oxidation thereof.

Therefore, in the context of the present invention, the terms "combustible fluid mixture" and "combustible fluid" are intended to embody all forms of combustible fluids which are capable of vaporization within the apparatus, and particularly hydrocarbon mixtures in which hydrocarbons predominate, but which may also contain significant amounts of non-hydrocarbon materials. In particular, the hydrocarbon fluids may contain such items as tetraethyl lead, tetramethyl lead, and other known anti-knock compounds for use in motor fuel compositions. In the preferred and practical embodiment of this invention, wherein the determined, composition characteristic is the measurement of octane rating, the feedstocks or test samples of unknown octane number which are chargeable to the apparatus of the present invention include those within the gasoline boiling range produced by blending such component fluids as straight-run gasoline, cracked gasoline, motor alkylate, catalytically reformed gasoline, thermally reformed gasoline, hydrocracker gasoline, etc.

As noted hereinabove, the apparatus of the present invention will be continuously recalibrated and compensated for combustion effects which are not indicative of the composition of the fluid being analyzed or of the composition characteristic being developed as the condition output signal. In order to achieve this compensation in the condition output signal, there is provided means for periodically isolating the blended fluid being tested from the combustion chamber of the apparatus, and for simultaneously introducing therein a sample of a reference fuel. Those skilled in the art are familiar with the procedures for obtaining reference fuels of known composition. Since the reference fuel is being compared to the unknown blended fluid, it is desirable that the hydrocarbon species of the reference fuel be similar to those of the unknown fluid being tested. Thus for example, if the fluid being analyzed is a hydrocarbon comprising a gasoline blend having an octane number of about 95 and consisting primarily of a reformate gasoline, it is particularly desirable, but not essential, that the reference fuel also have an octane rating of about 95 and that it primarily comprise a reformate gasoline.

The oxidizer or oxidizing agent utilized in the apparatus of the present invention is preferably an oxygen-contain-

ing gas, such as air, substantially pure oxygen, etc. or it may be a synthetic blend of oxygen with an inert or equilibrium effecting diluent, such as nitrogen, carbon dioxide or steam.

The generation of the stabilized cool flame is effected under combustion conditions generally including superatmospheric pressure and elevated temperature, although in some cases, it may be desirable to use atmospheric pressure or sub-atmospheric pressure. For example, the pressure may be in the range from about 15 p.s.i.a. to about 165 p.s.i.a. with a maximum flame front temperature in the range of 600° F. to 1000° F. For measuring the composition of a gasoline boiling range fraction it is preferable to employ pressures in the range from 16 p.s.i.a. to 65 p.s.i.a., more preferably, in the range from 16 p.s.i.a. to 30 p.s.i.a., together with an induction zone temperature of from about 550° F. to about 850° F. Control of induction zone temperature can be effected by the amount of preheat imparted to the air or oxidizer stream and to the incoming sample stream, including the test sample and the reference sample. Furthermore, induction zone temperature may be manipulated by adjusting the input of heat from an external source to the combustion zone proper. In any case, the permissible limits within which temperature and pressure may be individually varied without departure from stable operation, even outside of the specific operational limits referred to herein, can be determined by simple experiment for a particular type and quantity of combustible fluid sample.

As previously mentioned, the detection o the position within the combustion chamber for the test sample and for the reference sample is preferably effected by temperature responsive thermoelectrical means, although, other equivalent means can be used. The thermocouple sensing device may be placed within the combustion chambers, as discussed hereinabove, or outside of the combustion chamber, and may be either fixed or may be movable in such a manner as to completely and substantially traverse the length-wise direction of the combustion chamber in order to locate the position of the stabilized cool flame within the combustion chamber.

The output signal from the thermocouple sensing means is fed through signal means to suitable control means such as a motor activated control valve for regulating, perferably, the pressure within the combustion zone. Generally, the output signal from the thermocouple sensing means is not sent to a readout device, such as a strip chart or *x–y* recorder, for to do so would deplete the strength of the signal to such an extent that operational efficiency might be impaired. Preferably, the thermocouple sensing device comprises a pair of axially spaced thermocouple leads which are inserted into thin-walled thermal type pencil wells and may be constructed of any materials known to those skilled in the art, such as for example, iron-constantan. The lead wires from the thermowells are connected to a suitable differential temperature controller. Such controller may be a conventional self-balancing potentionmeter in combination with pneumatic control means. A suitable input span for the controller may be from −5 to +5 milivolts and the output signal thereof transmitted may be a conventional 3–15 p.s.i.a. air signal. This control signal is used, for example, to reset the set point on a back pressure controller or can be used to directly control the pressure within the combustion zone.

The present invention may be more fully understood by now referring to the accompanying drawings.

FIG. 1 comprises a simplified schematic representation of the apparatus for practicing the present invention in a typical gasoline blending system wherein the signal conditioning means is a computer means, which may be an analog computer or a digital computer.

FIG. 2 illustrates a schematic representation of the apparatus for practicing the present invention in a typical gasoline blending system wherein the signal conditioning means comprises an analog or a digital network.

DESCRIPTION OF THE DRAWINGS

With reference now to the accompanying FIG. 1, there is shown the apparatus of the present invention which comprises in combination a canister **1** enclosing a combustion chamber **2**. The canister has means for introducing a heat transfer fluid to surround the combustion chamber so that proper temperature conditions may be maintained within the combustion zone, by controlling temperature in an elevated temperature zone **3** which is confined between the canister **1** and the combustion chamber **2**. The configuration of the apparatus will be similar to that described in the cited U.S. Pat. 3,463,613. Thus the temperature within the elevated temperature zone **3** may be maintained by a constant circulation of a heat transfer fluid from an external source, or by conduction and natural convection of the heat transfer fluid as provided by immersion heaters contained within the canister and within the zone **3**, or heating elements encompassing the canister. If desired, the exterior of the enclosing canister **1** may be encased in one or more layers of insulation, not shown, and typically this will be done since the canister is normally located out-of-doors and exposed to atmospheric conditions. Those skilled in the art being familiar with the teachings presented herein and with the teachings presented in the cited patent will understand the appropriate manner of enclosing the combustion chamber in a suitable canister having appropriate temperature control means and having appropriate thermal insulation in order to minimize the thermal effects of atmospheric conditions.

With reference to the combustion chamber **2**, there is provided temperature sensing means **4** and **5** which are capable of sensing the location of the stabilized cool flame front generated within the combustion chamber by the oxidation of the sample being introduced therein. The combustion chamber **2** is provided with inlet means **6** which introduces a mixture of air, or other oxidizing agent, and a combustible fuel into a burner nozzle, not shown, contained within the lower section of the combustion chamber **2**. The air or oxidizing agent is introduced into the system via line **8** and the combustible fluid is introduced into the system via line **7**. The net combustion products are ultimately discharged from the combustion chamber via line **9**.

