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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
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☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

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Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

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Application Information:

Title of the Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines		
Attorney Docket Number	11381.122997	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122897
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

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This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	14/807125	2015-07-23
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	14/220529	2014-03-20
Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13/546220	2012-07-11
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
		12/701034	2010-02-05	8468983	2013-06-25

Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	11/758157	2007-06-05
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	11/100026	2005-04-06	7225787	2007-06-05

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
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Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	10/991774	2004-11-18	7314033	2008-01-01

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[1] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

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Application Number	Country[1]	Filing Date (YYYY-MM-DD)	Access Code[1] (if applicable)

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices

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Applicant Information:

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Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◯ Assignee	◯ Legal Representative under 35 U.S.C. 117	◯ Joint Inventor
◯ Person to whom the inventor is obligated to assign.	◯ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☒

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Email Address	

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Signature:

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Signature				Date (YYYY-MM-DD)	2017-03-20
First Name	Sam	Last Name	Pastemack	Registration Number	29578

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
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This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Nonprovisional Patent Application for

OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

MIT Case No. 11381K

Attorney Docket: 11381.122997

Sam (Bo) Pasternack
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OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

This application is a continuation of United States Patent Application Serial No. 14/807,125 filed on July 23, 2015 which is a continuation of United States Patent Application Serial No. 14/220529 filed on March 20, 2014 which is a continuation of United States Patent Application 13/546220 filed on July 11, 2012, which is a continuation of United States Patent Application Serial No. 12/701,034 filed on February 5, 2010, which is a continuation of United States Patent Application Serial No. 11/758,157 filed June 5, 2007, which is a continuation of United States Patent Application Serial No. 11/100,026, filed April 6, 2005, now Patent No. 7,225,787, which is a continuation-in-part of United States Patent Application Serial No. 10/991,774 filed November 18, 2004, now Patent No. 7,314,033, the contents of which are incorporated herein by reference.

Background of the Invention

This invention relates to an optimized fuel management system for use with spark ignition gasoline engines in which an anti-knock agent which is a fuel is directly injected into a cylinder of the engine.

There are a number of important additional approaches for optimizing direct injection ethanol enhanced knock suppression so as to maximize the increase in engine efficiency and to minimize emissions of air pollutants beyond the technology disclosed in parent application serial number 10/991,774 set out above. There are also additional approaches to protect the engine and exhaust system during high load operation by ethanol rich operation; and to minimize cost, ethanol fuel use and ethanol fuel storage requirements. This disclosure describes these approaches.

These approaches are based in part on more refined calculations of the effects of variable ethanol octane enhancement using a new computer model that we have developed. The model

determines the effect of direct injection of ethanol on the occurrence of knock for different times of injection and mixtures with port fuel injected gasoline. It determines the beneficial effect of evaporative cooling of the direct ethanol injection upon knock suppression.

Summary of the Invention

In one aspect, the invention is a fuel management system for operation of a spark ignition gasoline engine including a gasoline engine and a source of an anti-knock agent which is a fuel. The use of the anti-knock agent provides gasoline savings both by facilitating increased engine efficiency over a drive cycle and by substitution for gasoline as a fuel. An injector is provided for direct injection of the anti-knock agent into a cylinder of the engine and a fuel management control system controls injection of the anti-knock agent into the cylinder to control knock. The injection of the antiknock agent can be initiated by a signal from a knock sensor. It can also be initiated when the engine torque is above a selected value or fraction of the maximum torque where the value or fraction of the maximum torque is a function of the engine speed. In a preferred embodiment, the injector injects the anti-knock agent after inlet valve/valves are closed. It is preferred that the anti-knock agent have a heat of vaporization that is at least twice that of gasoline or a heat of vaporization per unit of combustion energy that is at least three times that of gasoline. A preferred anti-knock agent is ethanol. In a preferred embodiment of this aspect of the invention, part of the fuel is port injected and the port injected fuel is gasoline. The directly injected ethanol can be mixed with gasoline or with methanol. It is also preferred that the engine be capable of operating at a manifold pressure at least twice that pressure at which knock would occur if the engine were to be operated with naturally aspirated gasoline. A suitable maximum ethanol fraction during a drive cycle when knock suppression is desired is between 30% and 100% by energy. It is also preferred that the compression ratio be at least 10. With the higher manifold pressure, the engine can be downsized by a factor of two and the efficiency under driving conditions increased by 30%.

lt is preferred that the engine is operated at a substantially stoichiometric air/fuel ratio during part or all of the time that the anti-knock agent such as ethanol is injected. In this case, a three-way catalyst can be used to reduce the exhaust emissions from the engine. The fuel management system may operate in open or closed loop modes.

In some embodiments, non-uniform ethanol injection is employed. Ethanol injection may be delayed relative to bottom dead center when non-uniform ethanol distribution is desired.

Many other embodiments of the invention are set forth in detail in the remainder of this application.

Brief Description of the Drawing

Fig. 1 is a graph of ethanol fraction (by energy) required to avoid knock as a function of inlet manifold pressure. The ethanol fraction is shown for various values of β, the ratio of the change in temperature in the air cylinder charge due to turbocharging (and aftercooling if used) to the adiabatic temperature increase of the air due to the turbocharger.

Fig. 2a is a graph of cylinder pressure as a function of crank angle for a three bar manifold pressure.

Fig. 2b is a graph of charge temperature as a function of crank angle for a three bar manifold pressure.

Fig. 3 is a schematic diagram of an embodiment of the fuel management system disclosed herein for maintaining stoichiometric conditions with metering/control of ethanol, gasoline, and air flows into an engine.

Figs. 4a and 4b are schematic illustrations relating to the separation of ethanol from ethanol/gasoline blends.

Fig. 5 is a cross-sectional view of a flexible fuel tank for a vehicle using ethanol boosting of a gasoline engine.

Description of the Preferred Embodiment

Ethanol has a heat of vaporization that is more than twice that of gasoline, a heat of combustion per kg which is about 60% of that of gasoline, and a heat of vaporization per unit of combustion energy that is close to four times that of gasoline. Thus the evaporative cooling of the cylinder air/fuel charge can be very large with appropriate direct injection of this antiknock agent. The computer model referenced below shows that evaporative cooling can have a very beneficial effect on knock suppression. It indicates that the beneficial effect can be maximized by injection of the ethanol after the inlet valve that admits the air and gasoline into the cylinder is closed. This late injection of the ethanol enables significantly higher pressure operation without knock and thus higher efficiency engine operation than would be the case with early injection. It is thus preferred to the conventional approach of early injection which is used because it provides good mixing. The model also provides information that can be used for open loop *(i.e.,* a control system that uses predetermined information rather than feedback) fuel management control algorithms.

The increase in gasoline engine efficiency that can be obtained from direct injection of ethanol is maximized by having the capability for highest possible knock suppression enhancement. This capability allows the highest possible amount of torque when needed and thereby facilitates the largest engine downsizing for a given compression ratio.

Maximum knock suppression is obtained with 100% or close to 100% use of direct injection of ethanol. A small amount of port injection of gasoline may be useful in order to obtain combustion stability by providing a more homogeneous mixture. Port fuel injection of gasoline also removes the need for a second direct fuel system or a more complicated system which uses one set of injectors for both fuels. This can be useful in minimizing costs.

The maximum fraction of ethanol used during a drive cycle will depend upon the engine system design and the desired level of maximum torque at different engine speeds. A representative range for the maximum ethanol fraction by energy is between 20% and 100%.

In order to obtain the highest possible octane enhancement while still maintaining combustion stability, it may be useful for 100% of the fuel to come from ethanol with a fraction being port injected, as an alternative to a small fraction of the port-fueled gasoline.

The initial determination of the knock suppression by direct injection of ethanol into a gasoline engine has been refined by the development of a computer model for the onset of knock under various conditions. The computer modeling provides more accurate information for use in fuel management control. It also shows the potential for larger octane enhancements than our earlier projections. Larger octane enhancements can increase the efficiency gain through greater downsizing and higher compression ratio operation. They can also reduce the amount of ethanol use for a given efficiency increase.

The computer model combines physical models of the ethanol vaporization effects and the effects of piston motion of the ethanol/gasoline/air mixtures with a state of the art calculational code for combustion kinetics. The calculational code for combustion kinetics was the engine module in the CHEMKIN 4.0 code [R. J. Kee, F. M. Rupley, J. A. Miller, M. E. Coltrin, J. F. Grear, E. Meeks, H. K. Moffat, A. E. Lutz, G. Dixon-Lewis, M.D. Smooke, J. Warnatz, G. H. Evans, R. S. Larson, R. E. Mitchell, L. R. Petzold, W. C.Reynolds, M. Caracotsios, W. E. Stewart, P. Glarborg, C. Wang, O. Adigun, W. G. Houf, C. P. Chou, S. F. Miller, P. Ho, and D. J. Young, CHEMKIN Release 4.0, Reaction Design, Inc., San Diego, CA (2004)]. The CHEMKIN code is a software tool for solving complex chemical kinetics problems. This new model uses chemical rates information based upon the Primary Reference gasoline Fuel (PRF) mechanism from Curran *et al.* [Curran, H. J., Gaffuri, P., Pitz, W. J., and Westbrook, C. K. "A Comprehensive Modeling Study of iso-Octane Oxidation," *Combustion and Flame* 129:253-280 (2002) to represent onset of autoignition.

The compression on the fuel/air mixture end-gas was modeled using the artifact of an engine compression ratio of 21 to represent the conditions of the end gas in an engine with an actual compression ratio of l0. The end gas is defined as the un-combusted air/fuel mixture remaining after 75% (by mass) of the fuel has combusted. It is the end gas that is most prone to autoignition (knock). The larger compression ratio includes the effect of the increase in pressure in the cylinder due to the energy released in the combustion of 75% of the fuel that is not in the end gas region. The effect of direct ethanol vaporization on temperature was modeled by consideration of the effects of the latent heat of vaporization on temperature depending upon the time of the injection.

The effect of temperature increase due to turbocharging was also included. The increase in temperature with turbocharging was calculated using an adiabatic compression model of air. It is assumed that thermal transfer in the piping or in an intercooler results in a smaller temperature increase. The effect is modeled by assuming that the increase in temperature of the air charge into the cylinder ΔT_{charge} is $\Delta T_{charge} = \beta \Delta T_{turbo}$ where ΔT_{turbo} is the temperature increase after the compressor due to boosting and beta is a constant. Values of β of 0.3, 0.4 and 0.6 have been used in the modeling. It is assumed that the temperature of the charge would be 380 K for a naturally aspirated engine with port fuel injection gasoline.

Fig. I shows the predictions of the above-referenced computer model for the minimum ethanol fraction required to prevent knock as a function of the pressure in the inlet manifold, for various values of β. In Fig. 1 it is assumed that the direct injection of the ethanol is late (i.e. after the inlet valve that admits air and gasoline to the cylinder is closed) and a 87 octane PRF (Primary Reference Fuel) to represent regular gasoline. The corresponding calculations for the manifold temperature are shown in Table 1 for the case of a pressure in the inlet manifold of up to 3 bar for an engine with a conventional compression ratio of 10. The temperature of the charge varies with the amount of ethanol directly injected and is self-

consistently calculated in Table 1 and Fig. I.The engine speed used in these calculations is 1000 rpm.

Table 1

Computer model calculations of temperature and ethanol fraction required for knock prevention for an inlet manifold pressure of 3 bar for an engine with a compression ratio of 10, for various values of β (ratio of change of the cylinder air charge temperature due to turbocharging to the adiabatic temperature increase due to turbocharging $\Delta T_{charge} = \beta \Delta T_{turbo}$). The engine speed is 1000 rpm.

β		0.3	0.4	0.6
T_charge init	K	380	380	380
Delta T turbo	K	180	180	180
Delta T after intercooler	K	54	72	108
Delta T due to DI ethanol and gasoline	K	-103	-111	-132
T_init equivalent charge	K	331	341	356
Gasoline octane		87	87	87
Ethanol fraction (by energy) needed to prevent knock		74%	82%	97%

Direct fuel injection is normally performed early, before the inlet valve is closed in order to obtain good mixing of the fuel and air. However, our computer calculations indicate a substantial benefit from injection after the inlet valve is closed.

The amount of air is constant in the case of injection after the inlet valve has closed. Therefore the temperature change is calculated using the heat capacity of air at constant volume (c_v). The case of early injection where the valve that admits air and fuel to the cylinder is still open is modeled with a constant-pressure heat capacity (c_p). The constant volume case results in a larger evaporation induced decrease in charge temperature than in the case for constant pressure, by approximately 30%. The better evaporative cooling can allow operation at higher manifold pressure (corresponding to a

greater octane enhancement) without knock that would be the case of early injection by a difference of more than 1 bar. The increase in the evaporative cooling effect at constant volume relative to that at constant pressure is substantially higher for the case of direct injection of fuels such as ethanol and methanol than is the case for direct injection of gasoline.