The mixture of air and combustible fluid passes into the chamber **2** via line **6** wherein it is ignited due to the elevated temperature. The region of the combustion chamber **2** which is located between the inlet line **6** and the temperature sensing means **5** is known as the induction section. The induction section is defined as that portion of the combustion zone wherein oxidation of the combustible fluid is initiated. Therefore the induction section more particularly comprises that portion of the combustion chamber **2** located between the burner nozzle and the cool flame front which is generated by the combustion.

In a preferred embodiment of the present invention, the apparatus shown in the attached FIG. 1 is utilized to detect the octane number of a gasoline blend of unknown composition. The gasoline fraction is introduced into the analytical system via line **19** from a gasoline blending process which will be described more fully hereinafter. A sample of blend is passed via line **19** through control means **21**, and the sample then enters line **7** wherein it is contacted with a stream of air passing into the system via line **8**. The air and the gasoline sample pass into the combustion chamber **2** via line **6**. The mixture of air and gasoline passes through the burner nozzle at the bottom of chamber **2**, not shown, and enters the induction section of the combustion chamber. The temperature of the induction section is about 630° F. and is maintained thereat by the heated fluid medium which

completely surrounds the combustion chamber in the elevated temperature zone **3**. The oxygen and the gasoline react within the induction section producing an exothermic reaction resulting finally in a temperature elevation to a peak of about 750° F., whereat there is developed a cool flame front. At this point, the temperature of the combustion mixture falls off rapidly to about 640° F. When the cool flame front is stabilized, the temperature sensing means **4** and **5** will sense an identical temperature due to the fact that the combustion produces a peak temperature with a rapid tailing off of temperature. The exhaust gases from the combustion then leave the combustion chamber **2** via line **9**.

With reference to the combustion parameter which is manipulated and adjusted in order to stabilize or immobilize the cool flame front between temperature sensing means **4** and **5**, the preferred embodiment is to adjust the pressure within the combustion zone, as was previously mentioned hereinabove. In other words, an increase in pressure will cause the flame front to recede towards the burner end of combustion chamber and a decrease in pressure will cause the flame front to advance away from the burner end of the chamber and more closely approach the discharge end thereof. Therefore, if the flame front attempts to move toward the burner end of the chamber, the temperature sensing means **5** will reflect a temperature rise. Temperature sensing means **5** will reflect a temperature rise. Temperature sensing means **4** and **5** will transmit the sensed temperatures via transmitting means **10** and **11** to a differential temperature controller **12**, which will then activate a pressure controller **14** by passing a pressure control signal thereto via line **13**. The pressure controller will be activated in order to decrease combustion pressure until the flame front is restored to its original position between the axially spaced temperature sensing means **4** and **5**. Conversely, if the hydrocarbon composition changes so that the flame front attempts to move away from the burner end of the chamber, temperature sensing element **4** will sense a temperature rise and the differential temperature controller will activate the pressure controller **14** to increase combustion chamber pressure until the front is restored to the original position.

Although the preferred embodiment of the invention comprises the manipulation of pressure as the controlled combustion parameter, other combustion conditions may be adjusted, with equally satisfactory results, in a manner sufficient to immobilize the flame front to a constant position within the combustion chamber. Thus, as disclosed in the cited U.S. Pat. 3,463,613, a combustion parameter which may be adjusted by the control signal **13** from the differential temperature controller **12** includes the hydrocarbon sample flow rate in line **7**, the oxygen containing gas flow rate in line **8**, and the induction zone temperature. In either case, regardless of which combustion condition parameter is manipulated, the apparatus operates with the selected combustion parameter being adjusted in a manner to immobilize the flame front relative to its position within the combustion chamber **2**, regardless of changes in the test sample composition. Thus the combustion parameter is sensed and utilized to develop an output signal which is then indicative of the composition characteristic of the combustible fluid being analyzed, which in a preferred embodiment is the octane number of a gasoline sample.

The temperature sensing means for determining the location of the stabilized cool flame is preferably a thermalelectric means such as a pair of axially spaced thermocouples **4** and **5**. However, other means for determining the flame position will be apparent to those skilled in the control arts and are deemed embraced in the broad scope of this invention. For example, one may employ spaced resistance bulbs or simply a pair of spaced resistance wires stretched tightly across the combustion zone, connected in a standard bridge circuit, instead of the previously described thermalelectric elements. Alternatively, optical-electric means, such as radiation pyrometers may be used. Since the flame front contains an appreciable concentration of organic radicals and ions, its position may also be detected by ion sensitive means such as a capacitor in the tank circuit of a high frequency oscillator whereby linear displacement of the flame will change the dielectric constant of the capacitor and hence, the resonance characteristic of the oscillator. Or the flame region may comprise a direct-current ionization gap. Those skilled in the art may readily determine the appropriate sensing means for determining the position of the stabilized cool flame in the combustion zone of the present invention.

In a preferred embodiment of the inventive apparatus, the cool flame front for the combustible fluid sample is positioned between a pair of thermocouples **4** and **5** placed in the combustion zone. Both thermocouples will be at about the same temperature and the voltage appearing at the input of the differential temperature controller **12** will be approximately zero. However, equally satisfactory operation can be achieved by having a net voltage difference if the positive or negative corresponding to a temperature differential is in the order of 10° F. to 40° F. This means that the flame front in the combustion chamber **2** is then slightly asymmetrical with respect to the thermocouples **4** and **5**. While this mode achieves greater sensitivity, it is not a critical requirement and one may still get good results with the apparatus if a zero temperature differential is maintained within the device **12**.

In any event, the sensing means **4** and **5**, the transmitting means **10** and **11**, and the differential temperature controller **12** will enable one to determine the exact position of the cool flame front by a differential temperature measurement. Controller **12** will then activate the pressure control means **14** in order to adjust the flame front to a position where there is, as previously mentioned, typically a zero temperature differential. Therefore, the change in combustion pressure which is required to immobilize the flame front in its predetermined location, is a correlatable function with the composition of the fuel which is being oxidized within the combustion chamber **2**.

Accordingly, then, there is provided within the apparatus a pressure sensing means **15** which develops a continuous pressure signal transmitted via line **16** to a transducer **17**. The transducer **17** converts the pneumatic or mechanical pressure signal **16** into an electrical signal which may be a voltage signal or an amperage signal. The transducer **17** transmits a converted parameter output signal via line **18** into a signal conditioning means **25**, which in this embodiment comprises a digital or an analog computer means. Computer means **25** contains an internal computer program by which the converted parameter signal **18** is continuously converted into a pair of output signals **26** and **84**, which are functionally representative of and correlatable with the octane rating of the combustible sample of gasoline blend introduced into the system via line **19**. The condition output signal **26**, typically, is thereupon transmitted to an octane display device **27** which may comprise a recording chart device, or a tape print-out device, or any other type of indicating means. In addition, the octane display device **27** may comprise a control system whereby an output signal for control of octane number is transmitted to means **85**, to be discussed hereafter, for controlling the octane rating of the blend which provides the test sample entering via line **19**. However, in the embodiment of FIG. 1, control means **85** is adjusted by condition output signal **84**.

As previously noted, the apparatus of the present invention is typically located out-of-doors. Accordingly, it is subject to combustion effects created by changes in atmospheric conditions. In order to compensate for changing atmospheric conditions, there is provided within the apparatus of the present invention a temperature sensing means **28** which is capable of sensing any fluctuations in temperature within the elevated temperature zone **3**.

Alternatively, temperature sensing means **28** may be positioned within combustion chamber **2** in order to sense actual fluctuations in induction section temperature. Temperature sensing means **28** passes a temperature output signal via transmitting means **29** to the signal conditioning means **25**. The internal program of the computer means **25** thereupon makes a temperature correction to the condition output signals passing via lines **26** and **84**. Thus, the octane value thereafter indicated by octane display device **27** is continuously compensated for any error in the indicated composition characteristic which is due to temperature fluctuations in the induction section of chamber **2** or in the elevated temperature zone **3**, caused by changes in atmospheric conditions.

In addition, the method and apparatus of the present invention provides for a continuous compensating adjustment to condition output signals **26** and **84** which reflects and compensates for fluctuations in the relative proportion of the various component fluids which are entering the blending system to produce the finish blend, a test sample of which is passed into the apparatus via line **19**.

Referring again to FIG. 1, there is shown a typical blending system wherein a plurality of gasoline blending components are passed into a blending zone to produce a finished blended gasoline having a predetermined composition characteristic, such as octane rating. A reformate gasoline stream enters the blending process via line **40** and a straight-run gasoline stream enters line **40** via line **41**. Typically, the gasoline blending system will blend at least two component gasolines, but for illustrative purposes various component gasoline fractions are shown in FIG. 1, in order to illustrate the various types of hydrocarbon constituents which may be blended together. Thus, there is shown in FIG. 1 an alkylate gasoline fraction entering line **40** via line **42**, a cracked gasoline fraction entering line **40** via line **43**, a volatility component such as butane and/or pentane entering line **40** via line **44**, and an anti-knock agent such as a lead alkyl entering line **40** via line **45**.

The reformate gasoline fraction is a highly aromatic stock, while the straight-run gasoline fraction is a blending component which is high in normal paraffins and in naphthenes. The alkylate gasoline fraction is a blending component which is high in isoparaffins, while the cracked gasoline fraction is a stock which is high in olefins. Therefore, the relative amount of each component passing into the blend, and fluctuations thereof, will produce individual combustion effects in the analyzer of the present invention which introduce deviations in the condition output signal which are not indicative of the blended composition characteristic being determined.

The combination of blending components passes via line **40** into a mixing or blending zone, which for illustrative purposes is shown in FIG. 1 as an in-line blender **46**. The final gasoline blend is discharged from in-line blender **46** via line **47** and a sample of the finished blend is withdrawn via line **19** as discussed hereinabove.

In order to make compensating adjustments to the condition output signals **26** and **84** which are reflective of the varying proportions of components passing into the blending process, there is provided means for sensing the flow of each component fluid passing into the blending system. In order to sense the flow of reformate gasoline, there is provided in line **40** a flow sensing means such as an orifice **48** which transmits a flow signal via line **49** to a transducer **50**. The differential pressure signal developed by the fluid passing through orifice **48** and transmitted via line **49**, is converted by transducer **50** into an electrical signal which is passed via line **51** into the computer means **25**. The flow of straight-run gasoline is sensed by a flow sensing means **54** which transmits a ΔP flow signal via line **55** to transducer **56**, which thereafter passes an electrical flow signal via line **57** into computer means **25**. In a similar manner, the rate of flow of alkylate gasoline into the blending process is sensed by orifice **60** which transmits a ΔP flow signal via means **61** to transducer **62**, which in turn transmits an electrical flow signal to computer means **25** via line **63**. Additionally, the cracked gasoline flow rate is sensed and transmitted by means **66**, **67**, **68**, and **69** to deliver an electrical input signal of cracked gasoline flow to computer means **25**. The volatility component flow is sensed and transmitted by means **72**, **73**, **74**, and **75** to deliver an electrical flow signal of volatility component to computer means **25**. Finally, the flow rate of lead alkyl entering the blending process is sensed and transmitted by means **78**, **79**, **80**, and **81**, whereby an electrical flow signal is delivered to computer means **25**.

Computer means **25**, now continuously receiving the rate of flow for each component entering the blending process, takes the information into the internal program of the computer, whereby the relative influence of each component upon the combustion within the combustion chamber **2** is determined. In this manner, the relative rate of flow of each component provides a direct measurement of the relative combustion effect of the aromatic component entering the process, the normal paraffinic component entering the process, the naphthenic component entering the process, the isoparaffinic component entering the process, the olefinic component entering the process, the volatility component entering the process, and the anti-knock agent entering the process. Computer means **25** is able by means of the internal computer program, to make compensating adjustments to the parameter input signal **18**, and thereby render a correction to the resulting condition output signals **26** and **84** which reflect a correction to these output signals for the effects of the various components entering the gasoline blend.

Thus, condition output signals **26** and **84** are continuously compensated for combustion effects which are not indicative of the composition characteristic being determined, such as blend octane rating.

As noted hereinabove, the signal conditioning means **25** delivers a condition output signal via transmitting means **84** to a controlling means, which for illustrative purposes is shown as a valve means **85** located in line **45**. In this manner, then, the computer means **25** will adjust the input flow of one or more components entering the blending process, whereby the condition output signal generated by the analytical apparatus of the present invention is utilized to control the blending system in a manner sufficient to produce a constant value of composition characteristic for the final finished blend product. As noted hereinabove, in the preferred embodiment of the present invention, the blending process wherein the apparatus of the present invention is utilized is a gasoline blending process. Accordingly, therefore, it is preferable that the condition output signal **84** and the control means **85** be utilized to control the input of at least one high octane blending component such as the reformate gasoline entering the blending system via line **40**, or to control the input of an anti-knock agent such as the lead alkyl entering the blending system via line **45**. Alternatively, the input of a low octane component such as the straight-run gasoline could be controlled. In this manner, then, the apparatus and control system will produce a controlled finished gasoline blend which has a constant octane rating in accordance with the specification which is set for the given blend which is being produced and analyzed.

In addition, the apparatus of the present invention provides for a recalibration or a re-zeroing of the system for deviations created by other combustion effects which are not reflective of the composition characteristic of the blended fuel being tested. Accordingly, there is provided means for periodically passing into the combustion chamber **2** a reference fuel by which the system may be recalibrated.

Thus, there is shown in FIG. 1 a reference fuel passing into the system via line **20**. A timing device **23** passes a

timing signal via line 22 into a control valve 21. During the period of isolation, the control valve 21 receives a timing signal by which the test sample of line 19 is switched out of the system and the reference fuel of line 20 is switched into the system. Thereafter, during the isolation or reference period, reference fuel passes via line 7 into line 6 in admixture with the air entering via line 8.