Typical results from the calculations are shown in Fig. 2. The figure shows the pressure (a) and the temperature (b) of the cylinder charge as a function of crank angle, for a manifold pressure of 3 bar and a value of $\beta = 0.4$ Two values of the ethanol fraction are chosen, one that results in autoignition, and produces engine knock (0.82 ethanol fraction by fuel energy), and the other one without autoignition, i.e., no knock (0.83 ethanol fraction). Autoignition is a threshold phenomenon, and in this case occurs between ethanol fractions of 0.82 and 0.83. For an ethanol energy fraction of 0.83, the pressure and temperature rise at 360° (top dead center) is due largely to the compression of the air fuel mixture by the piston. When the ethanol energy fraction is reduced to 0.82, the temperature and pressure spikes as a result of autoignition. Although the autoignition in Figure 2 occurs substantially after 360 degrees, the autoignition timing is very sensitive to the autoignition temperature (5 crank angle degrees change in autoignition timing for a change in the initial temperature of 1 K, or a change in the ethanol energy fraction of 1%).

The effect of evaporative cooling from the antiknock agent (in this case, ethanol) is shown in Table 2, where three cases are compared. The first one is with port fuel injection of ethanol. In this case the vaporization of the ethanol on the walls of the manifold has a negligible impact on the temperature of the charge to the cylinder because the walls of the manifold are cooled rather than the air charge. The second case assumes direct injection, but with the inlet valve open, with evaporation at constant pressure, where the cooling of the charge admits additional air to the cylinder. The third case assumes, as in the previous discussions, late injection after the inlet valve has

closed. It is assumed stoichiometric operation, that the baseline temperature is 380 K, and that there is cooling in the manifold after the turbocharger with $\beta = 0.4$.

Table 2

Knock-free operation of ethanol port fuel injection (assuming no charge cooling) and of direct injection before and after the inlet valve is closed. Compression ratio of 10, baseline charge temperature of 380 K, intercooler/cooling post turbo with $\beta = 0.4$, stoichiometric operation, gasoline with 87 RON. Engine speed is 1000 rpm.

	No Evaporative Cooling	Evaporative cooling	
		Before Valve Closing	After Valve Closing
Ethanol fraction (by energy)	0.95	0.95	0.95
Max manifold pressure (bar)	1.05	2.4	4.0
Cylinder pressure after cooling (bar)	1.05	2.4	3.0
Cylinder charge temperature after cooling (K)	383	360	355

The results indicate the strong effect of the cooling. The maximum manifold pressure that prevents knock (without spark retard), with 0.95 ethanol fraction by energy in the case of port fuel injection is 1.05 bar. With direct injection of the ethanol, the maximum knock-free manifold and cylinder pressures are 2.4 bar, with a temperature decrease of the charge of ~75K. The final

case, with injection after inlet valve closing, allows a manifold pressure of 4 bar, a cylinder pressure (after cooling) of 3 bar, and a charge temperature decrease of ~120K. It should be noted that the torque of the late injection case after the valve has closed is actually higher than that of the early injection case, even though the early injection case allows for additional air (at constant pressure). For comparison, the model is also used to calculate the manifold pressure at which knock would occur for port fuel injection of 87 octane gasoline alone. This pressure is ~ 0.8 bar assuming spark timing at MBT (Maximum Brake Torque). Conventional gasoline engines operate at 1 bar by retarding the timing at high torque regions where knock would otherwise occur. Thus the model indicates that evaporative cooling effect of direct injection of ethanol after the inlet valve has closed can be significantly greater than that of the higher octane number rating of ethanol relative to gasoline.

A manifold pressure of 4 bar is very aggressive. Table 2 is indicative of the dramatically improved performance of the system with direct injection after the inlet valve has closed. The improved performance in this case can be traded for increased compression ratio or reduced use of the anti-knock agent.

It should be noted that, as mentioned above, the calculations of autoignition (knock) are conservative, as autoignition for the case shown in Fig. 2 occurs relatively late in the cycle, and it is possible that the fuel has been combusted before it autoignites. Also it should be noted that the calculations in Fig. 2 break down after autoignition, as the pressure trace would be different from that assumed. Figures similar to Fig. 2 are used to determine conditions where autoignition would not occur, and those conditions are then used to provide the information for Fig. 1. The initial temperatures of the cases shown in Fig. 2 are 341 K for 0.82 ethanol fraction, and 340 K for 0.83 ethanol fraction, a difference of 1K (the difference due to the cooling effect of the ethanol).

Because of the large heat of vaporization, there could be enough charge cooling with early injection so that the rate of vaporization of ethanol is substantially decreased. By instead injecting into the hot gases, which is the case with injection after the inlet valve has

closed, the temperature at the end of full vaporization of the ethanol is substantially increased with respect to early injection, increasing the evaporation rate and minimizing wall wetting.

The optimum timing of the injection for best mixing and a near homogeneous charge is soon after the inlet valve closes, provided that the charge is sufficiently warm for antiknock agent vaporization. If, on the other hand, a non-uniform mixture is desired in order to minimize ethanol requirements and improve ignition stability, then the injection should occur later than in the case where the best achievable mixing is the goal.

Late injection of the ethanol after the inlet valve has closed can be optimized through the use of diesel-like injection schemes, such as injectors with multiple sprays. It is important to inject the fuel relatively quickly, and at velocities which minimize any cylinder wall wetting, which as described below could result in the removal of the lubrication oils from the cylinder liner. Multiple sprays from a nozzle that has multiple holes results in a distributed pattern of sprays, with relatively low injection velocities. This is particularly important for ethanol, because of the higher volume throughputs (as compared with gasoline) of ethanol for equal energy content.

Injection after the valve has closed may require that a modest fraction of the fuel (e.g. 25%) be port injected in order to achieve the desired combustion stability. A tumble-like or swirl motion can be introduced to achieve the desired combustion stability. The port injected fuel can be either gasoline or ethanol.

Use of the computer model for operation with gasoline alone gives results that are consistent with the observed occurrence of knock in gasoline engine vehicles, thereby buttressing the credibility of the projections for ethanol. The computer model indicates that for knock-free gasoline operation alone with a compression ratio of 10, knock imposes a severe constraint upon the allowed manifold pressure for a naturally aspirated gasoline engine and very limited *(i.e.,* less than 1.2 bar) manifold pressure can be achieved even with

direct injection of gasoline unless spark retard and/or rich operation is used. These changes, however, can reduce efficiency and increase emissions.

Fig. 1 shows that knock can be prevented at manifold pressures greater than 2 bar with direct injection of an ethanol fraction of between 40 and 80% in an engine with a compression ratio of 10. The manifold pressure can be at least 2.5 bar without engine knock. A pressure of 3 bar would allow the engine to be downsized to ~1/3 of the naturally aspirated gasoline engine, while still producing the same maximum torque and power. The large boosting indicated by the calculations above may require a multiple-stage turbocharger. In addition to a multiple stage turbocharger, the turbocharger may be of the twin-scroll turbo type to optimize the turbocharging and decrease the pressure fluctuations in the inlet manifold generated by a small number of cylinders.

With an increase in allowed manifold pressure in an engine by more than a factor of 2, the engine could be downsized by a factor of 2 (that is, the cylinder volume is decreased by a factor of 2 or more) and the compression ratio could be held constant or raised. For example, the performance of an eight cylinder engine is achieved by a four cylinder engine.

The occurrence of knock at a given value of torque depends upon engine speed. In addition to providing substantially more maximum torque and power, direct injection of ethanol can be used to provide a significant improvement in torque at low engine speeds (less than 1500 rpm) by decreasing or eliminating the spark retard. Spark retard is generally used with gasoline engines to prevent knock at low engine speeds where autoignition occurs at lower values of torque than is the case at high engine speeds.

Fig. 1 can also be used to determine the ethanol fraction required to prevent knock at different levels of torque and horsepower, which scale with manifold pressure in a given size engine. This information can be used in an open loop control system.

The efficiency of a gasoline engine under driving conditions using direct ethanol injection enhancement can be at least 20% and preferably at least 30% greater than that of a naturally aspirated gasoline engine with a compression ratio of 10. This increase results from the substantial engine boosting and downsizing to give the same power, and also the high compression ratio operation (compression ratio of 11 or greater) that is enabled by a large octane enhancement. With more aggressive downsizing of more than 50% (where the same engine performance is obtained with less than one-half the displacement), the increase in efficiency could exceed 30%.

Greater downsizing and higher efficiency may also be obtained by decreasing the octane requirement of the engine by using variable valve timing (VVT). Thus, at conditions of high torque, variable valve timing can be used to decrease the compression ratio by appropriately changing the opening/closing of the inlet and exhaust valves. The loss in efficiency at high torque has a small impact on the overall fuel economy because the engine seldom operates in these conditions.

VVT can also be used to better scavenge the exhaust gases [B. Lecointe and G. Monnier, "Downsizing a Gasoline Engine Using Turbocharging with Direct Injection" SAE paper 2003-01-0542]. Decreasing the exhaust gas decreases the air/fuel temperature. Keeping both the inlet and exhaust valves open, while the pressure in the inlet manifold is higher than in the exhaust, can be used to remove the exhaust gases from the combustion chamber. This effect, coupled with slightly rich operation in-cylinder, can result in increased knock avoidance while the exhaust is still stoichiometric. Cooled EGR and spark timing adjustment can also be used to increase knock avoidance.

Any delay in delivering high engine torque at low engine speeds can decrease drivability of the vehicle. Under these conditions, because of the substantial engine downsizing, the vehicle would have insufficient acceleration at low engine speeds until the turbo produces high pressures. This delay can be removed through the use of direct injection

of ethanol by reduction of the spark retard or ethanol/gasoline with rich operation and also with the use of variable valve timing.

Another approach would be to use an electrically assisted turbo charger. Units that can generate the required boosting for short periods of time are available. The devices offer very fast response time, although they have substantial power requirements.

A multiple scroll turbocharger can be used to decrease the pressure fluctuations in the manifold that could result from the decreased number of cylinders in a downsized engine.

The temperature of the air downstream from the turbocharger is increased by the compression process. Use of an intercooler can prevent this temperature increase from increasing the engine's octane requirement. In addition, in order to maximize the power available from the engine for a given turbocharging, cooling of the air charge results in increased mass of air into the cylinder, and thus higher power.

In order to minimize emissions, the engine should be operated substantially all of the time, or most of the time, with a stoichiometric air/fuel ratio in order that a 3-way exhaust catalyst treatment can be used. Fig. 3 shows a 3-way exhaust treatment catalyst 10 and air, gasoline and ethanol control needed to maintain the substantially stoichiometric ratio of fuel to air that is needed for its effective operation. The system uses an oxygen sensor 12 as an input to an electronic control unit (ECU) 14. The ECU 14 controls the amount of air into a turbocharger 16, the amount of gasoline and the amount of ethanol so as to insure stoichiometric operation. During transients, open-loop algorithms from a stored engine map (not shown) arc used to determine air, gasoline and ethanol flows for keeping substantially stoichiometric combustion in a cylinder of the engine 18.

Thus when variable ethanol octane enhancement is employed, the fuel management system needs to adjust the amounts of air, gasoline and ethanol such that the fuel/air ratio is substantially equal to 1. The additional control is needed because, if the air/gasoline ratio

420 determined by the fuel management were not be corrected during the injection of ethanol, the mixture would no longer be stoichiometric. In contrast to the lean boost approach of Stokes *el al.* [J. Stokes, T. H. Lake and R. J. Osborne, "A Gasoline Engine Concept for Improved Fuel Economy – The Lean Boost System," SAE paper 2000-01-2902] stoichiometric operation with a 3-way catalyst results in very low tailpipe emissions.
425

There are certain regions in the engine operating map where the ECU 14 may operate open loop, that is, the control is determined by comparison to an engine map lookup table rather than by feedback from a sensed parameter which in this case is engine knock (closed
430 loop). As mentioned previously, open loop operation during transients may be advantageous.

Another situation where open loop control can be advantageous would be under high load, where fuel rich conditions (where the fuel/air ratio is greater than stoichiometric) may
435 be required to decrease the temperature of the combustion and thus protect the engine and the exhaust system (especially during prolonged operation). The conventional approach in gasoline engine vehicles is to use increased fuel/air ratio, that is, operating at rich conditions. The presence of ethanol on-board allows for two alternatives. The first is the use of ethanol fuel fractions beyond what is required to control knock, thus reducing the
440 combustion temperature by a greater amount than could be obtained by gasoline alone due to the higher cooling effect of evaporation in direct ethanol injection, even while at stoichiometric conditions. The second one is, as in conventional applications, the use of increased fueling in rich operation (which could result in relative air/fuel mass ratios as low as 0.75 where a stoichiometric mixture has a relative air/fuel ratio of l). The control system
445 can choose between two fuels, ethanol and gasoline. Increased use of ethanol may be better than use of gasoline, with emissions that are less damaging to the environment than gasoline and decreased amount of rich operation to achieve the temperature control needed. Open loop operation with both gasoline and ethanol may require substantial modification of the engine's "lookup table."

Thus, a method of operating an engine is, under conditions of partial load, to operate closed loop with the use of only gasoline. As the engine load increases, the engine control system may change to open loop operation, using a lookup table.