The reference fuel produces a stabilized cool flame which is indicative of the octane rating, or other composition characteristic being determined, of the reference fuel. The temperature sensing means 4 and 5 transmit the sensed temperature signals via means 10 and 11 into the differential temperature controller 12, whereupon differential temperature controller 12 passes a control signal via line 13 to pressure control means 14. The pressure sensing means 15 passes the pressure signal via line 16 into transducer 17 which in turn passes a converted parameter signal 18 into the computer means 25. The internal program of computer means 25 compares the signal 18 with a reference signal contained within the program. The reference signal is indicative of the known actual octane rating of the reference fuel. The timing device 23 sends a signal via line 24 to the computer means 25 during those periods of time when the reference fuel is being burned within combustion chamber 2.

Accordingly, then, the computer program will make a compensating adjustment to the condition output signal 26 in order to eliminate any deviation of converted parameter signal 18 from the known signal which is reflective of the actual composition characteristic or octane number of the reference fuel. When the period of isolation is ended, timer 23 sends a signal via line 22 to valve 21 to swing the valve in a manner sufficient to isolate the reference fuel of line 20 from the system and to continue the introduction of test sample via line 19. At this point then, the timing signal passing via line 24 to computer means 25, informs the computer means that the reference fuel has been cut out of the system and that the test sample has been reintroduced. The internal computer program of the computer means 25 at this point retains any reference fuel correction which was made within the system. Consequently, the resulting condition output signal passing via line 26 to octane display device 27 when the test sample is being tested, will reflect a compensation or recalibration of the system for the reference fuel.

Of course, those skilled in the art will readily perceive that during the isolation or reference period when the test sample of line 19 is replaced by the reference fuel of line 20, the condition output signal 84 cannot be utilized to control the valve means 85 and thereby maintain a constant predetermined value of octane rating for the finished blend. During this isolation period the converted parameter signal 18 passing into the signal conditioning means 25 will not be indicative of the composition characteristic of the finished blend since the signal 18 is produced by the combustion of the reference fuel. Accordingly therefore, when the timing signal 24 which passes into the computer means 25 relates to the internal program that reference fuel is passing into the combustion chamber 2, the internal program of computer means 25 will provide that the condition output signal 84 will be locked in, so that the valve means 85 will be held at a constant throttling position. Therefore, during the short period of recalibration or of re-zeroing the apparatus of the present invention to compensate for aging effects in the combustion tube as indicated by the combustion of the reference fuel, the finished blend will be produced at a constant predetermined octane rating in accordance with the last setting which was provided by the combustion of the test sample.

Accordingly then, when the timing device 23 again cuts the test sample of line 19 back into the apparatus of the present invention and simultaneously isolates the preference fuel of line 20 therefrom, the indicated octane number of the test sample which is thereafter produced during the testing period will have been corrected for component proportions, for temperature conditions, and for other combustion effects which were not truly indicative of the composition characteristic such as octane number. Accordingly then, the indicating condition output signal 26, as well as the controlling condition output signal 84, will be truly indicative of and directly correlatable with the octane number or other composition characteristic of the test sample being oxidized in combustion chamber 2.

Referring now to FIG. 2, there is shown a second embodiment of the present invention wherein the signal conditioning means of FIG. 1, the computer means 25 and its internally contained program, is replaced by a signal conditioning means preferably comprising a network of analog elements, although a network of digital elements may be used. The basic elements of the analytical apparatus and the blending system which are disclosed in FIG. 1, are again illustrated in FIG. 2.

In the embodiment of FIG. 2, however, the transducer output signal leaving transducer 17 is transmitted via means 18 into a signal conditioning network 30. The signal conditioning network 30 is a type of apparatus which is well known in the art. The converted parameter signal 18 passing from transducer 17 has a fixed correlation between the pressure which is sensed in the combustion chamber 2 by the pressure sensing means 15, and the resulting electrical output signal which is passed through the signaling conditioning network. The conditioning network 30 either multiplies, or it adds and subtracts to the received transducer signal 18 in order to produce a net output signal which is correlatable with octane rating or any other composition characteristic being determined. In the preferred embodiment, signal conditioning network 30 will add and subtract to the signal 18. The resulting pressure output signal is transmitted from signal conditioning network 30 via transmitting means 31 into a summing means 32.

In addition, in the embodiment illustrated in FIG. 2, the temperature signal which is sensed in the elevated temperature zone 3 by the sensing means 28 is transmitted via line 29 into a signal conditioning network 33. Again, the signal conditioning network 33 is a type of network which is well known in the art. The temperature signal has a fixed correlation between the temperature in the elevated temperature zone 3 and the octane rating or other composition characteristic being determined within the combustion chamber 2. The conditioning network 33, therefore, adds or subtracts to the signal 29 in a manner sufficient to compensate for any temperature deviations from a fixed temperature which is the standard base temperature for the elevated temperature zone 3. Alternatively, induction section temperature may be sensed by means 28, and network 33 may compensate for any deviation from the base induction section temperature. The resulting signal is passed from the signal conditioning network 33 with a compensation for any temperature deviation, into summing means 32 via transmitting means 34.

Furthermore, in the embodiment of FIG. 2, the converted flow signal 51 which is representative of the flow of reformate gasoline passing into the blending process, is transmitted to a signal conditioning network 52. Again the signal conditioning network 52 is a type of network which is well known in the art. There is a fixed correlation between the actual flow of the reformate gasoline and the resulting octane contribution to the final blended gasoline product octane number. Consequently, the signal conditioning network 52 develops a continuous octane correction factor for the flow of aromatic fluid passing through orifice 48. The aromatic or reformate octane correction factor is pased via transmitting means 53 to summing means 32.

In a similar manner, there is a provision for passing the converted flow signal 57, which is representative of

the flow of straight-run gasoline into the blending process, to a signal conditioning network **58**. This signal conditioning network is similar to that of network **52**. There is a fixed correlation between the actual flow of the straight-run gasoline and the resulting octane contribution of the straight-run gasoline to the final blended gasoline product octane number. Consequently, signal conditioning network **58** develops a continuous octane correction factor for the flow of this normal paraffinic fluid passing through the orifice **54**. This normal paraffinic or straight-run gasoline octane correction factor is transmitted via means **59** to the summing means **32**.

In a similar manner, the alkylate gasoline component flow signal **63** is passed to a signal conditioning network **64** which develops an octane correction factor for the isoparaffinic component passing to the gasoline blend. The octane correction factor is passed from signal conditioning means **64** via transmitting means **65** to the summing means **32**.

A correction to the octane contribution of the cracked gasoline is also provided for in the apparatus as set forth in FIG. 2. Flow signal **69** passes into a signal conditioning network **70** which thereafter transmits an octane correction factor for the olefinic component via transmitting means **71** into the summing means **32**. Similarly, a correction for the octane contribution of the volatility component is provided by sending the flow signal **75** to a signal conditioning network **76** which thereupon develops an octane correction factor signal passing via means **77** to the summing means **32**. Finally there is indicated in FIG. 2, an octane correction for the lead alkyl component passing into the blending process. This is provided by sending the anti-knock agent flow signal **81** into the signal conditioning network **82** which in turn develops an octane correction factor transmitted via means **83** to the summing means **32**.

Summing means **32** receiving the temperature signal **34**, the parameter output signal **31**, and the component octane correction factor signals **53**, **59**, **65**, **71**, **77**, and **83**, thereupon algebraically sums the signals. The net result of the algebraic summation accomplished by summing means **32** is a modified parameter signal which is in fact the net condition output signal which is indicative of the apparent composition characteristic as compensated for any component and temperature fluctuations. Thus when the test sample of line **19** is oxidized in combustion chamber **2**, the summing means **32** sends a condition output signal **26** to the octane display device **27** which gives the apparent octane rating of the test sample of the finished blended gasoline product.

In the embodiment illustrated in FIG. 2, the octane display device **27** contains a control system which not only gives an indication of the actual octane of the test sample but which also develops a control output signal **86** passing to the control valve **85**. The control set point contained within means **27** is set to the desired specification composition characteristic, in this instance the octane rating of the finished blend, and the control output **86** thereupon throttles the valve **85** to admit a sufficient amount of anti-knock agent (lead alkyl) to control the octane rating of the finished blend to the specification set point. Of course, as noted hereinabove, the control output signal **86** could alternatively be utilized to control the input of a high octane blending component such as the reformate gasoline in order to control the octane rating of the finished blend to the set point value. Similarly, signal **86** could be utilized to control the input of a low octane blending component such as the straight-run gasoline.

When reference fuel is being oxidized in chamber **2**, summing means **32** sends a condition output signal via transmitting means **35** to an error amplifier **36**, as well as the condition output signal **26** to the display device **27**. The error amplifier **36** is a device which is well known in the art. The error amplifier contains a manual set point which is representative of the actual known octane number of the reference fuel. Accordingly, the error amplifier receives the timing signal from timer **23** via transmitting means **24** when the reference fuel is being oxidized within the combustion chamber **2**. At this point then, the error amplifier compares the condition output signal **35** with the known set point which is correlatable with the known actual composition characteristic, such as octane number, of the reference fuel. Thereupon the error amplifier develops an output signal which is a function of the difference between the set point and the actual summation or condition output signal **35**.

Simultaneously, the timer **23** sends an additional timing signal via transmitting means **87** to the octane display device **27**. The timing signal **87** is passed to means **27** in order to lock the control signal **86** at a constant value during that period of time when the condition output signal **26** is no longer indicative of the octane rating of the blended product but instead is indicative of the octane rating indicated for the reference fuel. By this means, the system provides that the gasoline blending process will continue to make a gasoline blend meeting the octane specification in response to the test sample octane value and not in response to the currently developed octane value of the reference fuel. During the short period of time, which is typically from 3 to 5 minutes, during which the reference fuel is introduced into the apparatus, the gasoline blending process will continue to produce a gasoline blend which meets the specification responsive to the composition characteristic and the condition output signal **26** which is correlatable with the octane rating of the test sample as of the last moment when the test sample was passed into the combustion chamber.

Meanwhile, the error-amplifier **36** transmits its output signal via transmitting means **37** to a servo-amplifier **38**. The servo-amplifier is a device which is well known in the art. The servo-amplifier upon receiving the error-amplifier output signal, reponds to the error output signal in order to make a correction to bring the condition output signal **35** into balance with the set point contained within the error-amplifier. Accordingly, the servo-amplifier **38** develops an output signal which is portional to the error-amplifier output signal which has been received. The servo-amplifier is a power amplifier sending a power signal via means **39** to a servo-motor located within signal conditioning network **30**. The servo-motor mechanically adjusts the signal conditioning network **30** to produce an ultimate summation or condition output signal **35** which is identical to the manual set point which is contained in the error-amplifier **36**. Thus the system is corrected to the known octane value or other base line composition characteristic of the reference fuel.

The resulting pressure output signal transmitted via line **31** thereupon becomes directly correlatable with the octane number or other measured composition characteristic of the reference fuel being oxidized within combustion chamber **2**. Summing means **32** thereupon develops an output signal **35** which passes to the error-amplifier and is therein indicated to be in balance with the manual set point. At this juncture then, the modified condition output signal which is transmitted via means **26** to the octane display device **27** will indicate the true octane number for the reference fuel as corrected for combustion effects which are not indicative of the composition characteristic being determined.

When the system reaches a time when the period of isolation is over, timer **23** will switch valve **21** by means of a signal passing via line **22** in order to cut out the reference fuel **20** and reintroduce the test sample **19** into the analyzer of the present invention. At this point then, the timer **23** sends a signal via transmitting means **24** to the error-amplifier which will enable the system to hold the compensating adjustment which was made in signal conditioning network **30** to balance out the reference fuel

output signal **35** with the manual set point. Simultaneously, timer **23** passes a signal via line **87** which releases the hold which was placed upon the control output signal **86** during the isolation or reference period. In this manner then, when the test sample of line **19** is being oxidized the modified condition output signal **26** passing to the display device **27** is indicative of the composition characteristic being measured, such as octane number, while being compensated for component flows and temperature fluctuations and for any deviations of the reference fuel signal from the known base reference signal. Thereafter, control signal **86** will adjust control means **85** in a manner sufficient to pass the lead alkyl anti-knock agent into the blending process at a rate controlled to produce a final gasoline blend which meets the required specification value of octane rating or any other composition characteristic being determined.

PREFERRED EMBODIMENTS

Those skilled in the art will readily perceive the apparatus configuration of the present invention and the method of operation which have been disclosed hereinabove. Additionally, those skilled in the art can readily perceive the advantages of the present invention as disclosed hereinabove.

However, even though those skilled in the art will easily recognize the distinction between the terms "signal conditioning means" and "signal conditioning network," it is deemed advantageous to define and distinguish these terms as used herein. Referring to FIG. 1, the signal conditioning means comprises the computer means **25**, which contains an internal computer program for making compensating adjustments to produce the corrected condition output signal. Referring to FIG. 2, the signal conditioning means comprises the network of elements which is, in fact, a computing system for making the compensating adjustments. Thus, the signal conditioning networks **30, 33, 52, 58, 64, 70, 76,** and **82** which are disclosed in FIG. 2, are individual elements contained within the signal conditioning means of that embodiment.