The closed loop control of the engine can be such that a knock sensor (not shown) determines the fraction required of ethanol, while the oxygen sensor 12 determines the total amount of fuel. A variation of this scheme is to operate the knock control open loop, using a lookup table to determine the ethanol to gasoline ratio, but a closed loop to determine the total amount of fuel.

In order to minimize evaporative emission of the ethanol (which has a relatively low boiling point), solvents can be added to the ethanol to minimize the effect. An alternative means is to place an absorptive canister between the ethanol tank and the atmosphere that captures the ethanol and releases it when the engine is operational.

Because of the large cooling effect from ethanol, it has been known for some time that startup of a cold engine is difficult (for example, during the first 30 seconds). With the multiple fuels, it is possible to start up the engine without ethanol addition. Gasoline vaporizes easier than ethanol, and conventional operation with port-fuel or direct injected gasoline would result in easier engine start up. A greater fraction of gasoline than would be ordinarily used can be used to facilitate start-up operation at times during the first 30 seconds of engine operation.

Increased efficiency due to engine downsizing made possible through the use of 100% or close to 100% ethanol at the highest values of torque has the undesirable effect of requiring higher ethanol fractions. Hence the use of non-uniform ethanol distribution to minimize the use of ethanol at these values of torque becomes more attractive when achievement of the maximum efficiency gain is desired.

Below a certain value of torque or boost pressure it can be advantageous to use a non-uniform ethanol distribution in order to reduce the amount of ethanol that is used. Above certain torque or turbocharger or supercharger boost pressures, non-uniform charge would not be used since the engine is operating mostly on ethanol and ethanol non-uniformity cannot be used for minimizing ethanol consumption. This is especially important if the desired fraction is higher than 50%.

The capability to minimize the use of ethanol by non-uniform ethanol distribution in the cylinder can be realized by certain ethanol injection geometries. Ethanol can be injected in the periphery of a swirling charge. In order to minimize wall wetting by the ethanol, it would be convenient to achieve the injection in a manner such that the ethanol injection matches the swirling motion of the charge. The injection direction is thus positioned at an angle with respect to the main axis of the cylinder, injecting the ethanol with an angular direction component. Charge stratification in the case of swirl can be maintained by temperature stratification, with the cooler (and denser) regions in the periphery, which correspond to the end-gas zone.

An alternative or additional method to provide ethanol non-uniform distribution in the cylinder is to inject the ethanol relatively late with respect to bottom dead center. Thus the time for transport and diffusion of the ethanol is minimized. However, sufficient time should be allowed for full vaporization of the ethanol. As the temperatures are higher after Bottom-Dead-Center (BDC), the vaporization time is reduced, and it is less likely that the ethanol would wet the cylinder walls. Improved vaporization of the ethanol can also be achieved by using injectors that produce small droplets. The injector could be a single spray pattern injector with a relatively narrow directed jet. This type of jet would optimize the deposition of the ethanol in the desired region.

Creating a non-uniform ethanol distribution in the cylinder (in the outer regions of the cylinder) has two advantages. The first one is the increased cooling effect of the region that has the propensity to autoignite (knock), the end gas region. The second is that the central

region is not cooled, improving ignition and initial flame propagation. It is preferable to keep the central region hot, as having a fast flame speed early in the flame propagation has antiknock advantages, by reducing the burn time and the time for precombustion chemistry of the end gas. Minimizing the burn time decreases the propensity to knock, as there is no knock if the end gas is burned before it can autoignite. Thus it is possible to have good ignition properties of the air/fuel mixture, even under conditions where the gasoline is evenly spread throughout the cylinder.

Stratified operation can result in locally increased charge cooling. This is because the injected ethanol cools only a small fraction of the charge, and thus, for a given amount of ethanol, the local decrease in temperature is larger with stratified operation than the average decrease of temperature with uniform ethanol distribution. Late injection can aid in the formation of a non-uniform air/ethanol mixture as mixing time is limited. Since a fraction of the gasoline is port-fuel injected, it can be assumed that this fuel is homogeneously distributed in the cylinder, but ethanol is preferentially in the cooler edges (the end-gas). Thus, although overall the air/fuel charge is stoichiometric, locally near the spark it is lean while in the region of the end gas it is rich. Both of these conditions are advantageous, since the ignition occurs in a region with higher temperature (although slightly lean), while the outside is rich and cool, both of which are knock-suppressors.

In the case of swirl or tumble stratified air fuel charges with hot air/gasoline in the center and colder air/ethanol or air/ethanol/gasoline mixtures in the end gas, it is advantageous to place the spark in the region of the hot air/gasoline mixture (substantially near the center of the combustion chamber).

Ethanol consumption can be minimized if the gasoline is also directly injected. In this case, the heat of vaporization of gasoline is also useful in decreasing the temperature of the charge in the cylinder. The gasoline can be injected using a separate set of injectors. This would provide the most flexibility. However, it may be difficult to fit two sets of injectors per cylinder in the limited space in the cylinder head. An alternative means is to provide a

single set of injectors for injection of both the ethanol and the gasoline. Two options are possible, one in which there is a single nozzle and valve (and the gasoline and ethanol are co-injected), and one in which each fuel has a separate nozzle and valve.

Using direct injection of both the gasoline and the ethanol has the disadvantage of increased cost. In addition to a sophisticated injector or injectors, a second high pressure fuel pump is also needed. The ethanol and the gasoline also need to have parallel common plenums.

When a single nozzle is used, the ethanol and the gasoline are distributed in the same manner in the cylinder. In the case with a single nozzle and single valve, the fuels need to be mixed prior to the valve/nozzle part of the injector. This could be done either outside of the injector or in the injector body. The volume between the mixing point and the nozzle should be minimized to allow for fast response of the fuel mixture.

A slight modification of the above embodiment involves an injector that has two valves but a single nozzle. This minimizes the need for a second valve outside the injector for controlling the gasoline/ethanol mixture, in addition to minimizing the volume between the mixing point and the valves.

It is possible to use a separate nozzle/valve for each fuel in a single injector. In this case, the gasoline and the ethanol can be deposited in different regions of the cylinder. An additional advantage would be to provide different spray patterns for the ethanol and for the gasoline. This would provide the most flexible system (comparable to two independent injectors), with possibilities of simultaneous or asynchronous injection of varying fractions of ethanol/gasoline, as well as being able to deposit the ethanol and the gasoline in the desired location of the charge, for optimal non-uniform distribution of ethanol in the cylinder. Optimal distribution means knock avoidance with minimal consumption of ethanol, while maintaining engine drivability. Optimal non-uniform ethanol distribution can be obtained by centrally depositing the gasoline and by preferentially depositing the ethanol in

the periphery of the cylinder, where the end gas will be. This can be accomplished more easily with direct injection as opposed to achieving non-uniform distribution of the gasoline through non-uniform spraying in the inlet manifold. Because the heat of vaporization of the gasoline is substantially lower than for ethanol (a factor of 4 smaller on an energy basis), the cooling effect in the region near the spark is smaller, affecting less the initial flame propagation. In addition, it may be beneficial to retard the injection of the ethanol with respect to the gasoline.

When the ethanol has been exhausted, the engine can operate in a 'lower performance gasoline only' mode with turbocharger boost decrease (e.g. by a wastegate) and elimination or avoidance of operation at maximum torque levels. These conditions could be limiting, and in some cases a means of operating the vehicle at higher loads would be desired. This could be accomplished by using gasoline in the ethanol system with gasoline direct injection (GDI), while at the same time port-fuel injecting a fraction of the gasoline. Under these conditions the engine will operate at higher loads and higher torques, but still far below what ethanol could achieve. Only the cooling effect of the direct injection fuel is obtained, since the directly injected fuel has the same octane number as the port-injection fuel (gasoline in both cases).

If the ratio of ethanol in the ethanol fuel tank to gasoline in the gasoline fuel tank is lower than a predetermined value (because of the lack or availability of ethanol or for some other reason), it is possible to change the engine operation condition such that the ethanol/gasoline consumption ratio over a drive cycle is decreased. This is done for reducing the maximum ethanol fraction at a given engine speed that can be used in the engine. The allowed level of turbocharging and the maximum pressure, torque and horsepower would be correspondingly reduced to prevent knock. In this way, a continuous tradeoff between the ethanol/gasoline consumption ratio and the maximum torque and horsepower can be accomplished.

By proper expert system evaluation of the recent ethanol/gasoline usage and amounts of gasoline and ethanol it is possible to provide means to minimize the need of the 'low performance, gasoline only' mode. The usage of the antiknock agent can be restricted when the amount left in the tank is below a predetermined level, such that the main fuel will be exhausted prior to or simultaneously with the ethanol. It would be desirable to place a switch so that the operator could override the limitations, in those conditions where the desired vehicle operation will not be limited by the exhaustion of the antiknock agent.

Over a drive cycle, the amount of ethanol (by energy) required to enhance the octane number sufficiently to increase efficiency by at least 25% would be less than 15% of the fuel (ethanol + gasoline energy) without ethanol stratification and less than 5% with ethanol stratification.

Onboard separation of ethanol from diesel by fractional distillation has been demonstrated for use in ethanol exhaust aftertreatment catalysts ["Fuel-Borne Reductants for NOx Aftertreatment: Preliminary EtOH SCR Study", John Thomas, Mike Kass, Sam Lewis, John Storey, Ron Graves, Bruce Bunting, Alexander Panov, Paul Park, presented at the 2003 DEER (Diesel Engine Emissions Reduction) Workshop, Newport RI August 2003]. This approach could be employed for onboard separation of ethanol from a gasoline mixture. However, use of membrane separation can be simpler and less expensive. Although there is information about the use of membranes for the separation of ethanol from water, to our knowledge there is no available information on the membrane separation of ethanol from gasoline. Because the ethanol molecule is on the order of 4 Angstroms and the typical hydrocarbon fuel molecules are much larger, it is possible to use membranes for the separation. Both organic and inorganic membranes could be used. Since it is not necessary to obtain high purity ethanol, the process is relatively simple and requires low pressure.

Both porous and transfusion membranes can be used because ethanol with two carbon atoms has significantly different properties than most other gasoline compounds which have five

to ten carbon atoms. The other antiknock agents contemplated for use in this invention also have a small number of carbons relative to gasoline. For example, methanol has one carbon. The membrane approach can be significantly simpler than the distillation or absorption/desorption approaches (see Ilyama et al, US patent no. 6,332,448) that have been suggested for separation of various gasoline/diesel fuels where there is much less of a difference in the number of carbon atoms.

The location of the membrane could be in the region of high pressure in the fuel line (downstream from the pump), or upstream from it. If it is located downstream, the separation occurs only when the engine is operational and the pump is on, while if it is upstream the separation is continuous. The pressure of the fuel downstream from the pump is a few bars (characteristic of port fuel injection). This is to be differentiated from the pressure of the ethanol system, which is directly injected and thus requires much higher pressures.

The separated ethanol is transported to a separate tank where it is stored. If there is too much ethanol, three options are available: 1) additional separation is stopped; 2) some ethanol is used in the engine, even if not required 3) ethanol is returned to the main gasoline tank.

The tank should be reachable, in order to be able to introduce additional ethanol when required, as when towing, in high temperatures, or when doing extensive climbing, conditions that require operation at high torque and which if for extended periods of time would consume ethanol at a rate higher than what can be extracted from the fuel.

Extraction of ethanol from the gasoline can have the unintended effect of reducing the octane of the rest of the fuel. Thus, it is likely that somewhat increased use of injected ethanol would be required to prevent knock. Even in the case without non-uniform distribution of the ethanol, under normal driving conditions the system can be designed so that the amount of ethanol extracted from the fuel matches the required ethanol.

It may also be advantageous to separate the ethanol from a gasoline/ethanol mixture at the fueling station. As with onboard separation, this approach also allows use of the present fuel transportation infrastructure. The potential advantages could be greater flexibility in choice of a fuel separation system and lower cost relative to onboard separation. It may be of particular interest during the introductory phase of ethanol boosted engine vehicles.

It can be useful to have the capability to adjust the volume of the ethanol tank, thus varying the maximum amount of ethanol in the ethanol tank. This capability would make it possible to drive longer distances between ethanol refueling and to operate on different gasoline/ethanol ratios over a drive cycle, depending on the availability and cost of ethanol and gasoline. In some cases, it may be advantageous to use more ethanol than is needed to provide the desired octane enhancement *(e.g.,* to meet alternative fuel or CO_2 reduction goals). It is desirable to have this capability without increasing the overall fuel tank size. A single fuel tank with a membrane or plate separating variable amounts of gasoline and ethanol can be used to accomplish this goal.

The tank can be configured to have a horizontal or vertical moveable/deformable walls that are substantially impervious and separate the regions that are filled with gasoline and ethanol. Separate filling ports and fuel lines are incorporated for each region as shown in Figs. 4a and b. The separation between the gasoline and ethanol (or other anti-knock agent) does not have to be perfect since a small amount of leakage of one fuel into the other will not adversely affect operation of the vehicle. The wall can be moved in response to the amount of either fuel in the tank. This process is automatic in the case of a separating membrane, and the latter can be more impervious to leaks from one fuel to the other.