Furthermore, it is to be noted that the composition characteristic being determined by the present invention, typically octane rating, is indicated by a condition output signal which is a function of and correlatable with the composition characteristic being determined. However, those skilled in the art will realize that the condition output signal, as illustrated by the elements **26, 35,** and **84,** is in fact a modified parameter output signal which in the preferred embodiment is a pressure signal. Thus, when the reference fuel is passing to the combustion chamber **2** and condition output signal **35** is compared with the reference value signal in error-amplifier **36**, the reference value signal is, in fact, being matched with a modified parameter signal **35.**

Therefore, from the above description it may now be summarized that one preferred embodiment of the present invention provides a method for controlling the composition characteristic of a combustible fluid mixture produced by continuously blending a plurality of component fluids, which comprises: (a) introducing a sample stream of said fluid mixture and a stream of oxygen-containing gas into one end of a combustion zone including an induction section maintained at elevated temperature; (b) partially oxidizing said sample stream in said combustion zone under conditions sufficient to generate and maintain therein, a cool flame characterized by a relatively narrow well-defined flame front spaced from said one end; (c) sensing the position of said flame front relative to said one end, and developing therefrom a control signal; (d) utilizing said control signal to adjust a combustion parameter selected from the group consisting of combustion zone pressure, induction section temperature, sample stream flow rate, and oxygen-containing gas stream flow rate, in a manner sufficient to immobilize said flame front relative to said one end regardless of fluctuations in the composition characteristic of said sample stream; (e) sensing the adjusted parameter and developing a first parameter signal responsive to changes in said composition characteristic; (f) developing a first component signal representative of the relative amount of a first component fluid being blended in said plurality to produce said combustible fluid mixture; (g) passing said first parameter signal and said first component signal into signal conditioning means, and producing therefrom a first condition output signal functionally representative of the composition characteristic of said sample stream of fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture; (h) periodically isolating said sample stream from said combustion zone, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said zone in a manner sufficient to continue the generation of said immobilized flame front; (i) sensing the adjusted parameter during the period of isolation and passing a second parameter signal into said signal conditioning means, said second parameter signal being functionally representative of the apparent composition characteristic of said reference fuel; (j) comparing said second parameter signal with a reference value of parameter signal functionally corresponding to the actual known value of composition characteristic of said reference fuel; (k) adjusting said signal conditioning means in a manner sufficient to produce a second condition output signal which is compensated to reflect the elimination of the difference between said second parameter signal and said reference value parameter signal, and which is thereby functionally representative of the actual known composition characteristic of said reference fuel; (l) periodically isolating said reference fuel stream from said combustion zone while retaining the signal conditioning adjustment of step (k), and simultaneously passing said fluid sample stream into said zone in a manner sufficient to maintain said flame front, whereby said signal conditioning means receives a third parameter signal and a second component signal representative of the relative amount of said first component fluid, and said signal conditioning means therefrom develops a third condition output signal compensated for combustion effects not indicative of composition characteristic, and said third condition output signal is thereby functionally representative of the actual composition characteristic of said sample stream; and, (m) passing said third condition output signal to means controlling the relative amount of a second component fluid being blended in said plurality to produce said combustible fluid mixture, whereby the sample stream of fluid mixture produces a condition output signal functionally representative of a predetermined value of composition characteristic.

Furthermore, in its apparatus aspects, a preferred embodiment of the present invention resides in a blending process wherein a plurality of component fluids is continuously introduced into a blending zone producing a resulting combustible fluid mixture, each component fluid having associated therewith conduit means passing the associated fluid into said blending zone, a control system for maintaining a composition characteristic of said combustible fluid mixture at a predetermined level, which comprises in combination: (a) a combustion chamber, including an induction section; (b) means for generating within said combustion chamber, a cool flame characterized by a relatively narrow well-defined flame front, utilizing as fuel therefore said combustible fluid mixture to be analyzed, said generating means including means passing a stream of said fluid mixture and a stream of oxidizer into said combustion chamber; (c) means sensing the physical position of said flame front within said combustion chamber; (d) control means coupled to said position sensing means, and adapted to adjust a combus-

tion parameter selected from the group consisting of combustion pressure, induction section temperature, fluid stream flow rate, and oxidizer stream flow rate in a manner sufficient to immobilize said flame front in a constant physical position relative to said combustion chamber; (e) means sensing the adjusted parameter and developing a parameter output signal, which is functionally representative of the composition characteristic of said fluid stream; (f) means developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; (g) signal conditioning means receiving said parameter output signal and said component signal; (h) condition signal generating means within said signal conditioning means producing a condition output signal functionally representative of said composition characteristic; (i) means periodically isolating said fluid stream from said flame generating means, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said flame generating means in a manner sufficient to continue the generation of said immobilized flame front; (j) means passing to said signal conditioning means, a timing signal indicative of the passage of reference fuel to said flame generating means; (k) comparison means within said signal conidtioning means, responsive to said timing signal, adapted to compare the condition output signal generated due to reference fuel flame front with a reference value signal functionally corresponding to the actual known value of composition characteristic of said reference fuel, and therefrom developing a comparison signal; (l) adjusting means within said signal conditioning means, responsive to said comparison signal, and adapted to adjust said condition signal generating means to compensate for deviation between the condition output signal generated due to reference fuel flame front and said reference value signal; (m) means for retaining said adjustment to said condition signal generating means when said isolation period is ended and said fluid stream is returned to said flame generating means in place of said reference fuel, whereby the condition output signal generated by said fluid stream flame front is compensated for combustion effects not indicative of composition characteristic, and said condition output signal is thereby functionally representative of and correlatable with the actual composition characteristic of said combustible fluid mixture; (n) means controlling the relative amount of a second component fluid contained in said combustible fluid mixture; and, (o) means transmitting to said control means (m), said condition output signal, whereby said resulting combustible fluid mixture is controlled at a constant predetermined level of combustion characteristic.

The invention claimed is:

1. Method for detecting composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids, which comprises:

(a) introducing a sample stream of said fluid mixture and a stream of oxygen-containing gas into one end of a combustion zone including an induction section maintained at elevated temperature;

(b) partially oxidizing said sample stream in said combustion zone under conditions sufficient to generate and maintain therein, a cool flame characterized by a relatively narrow well-defined flame front spaced from said one end;

(c) sensing the position of flame front relative to said one end, and developing therefrom a control signal;

(d) utilizing said control signal to adjust a combustion parameter selected from the group consisting of combustion zone pressure, induction section temperature, sample stream flow rate, and oxygen-containing gas stream flow rate, in a manner sufficient to immobilize said flame front relative to said one end regardless of fluctuations in the composition characteristic of said sample stream;

(e) sensing the adjusted parameter and developing a parameter signal responsive to changes in said composition characteristic;

(f) developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; and,

(g) passing said parameter signal and said component signal into signal conditioning means, and producing therefrom a condition output signal functionally representative of the composition characteristic of said sample stream of fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture.

2. Method of claim 1 wherein said combustion zone is confined in an elevated temperature zone, a temperature selected from the group consisting of a temperature in said induction section and a temperature in said elevated temperature zone is sensed and a temperature signal is developed therefrom, said temperature signal is passed into said signal conditioning means, and said condition output signal is thereby rendered functionally representative of said composition characteristic as corrected for temperature deviations.

3. Method of claim 1 wherein said combustible fluid mixture comprises gasoline boiling range hydrocarbons and the detected composition characteristic is octane rating.