Ethanol is denser than gasoline. The movable/deformable wall can be placed such that the ethanol is located either on top of the gasoline or below the gasoline. However, since it is expected that less ethanol is required than gasoline, the preferred embodiment has the ethanol above the gasoline, as shown in Figure 5.

If the ethanol is stored so that it is separate from the gasoline, it can be mixed with various additives to insure the desired operation of the ethanol injection system. In addition, it is possible to use gasoline-ethanol mixtures, such as E85 (which contains 15% by volume of gasoline). The lubricity additives include fatty acids, organic amine salts (amine salts of acid phosphates and polyethyleneoxy acid phosphates), alkyl and aryl acid phosphates and dialkyl alkyl phosphonates.

The modeling calculations show that for direct injection of alcohols, the larger impact of knock suppression is not the intrinsic knock-resistance of the fuel antiknock agent but rather its high heat of vaporization. In order to evaluate alternatives to ethanol, Table 3 shows the properties of proposed fuel antiknock/alternative fuels. Although some of these additives have higher octane numbers than gasoline, some of them have a much larger effect on the cylinder charge temperature (Table 3 assumes injection after the inlet valve has closed). Some of these additives (mostly the ethers) have a comparable charge temperature effect to that of gasoline direct injection, and thus are of less interest. The alcohols have optimal properties for the application, with temperature changes that are a factor of 3 or larger than the temperature change due to gasoline direct injection (for 100% or near 100% operation with the additive). For ethanol, the change in temperature is a factor of more than 4 larger than that of gasoline, and for methanol the change is about 9 times larger. The temperature decrease of the air increases with the amount of oxygen in the fuel (in terms of the O/C ratio). Thus, it is highest for methanol, with an O/C ratio of 1, second for ethanol (O/C =2), and so on.

Table 3

Antiknock properties of various fuels (calculated from data obtained in SAE standard J 1297 Alternative Automotive Fuels, Sept 2002)

Fuel Type	Chemical formula	RON	MON	(R+M)/2	Net heat of Combustion MJ/kg	Latent heat of vaporization MJ/kg	Vaporization energy/heat of combustion	Stoic air/fuel ratio	Equiv. Latent heat of vaporization MJ/kg air	ΔT_{air} K
Gasoline					42.8	0.30	0.007	14.6	0.020	-28
Ethyl t-Buytl Ether	CH3CH2-O-C(CH3)3	118	102	110	36.3	0.31	0.009	12.1	0.026	-35
t-Amyl Methyl Ether	C2H5 C (CH3)2-O-CH3	111	98	105	36.3	0.32	0.009	12.1	0.027	-36
Toluene	C7H8	111	95	103	40.5	0.36	0.009	13.5	0.027	-37
Methyl t-Butil Ether	CH3-O-C(CH3)3	116	103	110	35.2	0.32	0.009	11.7	0.028	-37
Diisopropyl Ether	(CH3)2CH-O-CH(CH3)2	110	97	103	38.2	0.34	0.009	12.1	0.028	-39
t-Butly Alchohol	(CH3)3 C-OH	103	91	97	32.9	0.60	0.018	11.1	0.054	-74
Isopropanol	(CH3)2CHOH	118	98	108	30.4	0.74	0.024	10.4	0.071	-97
Methanol with cosolvent	50% methanol/TBA	114	96	105	26.5	0.88	0.033	8.8	0.100	-137
Ethanol	CH3CH2OH	129	102	115	26.7	0.91	0.034	9	0.102	-138
Methanol	CH3OH	133	105	119	20.0	1.16	0.058	6.4	0.181	-246

Also shown in Table 3 are the ratios of the heat of vaporization to the heat of combustion, a measure of the potential effects when used as antiknock agents. This parameter gives a measure of the amount of evaporative cooling for a given level of torque. The last entry, ΔT_{air}, measures the decrease in air temperature for a stoichiometric mixture with injection after the inlet valve closes. Although the effect clearly is maximized by the use of methanol, other considerations may make ethanol the preferred choice. Methanol is toxic and corrosive.

Hydrous ethanol (with a small amount of water) has the advantage of lower cost than pure (neat) ethanol. Removing the last 10% to 15% water from ethanol has significant expense and consumes considerable energy. Manufacturing facilities typically produce ethanol with about 10% water by volume unless there is a need for essentially pure (anhydrous) ethanol. It could be advantageous to use ethanol with a water concentration of 5% to 15% by volume.

By using a closed loop approach to identify engine knock, flexible gasoline grades (with different octane ratings) and flexible knock-prevention fuel grades can be used. An open loop system would require measurement of the quality of the antiknock additive.

Similarly, an open loop system would require determining the quality of the fuel (octane number). Closed loop operation allows the use of less expensive gasoline, when available, thus partially compensating for the more expensive anti-knock agent. It is also possible to use different antiknock fuel according to its availability, such as ethanol in the regions that produce and process corn, and methanol in those that have methanol production capabilities. Thus, the least expensive grade of gasoline available and the least expensive antiknock fuel can be used, allowing a decrease of the cost of operating the vehicle as well as increasing the availability of the antiknock fuel.

Although the above discussion has featured ethanol as an exemplary anti-knock agent, the same approach can be applied to other high octane fuel and fuel additives with high vaporization energies such as methanol (with higher vaporization energy per unit fuel), and other anti-knock agents such as isopropanol, tertiary butyl alcohol, or ethers such as methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE), or tertiary amyl methyl ether (TAME). It may be advantageous to use various mixtures of these fuels and additives with each other and with ethanol.

Particularly during the introduction phase of the present invention, the ethanol fueling could be performed by the use of containers, such as one-gallon containers. To facilitate ease of fueling an expandable pipe and funnel can be built into the ethanol fuel tank of the vehicle.

The ethanol in these containers would be denatured so as to prevent human consumption as an alcoholic beverage and could contain the additives described above. Ethanol sold for fuel, such as in Brazil, is denatured by a small fraction of gasoline (2%) among other denaturing agents (methanol, isopropanol and others).

Recycling of the container could take place at certain specific locations such as gasoline stations

Using a signal from a knock sensor to determine when and how much ethanol or other anti-knock agent must be used at various times in a drive cycle to prevent knock, the fuel management system can be employed to minimize the amount of ethanol or other anti-knock agent that is consumed over the drive cycle. If sufficient ethanol or other anti-knock agent is available, the fuel management system can also be used to employ more ethanol than would be needed to prevent knock. This would allow greater gasoline savings (the gasoline savings component from substitution of ethanol for gasoline would increase) and carbon dioxide reduction. In this case it may be desirable to operate at an anti-knock agent fraction which is either varied or constant during the drive cycle.

The contents of all of the references cited in this specification are incorporated by reference herein in their entirety.

It is recognized that modifications and variations of the inventions disclosed herein will be apparent to those of ordinary skill in the art and all such modifications and variations are included within the scope of the appended claims.

What is claimed is:

1. A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and increases knock suppression by evaporative cooling and where fueling is also provided by a second fueling system that injects fuel into a region outside of the cylinder;

and where there is a first torque range wherein both fueling systems are used throughout this range;

and wherein the fraction of fuel in the cylinder that is introduced by the first fueling system increases with increasing manifold pressure;

and where fueling from the second fueling system alone is used when the torque is decreased below the lower end of the first torque range.

2. The fuel management system of claim 1 where the maximum knock suppression during a driving cycle is provided by operation with fueling from both fueling systems.

3. The fuel management system of claims 1 or 2 where the combustion stability is greater with operation of the first fueling system and the second fueling system than operation with the first fueling system alone.

4. The fuel management system of claim 1 where variable valve timing is used.

5. The fuel management system of claim 1 where the fraction of fuel provided by the first fueling system increases with manifold pressure so as to prevent knock.

6. The fuel management system of claim 1 where variable valve timing is used so as to reduce the fraction of fuel provided by the first fueling system.

7. The fuel management system of claim 1 where as the manifold pressure is increased, the increase in the fraction of fuel in the cylinder that is provided by the first fueling system is matched to that needed to prevent knock, during at least part of pressure range in which both the first and second fueling systems are used.

8. The fuel management system of claim 7 where the increase in the fraction of fuel provided by the first fueling system is matched to that needed to prevent knock throughout the entire first torque range.

9. The fuel management system of claim 1 where when the pressure in the manifold is increased, the fraction of fuel in the cylinder that is provided by the first fueling system is increased and is the minimum needed to prevent knock.

10. The fuel management system of claim 1 where only second fueling system is used between zero torque and the lowest torque in the first torque range.

11. The fuel management system of claim 1 where the lowest torque in the first torque range is the lowest torque at which the first fueling system is needed to prevent knock.

12. The fuel management system of claim 1 where the second fueling system uses port fuel injection.

13. The fuel management system of claim 1 where the first fueling system is operated so as to minimize wall wetting.

14. The fuel management system of claim 1 where during the first 30 seconds of operation all of the fuel is provided by the second fueling system.

15. The fuel management system of claim 1 where during engine start up all of the fuel is provided by the second fueling system.

16. The fuel management system of claim 1 where during engine startup a higher fraction of fuel is provided by the second fueling system than would ordinarily be used.

17. A fuel management system for a turbocharged spark ignition engine where during part of the drive cycle the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and increases knock suppression by evaporative cooling and from a second fueling system that injects fuel into a region outside of the cylinder;

and where the fuel from the first fueling system is injected so as to provide a non uniform distribution of fuel in the cylinder;

and where there is a range of torque throughout which both fueling systems are used;

and where the- fraction of fuel in the cylinder that is introduced by the first fueling system increases with increasing manifold pressure so as to prevent knock.

18. The fuel management system of claim 17 where second fuel system uses\ port fuel injection.

19. A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and increases knock suppression by evaporative cooling and from a second fueling system that injects fuel into a region outside of the cylinder;

and where there is a range of torque throughout which both fueling systems are used;

and where the fraction of fuel in the cylinder that is introduced by the first fueling system increases with increasing manifold pressure so as to prevent knock by providing increased knock resistance;

and where the fuel management system controls the change in the fraction of fuel introduced by the first fueling system using closed loop control that utilizes a sensor that detects knock;

and where the direct injection of fuel by the first fueling system is carried out so as to minimize wall wetting.

20. The fuel management system of claim 19 where the timing of the direct injection of fuel by the first fueling system is carried out so as to minimize wall wetting.

21. The fuel management system of claim 19 where the fuel is directly injected so that it encounters higher temperature gas when it is injected.

22. The fuel management system of claim 19 where the directly injected fuel is introduced in the cylinder after the inlet valve has closed.

23. The fuel management system of claim 19 where open loop control is also used.

24. The fuel management system of claim 23 where open loop control is used during transients in load.

25. A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and increases knock suppression by evaporative cooling and where fueling is also provided by a second fueling system fueling system that uses port fuel injection

and where there is a first torque range where fueling from the first fueling system is used throughout this range;

and where fueling from the second fueling system alone is used when the torque is decreased below the lower end of the first torque range.

26. The fuel management system of claim 25 where the second fueling system is also used throughout the first torque range.

27. The fuel management system of claim 25 where fueling from the second fueling system is used between zero torque and the lowest torque of the first torque range.

28. The fuel management system of claim 25 or 27 where the lowest torque in the first torque range is the lowest torque at which fueling from the first fueling is needed to prevent knock.

29. The fuel management system of claim 27 where when the highest knock resistance is required both the first and second fueling systems are used.

30. The fuel management system of claim 25 where for the first 30 seconds of engine operation more fueling is provided by the second fueling system that would ordinarily be the case.

31. The fuel management system of claim 25 where all of the fueling is provided by the second fueling system during the first 30 seconds of operation.

Abstract of the Disclosure

Fuel management system for enhanced operation of a spark ignition gasoline engine. Injectors inject an anti-knock agent such as ethanol directly into a cylinder. It is preferred that the direct injection occur after the inlet valve is closed. It is also preferred that stoichiometric operation with a three way catalyst be used to minimize emissions. In addition, it is also preferred that the anti-knock agents have a heat of vaporization per unit of combustion energy that is at least three times that of gasoline.