4. Method for detecting composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids, which comprises:

(a) introducing a sample stream of said fluid mixture and a stream of oxygen-containing gas into one end of a combustion zone including an induction section maintained at elevated temperature;

(b) partially oxidizing said sample stream in said combustion zone under conditions sufficient to generate and maintain therein, a cool flame characterized by a relatively narrow well-defined flame front spaced from said one end;

(c) sensing the position of said flame front relative to said one end, and developing therefrom a control signal;

(d) utilizing said control signal to adjust a combustion parameter selected from the group consisting of combustion zone pressure, induction section temperature, sample stream flow rate, and oxygen-containing gas stream flow rate, in a manner sufficient to immobilize said flame front relative to said one end regardless of fluctuations in the composition characteristic of said sample stream;

(e) sensing the adjusted parameter and developing a first parameter signal responsive to changes in said composition characteristic;

(f) developing a first component signal representative of the relative amount of a first component fluid of said plurality contained in said combustion fluid mixture;

(g) passing said first parameter signal and said first component signal into signal conditioning means, and producing therefrom a first condition output signal functionally representative of the composition characteristic of said sample stream of fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture;

(h) periodically isolating said sample stream from said combustion zone, and simultaneously passing a stream of reference fuel having a known value of

composition characteristic, into said zone in a manner sufficient to continue the generation of said immobilized flame front;

(i) sensing the adjusted parameter during the period of isolation and passing a second parameter signal into said signal conditioning means, said second parameter signal being functionally representative of the apparent composition characteristic of said reference fuel;

(j) comparing said second parameter signal with a reference value of parameter signal functionally corresponding to the actual known value of composition characteristic of said reference fuel;

(k) adjusting said signal conditioning means in a manner sufficient to produce a second condition output signal which is compensated to reflect the elimination of the difference between said second parameter signal and said reference value parameter signal, and which is thereby functionally representative of the actual known composition characteristic of said reference fuel; and,

(l) periodically isolating said reference fuel stream from said combustion zone while retaining the signal conditioning adjustment of step (k), and simultaneously passing said fluid sample stream into said zone in a manner sufficient to maintain said flame front, whereby said signal conditioning means receives a third parameter signal and a second component signal representative of the relative amount of said first component fluid, and said signal conditioning means therefrom develops a third condition output signal compensated for combustion effects not indicative of composition characteristic, and said third condition output signal is thereby functionally representative of the actual composition characteristic of said sample stream.

5. Method of claim **4** wherein said combustion zone is confined in an elevated temperature zone, a temperature selected from the group consisting of a temperature in said induction section and a temperature in said elevated temperature zone is sensed and a temperature signal is developed therefrom, said temperature signal is passed into said signal conditioning means, and each condition output signal is thereby rendered functionally representative of said composition characteristic as corrected for temperature deviations.

6. Method of claim **4** wherein said combustible fluid mixture comprises gasoline boiling range hydrocarbons and the detected composition characteristic is octane rating.

7. Method for controlling the composition characteristic of a combustible fluid mixture produced by continuously blending a plurality of component fluids, which comprises:

(a) introducing a sample stream of said fluid mixture and a stream of oxygen-containing gas into one end of a combustion zone including an induction section maintained at elevated temperature;

(b) partially oxidizing said sample stream in said combustion zone under conditions sufficient to generate and maintain therein, a cool flame characterized by a relatively narrow well-defined flame front spaced from said one end;

(c) sensing the position of said flame front relative to said one end, and developing therefrom a control signal;

(d) utilizing said control signal to adjust a combustion parameter selected from the group consisting of combustion zone pressure, induction section temperature, sample stream flow rate, and oxygen-containing gas stream flow rate, in a manner sufficient to immobilize said flame front relative to said one end regardless of fluctuations in the composition characteristic of said sample stream;

(e) sensing the adjusted parameter and developing a first parameter signal responsive to changes in said composition characteristic;

(f) developing a first component signal representative of the relative amount of a first component fluid being blended in said plurality to produce said combustible fluid mixture;

(g) passing said first parameter signal and said first component signal into signal conditioning means, and producing therefrom a first condition output signal functionally representative of the composition characteristic of said sample stream of fluid mixture, said condition output signal being indicative of said composition characteristic as corrected for deviations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture;

(h) periodically isolating said sample stream from said combustion zone, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said zone in a manner sufficient to continue the generation of said immobilized flame front;

(i) sensing the adjusted parameter during the period of isolation and passing a second parameter signal into said signal conditioning means, said second parameter signal being functionally representative of the apparent composition characteristic of said reference fuel;

(j) comparing said second parameter signal with a reference value of parameter signal functionally corresponding to the actual known value of composition characteristic of said reference fuel;

(k) adjusting said signal conditioning means in a manner sufficient to produce a second condition output signal which is compensated to reflect the elimination of the difference between said second parameter signal and said reference value parameter signal, and which is thereby functionally representative of the actual known composition characteristic of said reference fuel;

(l) periodically isolating said reference fuel stream from said combustion zone while retaining the signal conditioning adjustment of step (k), and simultaneously passing said fluid sample stream into said zone in a manner sufficient to maintain said flame front, whereby said signal conditioning means receives a third parameter signal and a second component signal representative of the relative amount of said first component fluid, and said signal conditioning means therefrom develops a third condition output signal compensated for combustion effects not indicative of composition characteristic, and said third condition output signal is thereby functionally representative of the actual composition characteristic of said sample stream; and,

(m) passing said third condition output signal to means controlling the relative amount of a second component fluid being blended in said plurality to produce said combustible fluid mixture, whereby the sample stream of fluid mixture produces a condition output signal functionally representative of a predetermined value of composition characteristic.

8. Method of claim **7** wherein said combustion zone is confined in an elevated temperature zone, a temperature selected from the group consisting of a temperature in said induction section and a temperature in said elevated temperature zone is sensed and a temperature signal is developed therefrom, said temperature signal is passed into said signal conditioning means, and each condition output signal is thereby rendered functionally representative of said composition characteristic as corrected for temperature deviations.

9. Method of claim **7** wherein said second component fluid is said first component fluid.

10. Method of claim **7** wherein said combustible fluid mixture comprises gasoline boiling range hydrocarbons

and the detected composition characteristic is octane rating.

11. Method of claim 10 wherein said second component fluid comprises an anti-knock agent.

12. A composition analyzer for detecting a composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids, which comprises in combination:

(a) a combustion chamber, including an induction section;

(b) means for generating within said combustion chamber, a cool flame characterized by a relatively narrow well-defined flame front, utilizing as fuel therefor said combustible fluid mixture to be analyzed, said generating means including means passing a stream of said fluid mixture and a stream of oxidizer into said combustion chamber;

(c) means sensing the physical position of said flame front within said combustion chamber;

(d) control means coupled to said position sensing means, and adapted to adjust a combustion parameter selected from the group consisting of combustion pressure, induction section temperature, fluid stream flow rate, and oxidizer stream flow rate in a manner sufficient to immobilize said flame front in a constant physical position relative to said combustion chamber;

(e) means sensing the adjusted parameter and developing a parameter output signal which is functionally representative of the composition characteristic of said fluid stream;

(f) means developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture; and,

(g) signal conditioning means receiving said parameter output signal and said component signal, and producing therefrom a condition output signal which is functionally representative of and correlatable with said composition characteristic of the combustible fluid mixture, said condition output signal being indicative of sad compositon characteristic as corrected for devations in said parameter signal caused by the relative amount of said first component fluid in said combustible fluid mixture.

13. Apparatus of claim 12 wherein said control means (d) comprises means adjusting said combustion pressure.

14. Apparatus of claim 12 wherein said signal conditioning means comprises computer means.

15. Apparatus of claim 12 wherein said flame position sensing means comprises a pair of axially spaced temperature sensing elements.

16. Apparatus of claim 12 wherein there is provided an outer chamber encompassing said combustion chamber and confining a zone of elevated temperature therein-between, means sensing a temperature selected from the group consisting of a temperature in said induction section and a temperature in said elevated temperature zone, and means transmitting a temperature signal from said temperature sensing means to said signal conditioning means, whereby said condition output signal is rendered functionally representative of said composition characteristic as corrected for temperature deviations.

17. A composition analyzer for detecting a composition characteristic of a combustible fluid mixture produced by combining a plurality of component fluids which comprises in combination:

(a) a combustion chamber, including an induction section;

(b) means for generating within said combustion chamber, a cool flame characterized by a relatively narrow well-defined flame front, utilizing as fuel therefor said combustible fluid mixture to be analyzed, said generating means including means passing a stream of said fluid mixture and a stream of oxidizer into said combustion chamber;

(c) means sensing the physical position of said flame front within said combustion chamber;

(d) control means coupled to said position sensing means, and adapted to adjust a combustion parameter selected from the group consisting of combustion pressure, induction section temperature, fluid stream flow rate, and oxidizer stream flow rate in a manner sufficient to immobilize said flame front in a constant physical position relative to said combustion chamber;

(e) means sensing the adjusted parameter and developing a parameter output signal which is functionally representative of the composition characteristic of said fluid stream;

(f) means developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture;

(g) signal conditioning means receiving said parameter output signal and said component signal;

(h) condition signal generating means within said signal conditioning means producing a condition output signal functionally representative of said composition characteristic;

(i) means periodically isolating said fluid stream from said flame generating means, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said flame generating means in a manner sufficient to continue the generation of said immobilized flame front;

(j) means passing to said signal conditioning means, a timing signal indicative of the passage of reference fuel to said flame generating means;

(k) comparison means within said signal conditioning means, responsive to said timing signal, adapted to compare the condition output signal generated due to reference fuel flame front with a reference value signal functionally corresponding to the actual known value of composition characteristic of said reference fuel, and therefrom developing a comparison signal;

(l) adjusting means within said signal conditioning means, responsive to said comparison signal, and adapted to adjust said condition signal generating means to compensate for deviation between the condition output signal generated due to reference fuel flame front and said reference value signal; and,

(m) means for retaining said adjustment to said condition signal generating means when said isolation period is ended and said fluid stream is returned to said flame generating means in place of said reference fuel, whereby the condition output signal generated by said fluid stream flame front is compensated for combustion effects not indicative of composition characteristic, and said condition output signal is thereby functionally representative of and correlatable with the actual composition characteristic of said combustible fluid mixture.

18. Apparatus of claim 17 wherein said means (d) comprises means adjusting said combustion pressure.

19. Apparatus of claim 17 wherein said signal conditioning means comprises computer means.

20. Apparatus of claim 17 wherein said flame position sensing means comprises a pair of axially spaced temperature sensing elements.

21. Apparatus of claim 17 wherein there is provided an outer chamber encompassing said combustion chamber and confining a zone of elevated temperature therein-between, means sensing a temperature selected from the group consisting of a temperature in said induction section and a temperature in said elevated temperature zone, and means transmitting a temperature signal from said temperature sensing means to said signal conditioning means, whereby said condition output signal is rendered functionally representative of said composition characteristic as corrected for temperature deviations.

22. In a blending process wherein a plurality of component fluids is continuously introduced into a blending zone producing a resulting combustible fluid mixture, each component fluid having association therewith conduit means passing the associated fluid into said blending zone, a control system for maintaining a composition characteristic of said combustible fluid mixture at a predetermined level, which comprises in combination:

(a) a combustion chamber, including an induction section;

(b) means for generating within said combustion chamber a cool flame characterized by a relatively narrow well-defined flame front, utilizing as fuel therefor said combustible fluid mixture to be analyzed, said generating means including means passing a stream of said fluid mixture and a stream of oxidizer into said combustion chamber;

(c) means sensing the physical position of said flame front within said combustion chamber;

(d) control means coupled to said position sensing means, and adapted to adjust a combustion parameter selected from the group consisting of combustion pressure, induction section temperature, fluid stream flow rate, and oxidizer stream flow rate in a manner sufficient to immobilize said flame front in a constant physical position relative to said combustion chamber;

(e) means sensing the adjusted parameter and developing a parameter output signal which is functionally representative of the composition characteristic of said fluid stream;

(f) means developing a component signal representative of the relative amount of a first component fluid of said plurality contained in said combustible fluid mixture;

(g) signal conditioning means receiving said parameter output signal and said component signal;

(h) condition signal generating means within said signal conditioning means producing a condition output signal functionally representative of said composition characteristic;

(i) means periodically isolating said fluid stream from said flame generating means, and simultaneously passing a stream of reference fuel having a known value of composition characteristic, into said flame generating means in a manner sufficient to continue the generation of said immobilized flame front;

(j) means passing to said signal conditioning means, a timing signal indicative of the passage of reference fuel to said flame generating means;

(k) comparison means within said signal conditioning means, responsive to said timing signal, adapted to compare the condition output signal generated due to reference fuel flame front with a reference value signal functionally corresponding to the actual known value of composition characteristic of said reference fuel, and therefrom developing a comparison signal;

(l) adjusting means within said signal conditioning means, responsive to said comparison signal, and adapted to adjust said condition signal generating means to compensate for deviation between the condition output signal generated due to reference fuel flame front and said reference value signal;

(m) means for retaining said adjustment to said condition signal generating means when said isolation period is ended and said fluid stream is returned to said flame generating means in place of said reference fuel, whereby the condition output signal generated by said fluid stream flame front is compensated for combustion effects not indicative of composition characteristic, and said condition output signal is thereby functionally representative of and correlatable with the actual composition characteristic of said combustible fluid mixture;

(n) means controlling the relative amount of a second component fluid contained in said combustible fluid mixture; and

(o) means transmitting to said control means (m), said condition output signal, whereby said resulting combustible fluid mixture is controlled at a constant predetermined level of combustion characteristic.

23. System of claim 22 wherein said means (f) comprises flow indicating means sensing the flow of first component fluid passing to said blending zone in the associated first conduit means.

24. System of claim 22 wherein said means (m) comprises flow control means controlling the flow of second component fluid passing to said blending zone in the associated second conduit means.

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