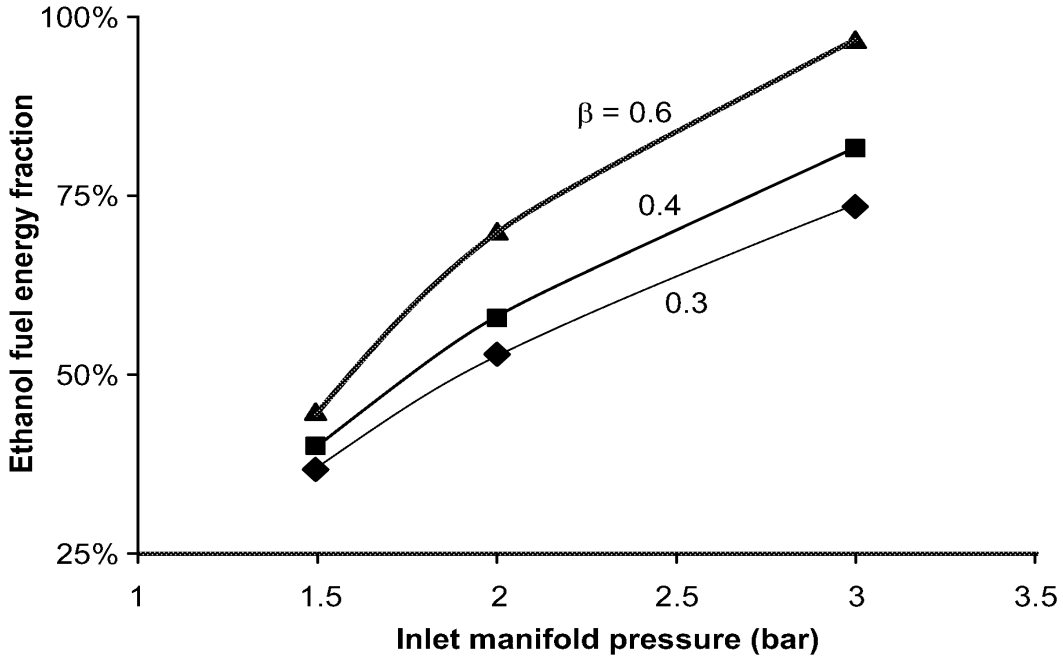
100%
75%
50%
25%
Ethanol fuel energy fraction
β = 0.6
0.4
0.3
1
1.5
2
2.5
3
3.5
Inlet manifold pressure (bar)

FIG. 1

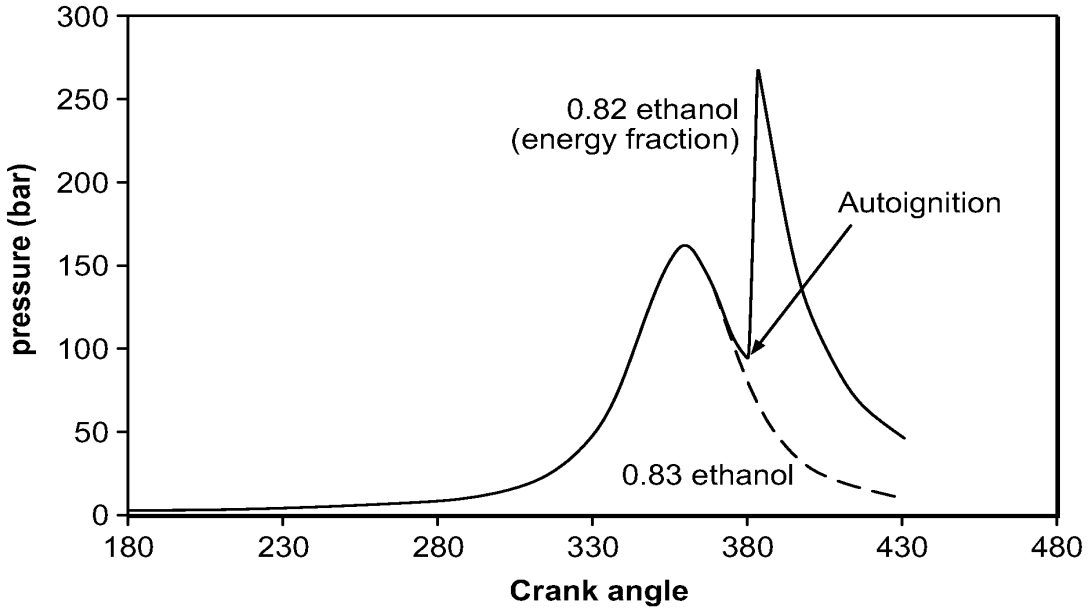
300
250
200
150
100
50
0
pressure (bar)
0.82 ethanol
(energy fraction)
Autoignition
0.83 ethanol
180
230
280
330
380
430
480
Crank angle

FIG. 2A

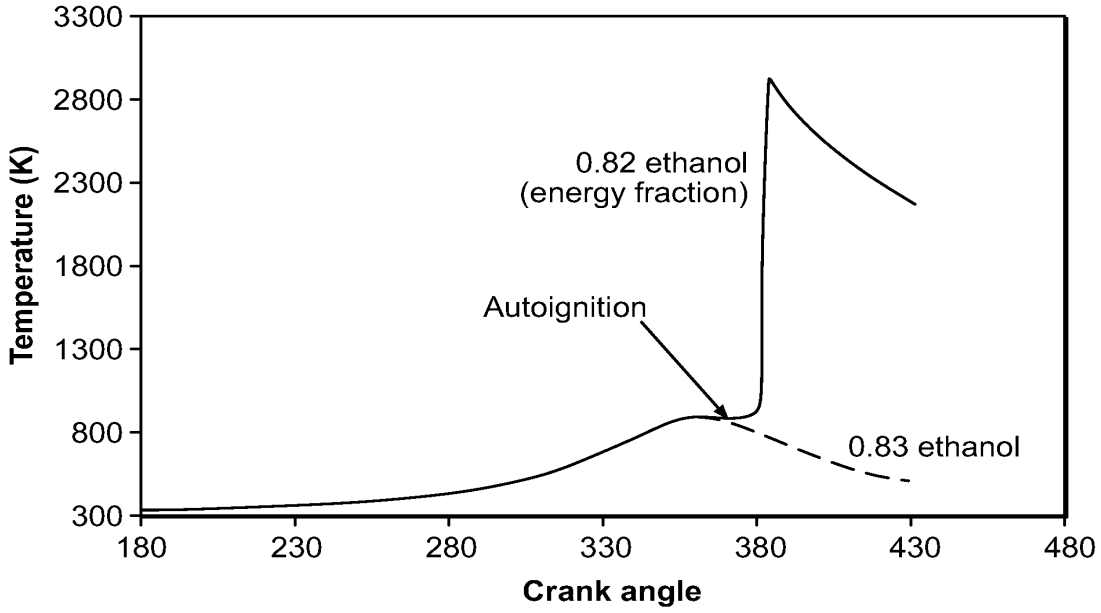
3300
2800
2300
1800
1300
800
300
Temperature (K)
0.82 ethanol
(energy fraction)
Autoignition
0.83 ethanol
180
230
280
330
380
430
480
Crank angle

FIG. 2B

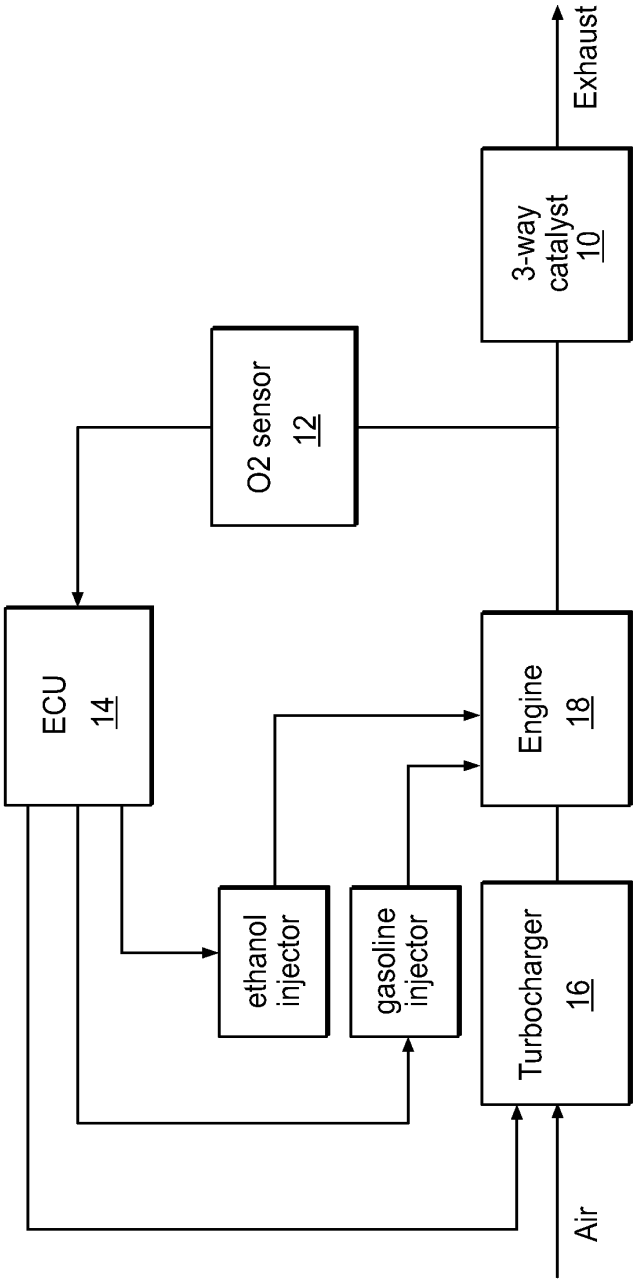
Exhaust
3-way catalyst 10
O2 sensor 12
ECU 14
Engine 18
ethanol injector
gasoline injector
Turbocharger 16
Air

FIG. 3

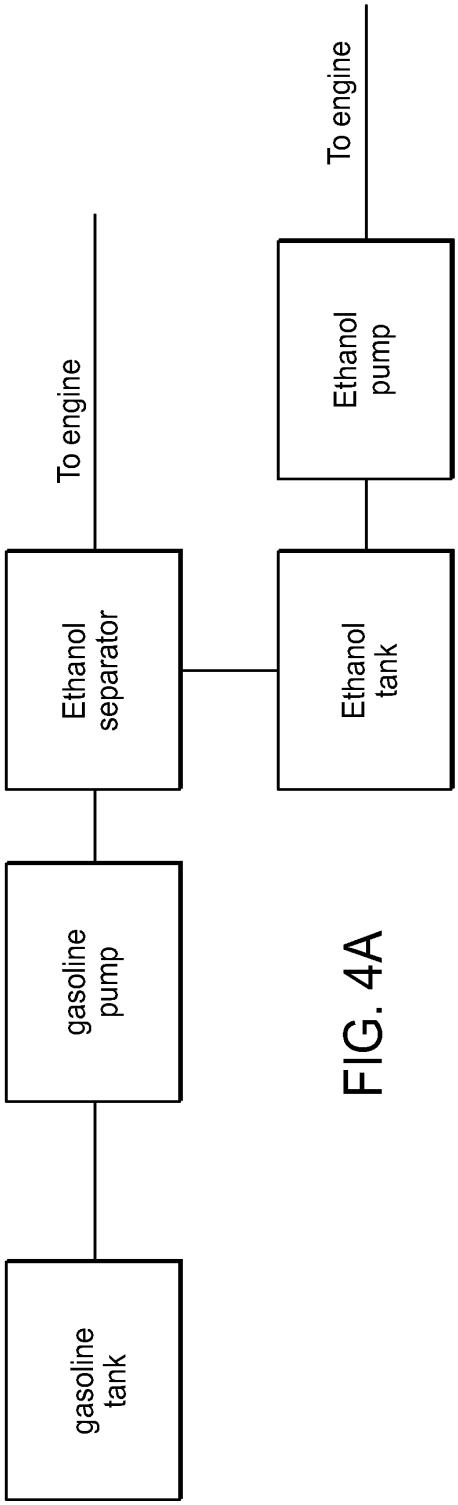
gasoline tank
gasoline pump
Ethanol separator
To engine
Ethanol tank
Ethanol pump
To engine

FIG. 4A

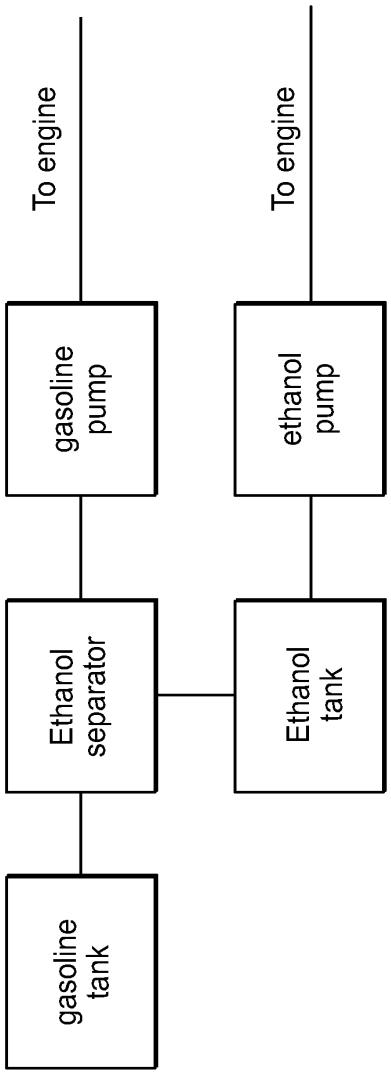
gasoline tank
Ethanol separator
gasoline pump
To engine
Ethanol tank
ethanol pump
To engine

FIG. 4B

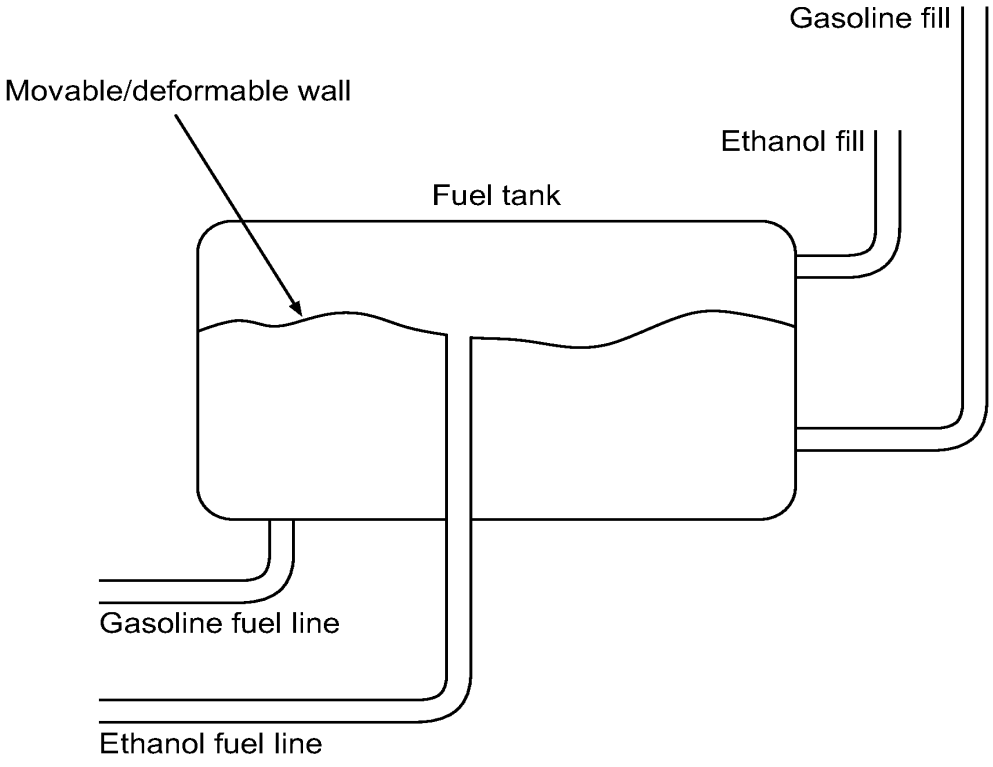
Gasoline fill
Movable/deformable wall
Ethanol fill
Fuel tank
Gasoline fuel line
Ethanol fuel line

FIG. 5

Electronic Patent Application Fee Transmittal					
Application Number:					
Filing Date:					
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES				
First Named Inventor/Applicant Name:	Leslie Bromberg				
Filer:	Sam Pasternack/Abram Barrett				
Attorney Docket Number:	11381.122997				
Filed as Large Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
UTILITY APPLICATION FILING		1011	1	280	280
UTILITY SEARCH FEE		1111	1	600	600
UTILITY EXAMINATION FEE		1311	1	720	720
Pages:					
Claims:					
CLAIMS IN EXCESS OF 20		1202	11	80	880
INDEPENDENT CLAIMS IN EXCESS OF 3		1201	1	420	420
MULTIPLE DEPENDENT CLAIMS		1203	1	780	780

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		3680

Electronic Acknowledgement Receipt	
EFS ID:	28674648
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	20-MAR-2017
Filing Date:	
Time Stamp:	12:30:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$3680
RAM confirmation Number	032017INTEFSW00011483192553
Deposit Account	192553
Authorized User	Abram Barrett
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	11381122997ADS.pdf	1318177 e796bd14df7671ce549a800f810f610e1db310df	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
2	Specification	11381122997Spec.pdf	371575 62fd3479f910d88558ffbe3d52c1e448db1ee5f0	no	34
Warnings:					
Information:					
3	Drawings-only black and white line drawings	11381122997Figs.pdf	33659 f68acd25c7f1cc0023b71251ffca16bde3442058	no	5
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	39893 051eef64c05ad5633ce55a8ebdabb39d8c39229a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1763304		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Document code: WFEE

United States Patent and Trademark Office
Sales Receipt for Accounting Date: 03/27/2017

ASAHLE	SALE	#00000001	Mailroom Dt:	03/20/2017		192553	15463100
		01	FC : 1051	140.00	DA		
		02	FC : 1202	160.00	DA		

ATTORNEY DOCKET NO.: 11381.122997
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Leslie Bromberg

Examiner: Not Yet Assigned

Application No.: 15/463,100

Art Unit: 3747

Filing Date: 03-20-2017

Confirmation No.: 1002

Title: OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

Petition to Make Special Under C.F.R. 1.102(C) (1)

Via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

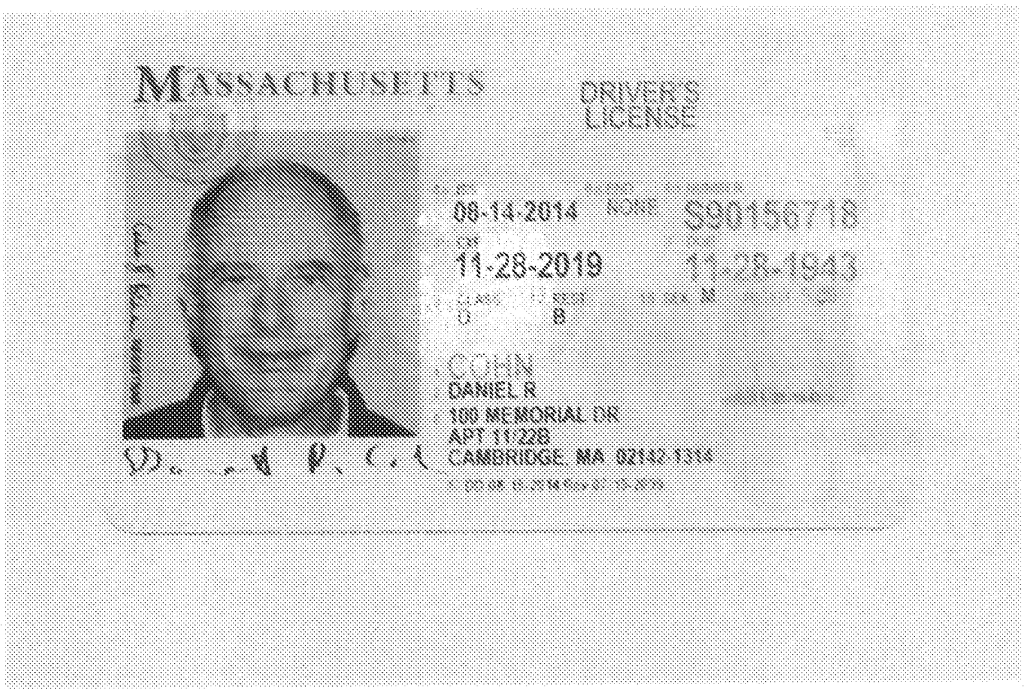
It is requested that the examination of the above identified patent application be advanced based on the age of the applicant.

As shown in the attached Exhibit, Daniel R. Cohn was born on November 28, 1943 and is therefore over 65 years of age.

Respectfully Submitted,

Sam (Bo) Pasternack
Registration Number: 29576
Massachusetts Institute of Technology
One Cambridge Center
Room NE18-501
Cambridge, MA 02142
617.258.7171

Exhibit


MASSACHUSETTS
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08-14-2014
S9015671B
11-28-2019
11-28-1943
M
COHN
DANIEL R
100 MEMORIAL DR
APT 11-22B
CAMBRIDGE, MA 02142-1314

Electronic Acknowledgement Receipt	
EFS ID:	28708251
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	22-MAR-2017
Filing Date:	
Time Stamp:	16:18:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Petition to make special based on Age/ Health	11381122997PetitionSpecial.pdf	381139 19b61e3d0f4549178068fe2463af8111c680cd8a	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	381139

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/463,100	03/20/2017	3747	3980	11381.122997	31	4

CONFIRMATION NO. 1002

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

FILING RECEIPT

OC000000090184904

Date Mailed: 03/29/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Leslie Bromberg, Sharon, MA;
Daniel R. Cohn, Cambridge, MA;
John B. Heywood, Newtonville, MA;

Applicant(s)

Massachusetts Institute of Technology, Cambridge, MA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 14/807,125 07/23/2015
and is a CON of 14/220,529 03/20/2014 ABN
and is a CON of 13/546,220 07/11/2012 ABN
and is a CON of 11/758,157 06/05/2007 ABN
and is a CON of 11/100,026 04/06/2005 PAT 7225787
and is a CON of 10/991,774 11/18/2004 PAT 7314033

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: No

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/27/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/463,100**

Projected Publication Date: 07/06/2017

Non-Publication Request: No

Early Publication Request: No

Title

OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

Preliminary Class

123

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
15463100	

Applicant(s) Leslie Bromberg

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1					
2		1				
3		2				
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50						
Total Indep	4		0		0	
Total Depend	29	↵	0	↵	0	↵
Total Claims	33		0		0	

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	11381.122997

CONFIRMATION NO. 1002

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

INFORMAL NOTICE

OC000000090184905

Date Mailed: 03/29/2017

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Leslie Bromberg
  Daniel R. Cohn
  John B. Heywood

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/amanalac/

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/463,100

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	33 minus 20 =	* 13			OR	x 80 =	1040
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 420 =	420
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							780
			TOTAL			TOTAL	3840

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	11381.122997

CONFIRMATION NO. 1002

IMPROPER CFR REQUEST

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

OC000000090184954

Date Mailed: 03/29/2017

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Continuity, Priority Claims, Petitions, and Non-Publication Requests

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- One or more of the benefit claims under 35 U.S.C. § 120 cannot be included on the Filing Receipt since applicant did not specify whether the application is a continuation, divisional or continuation-in-part of the prior application. Applicant must submit a new application data sheet (ADS) that sets forth the relationship, and the ADS must be accompanied by a petition under 37 CFR 1.78 if filed after the time period set forth in 37 CFR 1.78.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/dmnguyen/

ATTORNEY DOCKET NO.: 11381.122997
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Massachusetts Institute of Technology	Examiner: Not Yet Assigned
Serial No.: 15/463,100	Art Unit: 3747
Filing Date: 03-20-2017	Confirmation No.: 1002

Title: OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

REQUEST FOR CORRECTED FILING RECEIPT

Via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant hereby requests that a corrected Filing Receipt be issued in the above-identified patent application. The official Filing Receipt received by Applicant contains an error in the Benefit Claims.

Applicant hereby submits a Supplementary Application Data Sheet that indicates the Benefit Claims relationship.

Applicant additionally requests that all pertinent U.S. Patent and Trademark Office records relating to the subject application be changed to reflect this correction.

Applicant believes no fee is due with this request. However, if a fee is due, please charge our Deposit Account No. 192553 under Docket No. 11381.122997 from which the undersigned is authorized to draw

Respectfully Submitted,

Sam (Bo) Pasternack
Registration Number: 29576
Massachusetts Institute of Technology
One Cambridge Center
Room NE18-501
Cambridge, MA 02142
617.258.7171

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Leslie		Bromberg	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Sharon	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	176 Wilshire Drive		
Address 2			
City	Sharon	State/Province	MA
Postal Code	02067-1562	Country i	US

Inventor 2 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Daniel	R.	Cohn	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Cambridge	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	100 Memorial Drive, Apt 11-22 B		
Address 2			
City	Cambridge	State/Province	MA
Postal Code	02142	Country i	US

Inventor 3 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	John	B.	Heywood	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

City	Newtonville	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	218 Mill St.		
Address 2			
City	Newtonville	State/Province	MA
Postal Code	02460-2444	Country i	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	91197		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines		
Attorney Docket Number	11381.122997	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.**

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	(◉) Customer Number	( ) US Patent Practitioner	( ) Limited Recognition (37 CFR 11.9)
Customer Number	91197		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	14/807125	2015-07-23
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	14/220529	2014-03-20
Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13/546220	2012-07-11
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	12/701034	2010-02-05	8468983	2013-06-25

Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	11/758157	2007-06-05
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	11/100026	2005-04-06	7225787	2007-06-05

Prior Application Status	Patented	Remove

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	10/991774	2004-11-18	7314033	2008-01-01

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☒

Organization Name	Massachusetts Institute of Technology		
Mailing Address Information For Applicant:			
Address 1	77 Massachusetts Avenue		
Address 2			
City	Cambridge	**State/Province**	MA
Country	US	Postal Code	02139
Phone Number		Fax Number	

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Email Address	

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee Including Non-Applicant Assignee:

Address 1			
Address 2			
City		State/Province	
Country[i]		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature				Date (YYYY-MM-DD)	2017-03-20
First Name	Sam	Last Name	Pasternack	Registration Number	29576

Additional Signature may be generated within this form by selecting the Add button.

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Electronic Acknowledgement Receipt

EFS ID:	29038236
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	26-APR-2017
Filing Date:	20-MAR-2017
Time Stamp:	16:37:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Corrected Filing Receipt	11381122997RCFR.pdf	373655 97f97c2c2a85c5d77d53901d1a222749b3e36f00	no	2

Warnings:

Information:					
2	Application Data Sheet	11381122997SupADS.pdf	1492156 4864bc0e818eab16fd7aaa4247cf18dc57969a27	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
		Total Files Size (in bytes):	1865811		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	11381.122997

CONFIRMATION NO. 1002

IMPROPER CFR REQUEST

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

OC000000090985061

Date Mailed: 04/28/2017

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Power of Attorney, Claims, Fees, System Limitations, and Miscellaneous

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- The ADS submitted on _04/26/2017_ was not properly marked up to show the desired changes. For information being changed relative to the information already of record, additions must be shown with underlining, and deletions must be shown with strike-through or brackets. See 37 CFR 1.76(c)(2)

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mmasfaw/

ATTORNEY DOCKET NO.: 11381.122997
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Massachusetts Institute of Technology	Examiner: Not Yet Assigned
Serial No.: 15/463,100	Art Unit: 3747
Filing Date: 03-20-2017	Confirmation No.: 1002

Title: OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

REQUEST FOR CORRECTED FILING RECEIPT

Via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant hereby requests that a corrected Filing Receipt be issued in the above-identified patent application. The official Filing Receipt received by Applicant contains an error in the Benefit Claims.

Applicant hereby submits a Supplementary Application Data Sheet that indicates the Benefit Claims relationship.

Applicant additionally requests that all pertinent U.S. Patent and Trademark Office records relating to the subject application be changed to reflect this correction.

Applicant believes no fee is due with this request. However, if a fee is due, please charge our Deposit Account No. 192553 under Docket No. 11381.122997 from which the undersigned is authorized to draw

Respectfully Submitted,

Sam (Bo) Pasternack
Registration Number: 29576
Massachusetts Institute of Technology
One Cambridge Center
Room NE18-501
Cambridge, MA 02142
617.258.7171

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Leslie		Bromberg	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Sharon	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	176 Wilshire Drive		
Address 2			
City	Sharon	State/Province	MA
Postal Code	02067-1562	Country	US

Inventor 2 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Daniel	R.	Cohn	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Cambridge	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	100 Memorial Drive, Apt 11-22 B		
Address 2			
City	Cambridge	State/Province	MA
Postal Code	02142	Country	US

Inventor 3 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	John	B.	Heywood	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	

Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines

City	Newtonville	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	218 Mill St.		
Address 2			
City	Newtonville	State/Province	MA
Postal Code	02460-2444	Country	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence information of this application.**

Customer Number	91197		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines		
Attorney Docket Number	11381.122997	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	(●) Customer Number	( ) US Patent Practitioner	( ) Limited Recognition (37 CFR 11.9)
Customer Number	91197		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	14/807125	2015-07-23
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	14/220529	2014-03-20
Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13/546220	2012-07-11
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	12/701034	2010-02-05	8468983	2013-06-25

Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	11/758157	2007-06-05
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	11/100026	2005-04-06	7225787	2007-06-05

Prior Application Status	Patented		Remove

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	10/991774	2004-11-18	7314033	2008-01-01

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[1] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[1]	Filing Date (YYYY-MM-DD)	Access Code[1] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices

Supplemental ADS

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	

Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◯ Assignee	◯ Legal Representative under 35 U.S.C. 117	◯ Joint Inventor
◯ Person to whom the inventor is obligated to assign.	◯ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :	

If the Applicant is an Organization check here. ☒

Organization Name	Massachusetts Institute of Technology

Mailing Address Information For Applicant:

Address 1	77 Massachusetts Avenue		
Address 2			
City	Cambridge	**State/Province**	MA
Country	US	Postal Code	02139
Phone Number		Fax Number	

Supplemental ADS

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11381.122997
	Application Number	

Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines

Email Address	

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		State/Province	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature				Date (YYYY-MM-DD)	2017-03-30
First Name	Sam	Last Name	Pasternack	Registration Number	29578

Additional Signature may be generated within this form by selecting the Add button.

Supplemental ADS

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	11301.122997
	Application Number	
Title of Invention	Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines	

Electronic Acknowledgement Receipt	
EFS ID:	29316940
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	25-MAY-2017
Filing Date:	20-MAR-2017
Time Stamp:	16:34:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Corrected Filing Receipt	11381122997RCFR.pdf	373655 97f97c2c2a85c5d77d53901d1a222749b3e36f00	no	2

Warnings:

Information:					
2	Application Data Sheet	11381122997SupADS2.pdf	5414645 f97d95327db61a777d5eea94c1be6dcfc7b18d57	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
		Total Files Size (in bytes):	5788300		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/463,100	03/20/2017	3747	3980	11381.122997	31	4

CONFIRMATION NO. 1002

CORRECTED FILING RECEIPT

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

OC000000091688914

Date Mailed: 06/01/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Leslie Bromberg, Sharon, MA;
Daniel R. Cohn, Cambridge, MA;
John B. Heywood, Newtonville, MA;

Applicant(s)

Massachusetts Institute of Technology, Cambridge, MA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 14/807,125 07/23/2015
and is a CON of 14/220,529 03/20/2014 ABN
and is a CON of 13/546,220 07/11/2012 ABN
and is a CON of 12/701,034 02/05/2010 PAT 8468983
and is a CON of 11/758,157 06/05/2007 ABN
and is a CON of 11/100,026 04/06/2005 PAT 7225787
and is a CON of 10/991,774 11/18/2004 PAT 7314033

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: No

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/27/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/463,100**

Projected Publication Date: 07/06/2017

Non-Publication Request: No

Early Publication Request: No

Title

OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

Preliminary Class

123

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Office of Petitions: Routing Sheet

Application No. 15463100

This application is being forwarded to your office for further processing. A decision has been rendered on a petition filed in this application, as indicated below. For details of this decision, please see the document PET.OP.DEC filed on the same date as this document.

- [X] **GRANTED**
- [ ] **DISMISSED**
- [ ] **DENIED**

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/463,100	03/20/2017	Leslie Bromberg	11381.122997	1002

91197 7590 06/15/2017

MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

EXAMINER
TRAN, LONG T

ART UNIT	PAPER NUMBER
3747	

NOTIFICATION DATE	DELIVERY MODE
06/15/2017	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mitdocket@mit.edu

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

In re Application of	:	
Leslie Bromberg, et al.	:	
Application No. 15/463,100	:	DECISION ON PETITION
Filed: March 20, 2017	:	TO MAKE SPECIAL UNDER
Attorney Docket No. 11381.122997	:	37 CFR 1.102(c)(1)
	:	

This is a decision on the petition under 37 CFR 1.102(c)(1), filed March 22, 2017, to make the above-identified application special based on applicant's age as set forth in M.P.E.P. § 708.02, Section IV.

The petition is **GRANTED**.

A grantable petition to make an application special under 37 CFR 1.102(c)(1) and MPEP § 708.02, Section IV: Applicant's Age must be accompanied by evidence showing that at least one of the applicants is 65 years of age, or more, such as a birth certificate or a statement by applicant. No fee is required

There is no indication that the petition is signed by a registered patent attorney or patent agent of record. However, in accordance with 37 CFR 1.34, the signature of Mr. Sam (Bo) Paternack appearing on the correspondence shall constitute a representation to the United States Patent and Trademark Office that he is authorized to represent the particular party in whose behalf he acts. If, Mr. Sam (Bo) Pasternack desires to receive correspondence regarding this file, the appropriate power of attorney documents must be submitted.

The instant petition includes a statement from a registered practitioner declaring that he is in possession of such evidence that shows the applicant, Daniel R. Cohn, is 65 years of age or older. Accordingly, the above-identified application has been accorded "special" status.

The application is being forwarded to the Technology Center Art Unit 3747 for action on the merits commensurate with this decision.

Telephone inquiries concerning this decision should be directed to the undersigned at (571) 272-1058. All other inquiries concerning either the examination or status of the application should be directed to the Technology Center.

/Angela Walker/
Angela Walker
Paralegal Specialist
Office of Petitions

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Mailing Month 6

Application No. 15463100

15463100

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For PCT: enter "51+single digit of year of filing+last 5 numbers", Ex. for PCT/US05/12345, enter 51512345

Deciding Official: Walker, Angela

Count (1) - Palm Credit 15463100

Decision: GRANT

FINANCE WORK NEEDED
☐ Select Check Box for YES

GRANT

Decision Type: 601 - TO MAKE APPLICATION SPECIAL ON GROUND OF

601

Notes:

Count (2)

Decision: n/a

FINANCE WORK NEEDED
☐ Select Check Box for YES

Decision Type: NONE

Notes:

Count (3)

Decision: n/a

FINANCE WORK NEEDED
☐ Select Check Box for YES

Decision Type: NONE

Notes:

Initials of Approving Official (if required)

If more than 3 decisions, attach 2nd count sheet & mark this box ☐

Printed on: 6/12/2017

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PLUS Search Results for S/N 15463100, Searched Wed Jul 05 12:33:37 EDT 2017

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8015951 99
8037874 99
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ATTORNEY DOCKET NO.: 11381.122997
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Massachusetts Institute of Technology Examiner: TRAN, LONG T

Serial No.: 15/463,100 Art Unit: 3747

Filing Date: 03-20-2017 Confirmation No.: 1002

Title: OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

PRELIMINARY AMENDMENT

Via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

Prior to examination, please amend the application as follows:

Listing of Claims

1-31. (Cancelled)

32. (New) A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and from a second fueling system that uses port fuel injection;

and where the engine operates in a first torque range wherein throughout this torque range both fueling systems are used;

and wherein the fraction of fuel provided by the first fueling system is higher at the highest torque in the first torque range than at the lowest torque in the first torque range;

and wherein direct injection is needed at the highest torque in the first torque range in order to prevent knock;

and wherein during at least part of the first torque range the fraction of fuel provided by the first fueling system is increased so as to prevent knock;

and where when the torque is decreased below lowest torque in the first torque range the fueling is provided by only the second fueling system;

and where there is a second torque range between zero torque and a higher value of torque where only the second fueling system is employed.

33. (New) The fuel management system of claim 32 where both the first and second fueling system are used at the highest torque that is provided by the engine.

34. (New) The fuel management system of claim 32 where the second torque range extends from zero torque to the lowest torque in the first torque range.

35. (New) The fuel management system of claim 32 where the second torque range extends from zero torque to the lowest torque in the first torque range;

and where the highest torque in the second torque range is the lowest torque at which fueling from the first fueling source is not needed to prevent knock.

36. (New) The fuel management system of claim 32 where the second torque range extends from zero torque to the lowest torque in the first torque range;

and where during at least part of the first torque range the fraction of total fuel introduced by the first fueling system is matched to that needed to prevent knock as manifold pressure is increased.

37. (New) The fuel management system of claim 32 where the second torque range extends from zero torque to the lowest torque in the first torque range and where throughout the first torque range the fraction of fuel introduced into the cylinder by the first fueling system is matched to that needed to prevent knock as the manifold pressure is increased and where the amount of directly injected fuel that is used is minimized.

38. (New) The fuel management system of claim 32 where during at least part of the first torque range the fraction of total fuel introduced by the first fueling system is matched to that needed to prevent knock as manifold pressure is increased and where a knock sensor is used in a control system that increases the fraction of total fuel that is provided by the first fueling system to that needed to prevent knock as the manifold pressure increases.

39. (New) The fuel management system of claim 32 where during at least part of the first torque range the fraction of total fuel introduced by the first fueling system is matched to that needed to prevent knock as manifold pressure is increased and where a knock sensor is used in a control

system that increases the fraction of total fuel that is provided by the first fueling system in such a way that knock is prevented as the manifold pressure increases and where open loop control using an engine map is also used to control the fraction of fuel that is provided by the first fueling system.

40. (New) The fuel management system of claim 32 where the second fueling system is used throughout the entire torque range of engine operation.

41. (New) The fuel management system of claim 32 where in the first torque range the first fueling system is used so as to reduce wall wetting.

42. (New) The fuel management system of claim 32 where fueling with the first fueling system begins after the inlet valve has closed.

43. (New) The fuel management system of claim 32 where during the first 30 seconds of operation the engine is not fueled with ethanol from the first fueling system.

44. (New) A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and from a second fueling system that uses port fuel injection;

and where the engine operates in a first torque range wherein throughout this torque range both fueling systems are used;

and wherein the fraction of fuel provided by the first fueling system is higher at the highest torque in the first torque range than at the lowest torque in the first torque range; and wherein direct injection is needed at the highest torque in the first torque range in order to prevent knock;

and wherein during at least part of the first torque range the fraction of fuel provided by the first fueling system is increased in such a way that knock is prevented as the manifold pressure increases;

and where when the torque is decreased below lowest torque in the first torque range the fueling is provided by only the second fueling system;

and where both fueling systems are used at the maximum torque provided by the engine.

45. (New) The fuel management system of claim 44 where only the second fueling system is used between zero torque and the lowest torque in the first torque range and where the second fueling system is used throughout the entire torque range of engine operation.

46. (New) The fuel management system of claim 44 where in engine operation in the first torque range the first fueling system is used so as to reduce wetting of a surface and where the second fueling system is used throughout the entire torque range of engine operation.

47. (New) The fuel management system of claim 44 where the first fueling system is used so as to reduce wall wetting.

48. (New) The fuel management system of claim 44 here the first fueling system is used so as to reduce wetting of a surface and the direct injection of fuel occurs after the inlet valve has closed.

49. (New) A fuel management system for a spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and from a second fueling system that uses port fuel injection;

and where the engine operates in a first torque range throughout which both fueling systems are used;

and where the fraction of fuel provided by the first fueling system is higher at the highest torque in the first torque range than at the lowest torque in the first torque range;

and where the fraction of total fueling provided by the first fueling system is increased so as to prevent knock that would otherwise occur when the manifold pressure is increased;

and where when the torque is lower than the lowest torque in the first torque range only the second fueling system is used;

and where during at least part of the first torque range the fraction of total fueling provided by the first fueling system is matched to that needed to prevent knock as the manifold pressure is increased;

and where both fueling systems are used at the maximum torque provided by the engine.

50. (New) The fuel management system of claim 49 where combustion stability is greater than it would be in the case of use of direct injection alone.

51. (New) The fuel management system of claim 49 where there is a second range of torque between the zero torque and the lowest value of torque in the first range of torque range of torque and where in the second range of torque only fueling from the second fueling system is used.

52. (New) The fuel management system of claim 49 where the second fueling system is used throughout the entire range of torque of engine operation.

53. (New) The fuel management system of claim 49 where both open loop control using an engine map look up table and closed loop control using s knock sensor are employed to control fueling: and where spark retard is employed to increase the fraction of total fuel provided the second fueling system relative to what it would otherwise be.

54. (New) The fuel management system of claim 49 where the fueling from the first fueling system is such as to minimize wall wetting when the engine is operated in the first torque range.

55. (New) The fuel management system of claim 49 where fueling from the first fueling system is such as to reduce wetting of a surface.

56. (New) The fuel management system of claim 49 where the fuel from the first fueling system is injected after the inlet valve has closed.

57. (New) The fuel management system of claim 49 where fueling from the first fueling system is such as to reduce wetting of a surface and where the fueling from the first fueling system is injected after the inlet valve has closed.

58. (New) The fuel management system of claim 49 where there is a stoichiometric fuel air ratio and the fuel from the first fueling system is injected after the inlet valve has closed.

59. (New) A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and from a second fueling system that uses port fuel injection;

and where the engine operates in a first torque range wherein throughout this torque range both fueling systems are used;

and wherein the fraction of fuel provided by the first fueling system is higher at the highest torque in the first torque range than at the lowest torque in the first torque range;

and wherein direct injection is needed at the highest torque in the first torque range in order to prevent knock;

and wherein during at least part of the first torque range the fraction of fuel provided by the first fueling system is increased so as to prevent knock;

and where when the torque is decreased below lowest torque in the first torque range the fueling is provided by only the second fueling system;

and where the first fueling system is used so as to reduce wetting of a surface.

60. (New) The fuel management system of claim 59 where fueling from the first fueling system is introduced into the at least one cylinder after the inlet valve has closed.

61. (New) The fuel management system of claim 59 where the first fueling system is operated during the first torque range so as to reduce wetting of a surface.

62. (New) The fuel management system of claim 59 where fueling from the first fueling system occurs after the inlet valve has closed and the engine is operated with a stoichiometric fuel air ratio.

63. (New) The fuel management system of claim 59 where fueling from the first fueling system is introduced into the at least one cylinder after the inlet valve has closed and the fuel the first fueling system is introduced into a hot gas.

64. (New) The fuel management system of claim 59 where he second fueling system is also used when fuel from the first fueling system is introduced into the at least one cylinder after the inlet valve has been closed.

65. (New) The fuel management system of claim 59 where the second fueling system is used when the fuel from the first fueling system is introduced into the at least one cylinder after the inlet valve has been closed and use of the second fueling system provides combustion stability.

66. (New) A fuel management system for a turbocharged spark ignition engine where the fuel management system controls fueling from a first fueling system that directly injects fuel into at least one cylinder as a liquid and from a second fueling system that uses port fuel injection;

and where the engine operates in a first torque range wherein throughout this torque range both fueling systems are used;

and wherein the fraction of fuel provided by the first fueling system is higher at the highest torque in the first torque range than at the lowest torque in the first torque range;

and wherein direct injection is needed at the highest torque in the first torque range in order to prevent knock;

and wherein during at least part of the first torque range the fraction of fuel provided by the first fueling system is increased so as to prevent knock;

and where only the second fueling system is used between zero torque and the lowest torque in the first torque range;

and where spark retard is used to reduce the amount of fueling from the first fueling system that would otherwise be employed.

67. (New) The fuel management system of claim 66 where the second fueling system is used throughout the entire torque range between zero torque and the maximum torque at which the engine is operated and where during the first 30 seconds of engine operation the engine is not fueled with ethanol from the first fueling system.

Remarks

This preliminary amendment more particularly points out and distinctly claims the invention. No new matter is being introduced as these new claims are fully supported by the specification.

If there is a fee occasioned by this communication, the director is hereby authorized to charge any deficiency or credit any overpayment in the fees filed, asserted to be filed or which should have been filed herewith to our Deposit Account No. 192553, under Docket No. 11381.122997.

Respectfully Submitted,

Sam (Bo) Pasternack
Registration Number: 29576
Massachusetts Institute of Technology
One Cambridge Center
Room NE18-501
Cambridge, MA 02142
617.258.7171

Electronic Acknowledgement Receipt

EFS ID:	29689870
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	05-JUL-2017
Filing Date:	20-MAR-2017
Time Stamp:	14:51:39
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	11381122997PreAmendment.pdf	4413019 26f6fa7326afa710cce2dce505d47be819bd3f98	no	10

Warnings:

Information:	
Total Files Size (in bytes):	4413019

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	11381.122997

CONFIRMATION NO. 1002

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

PUBLICATION NOTICE

OC000000092570900

Title:OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

Publication No.US-2017-0191430-A1
Publication Date:07/06/2017

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The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/463,100	03/20/2017	Leslie Bromberg	11381.122997	1002

91197 7590 07/11/2017

MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

EXAMINER	
TRAN, LONG T	

ART UNIT	PAPER NUMBER
3747	

NOTIFICATION DATE	DELIVERY MODE
07/11/2017	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mitdocket@mit.edu

Office Action Summary	Application No. 15/463,100	Applicant(s) BROMBERG ET AL.	
	Examiner LONG T. TRAN	Art Unit 3747	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 March 2017*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-31* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☒ Claim(s) *19-24* is/are allowed.

7)☒ Claim(s) *1-18 and 25-31* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *20 March 2017* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. Claims 1 – 31 remain pending in the application and have been fully considered.

Claim Rejections - 35 USC § 102

3. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1 – 18 are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Russell (US 2011/0126797).

Regarding Claim 1:

Russell teaches a fuel management system for a turbocharged spark ignition engine (supercharger 174, engine 10, spark 192) where the fuel management system controls fueling from a first fueling system (172) that directly injects fuel (166) into at least one cylinder (14) as a liquid and increases knock suppression by evaporative cooling (paragraph 0038 discusses the increasing of ethanol based fuel and its charge cooling effect of alcohol) and where fueling is

also provided by a second fueling system (173) that injects fuel (170) into a region outside of the cylinder; and where there is a first torque range wherein both fueling systems are used throughout this range (Fig 4 shows both fuels being used in the middle of the desired torque range); and wherein the fraction of fuel in the cylinder that is introduced by the first fueling system increases with increasing manifold pressure (via 166, as the ethanol injection amount increases, the manifold pressure increases as well); and where fueling from the second fueling system alone is used when the torque is decreased below the lower end of the first torque range (Fig 4 shows only gasoline is used in the low torque range).

Regarding Claim 2:

Russell teaches the maximum knock suppression during a driving cycle is provided by operation with fueling from both fueling systems (knock is suppressed with an increase in the first fuel while the second fuel is supplied).

Regarding Claim 3:

Russell teaches the combustion stability is greater with operation of the first fueling system and the second fueling system than operation with the first fueling system alone (paragraph 0035 discusses varying the fuel injection to optimize engine performance.

Regarding Claim 4:

Russell teaches variable valve timing is used (paragraph 0022).

Regarding Claim 5:

Russell teaches the fraction of fuel provided by the first fueling system increases with manifold pressure so as to prevent knock (via 166).

Regarding Claim 6:

Russell teaches variable valve timing is used so as to reduce the fraction of fuel provided by the first fueling system (the VVT is used as an input for controller 12, which controls the fuel injection amount).

Regarding Claim 7:

Russell teaches as the manifold pressure is increased, the increase in the fraction of fuel in the cylinder that is provided by the first fueling system is matched to that needed to prevent knock, during at least part of pressure range in which both the first and second fueling systems are used (via controller 12).

Regarding Claim 8:

Russell teaches the increase in the fraction of fuel provided by the first fueling system is matched to that needed to prevent knock throughout the entire first torque range (via controller 12).

Regarding Claim 9:

Russell teaches when the pressure in the manifold is increased, the fraction of fuel in the cylinder that is provided by the first fueling system is increased and is the minimum needed to prevent knock (via controller 12).

Regarding Claim 10:

Russell teaches only second fueling system is used between zero torque and the lowest torque in the first torque range (gasoline, Fig 4).

Regarding Claim 11:

Russell teaches the lowest torque in the first torque range is the lowest torque at which the first fueling system is needed to prevent knock (Fig 4, and via controller 12).

Regarding Claims 12 and 18:

Russell teaches the second fueling system uses port fuel injection (170).

Regarding Claim 13:

Russell teaches the first fueling system is operated so as to minimize wall wetting (the speed of the direct injection is increased to produce fine particles).

Regarding Claim 14:

Russell teaches during the first 30 seconds of operation all of the fuel is provided by the second fueling system (Fig 4).

Regarding Claim 15:

Russell teaches during engine start up all of the fuel is provided by the second fueling system (gasoline, Fig 4).

Regarding Claim 16:

Russell teaches during engine startup a higher fraction of fuel is provided by the second fueling system than would ordinarily be used (fig 4 and via controller 12).

Regarding Claims 17, 25 - 31:

Russell teaches a fuel management system for a turbocharged spark ignition engine (10) where during part of the drive cycle the fuel management

system controls fueling from a first fueling system (172) that directly injects (166) fuel into at least one cylinder as a liquid and increases knock suppression by evaporative cooling and from a second fueling system (173) that injects fuel (170) into a region outside of the cylinder; and where the fuel from the first fueling system is injected so as to provide a non uniform distribution of fuel in the cylinder (the fuel contains a mixture of gasoline and a form of alcohol); and where there is a range of torque throughout which both fueling systems are used (Fig 4); and where the- fraction of fuel in the cylinder that is introduced by the first fueling system increases with increasing manifold pressure so as to prevent knock (via 166, as the ethanol injection amount increases, the manifold pressure increases as well, and the ethanol reduces knock).

Allowable Subject Matter

5. Claims 19 – 24 are allowed.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LONG T. TRAN whose telephone number is (571)270-1899. The examiner can normally be reached on M-F, 7:30am - 5:00pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lindsay Low can be reached on 571-272-1196. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/LONG T TRAN/
Examiner, Art Unit 3747

Notice of References Cited	Application/Control No. 15/463,100	Applicant(s)/Patent Under Reexamination BROMBERG ET AL.	
	Examiner LONG T. TRAN	Art Unit 3747	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2013/0284145 A1	10-2013	Surnilla; Gopichandra	F02D35/027	123/25C
*	B	US-8,522,758 B2	09-2013	Bromberg; Leslie	F02B17/005	123/304
*	C	US-8,413,643 B2	04-2013	Pursifull; Ross Dykstra	F02D13/0203	123/399
*	D	US-8,342,158 B2	01-2013	Ulrey; Joseph Norman	F02D19/0694	123/431
*	E	US-8,275,538 B2	09-2012	Surnilla; Gopichandra	F02B17/005	123/179.16
*	F	US-8,165,780 B2	04-2012	Russell; John D.	F02D35/027	701/103
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*	I	US-7,707,988 B2	05-2010	Irisawa; Yasuyuki	F02D13/0226	123/299
*	J	US-7,426,925 B2	09-2008	Leone; Thomas G.	F02D19/0684	123/1A
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15463100	BROMBERG ET AL.
	Examiner	Art Unit
	LONG T TRAN	3747

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/05/2017								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
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	24	=								
	25	✓								
	26	✓								
	27	✓								
	28	✓								
	29	✓								
	30	✓								
	31	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15463100	BROMBERG ET AL.
	Examiner	Art Unit
	LONG T TRAN	3747

CPC- SEARCHED		
Symbol	Date	Examiner
F02D41/0025; F02D19/081; F02D19/084; F02D19/08; F02D41/3094; F02D19/0655; F02D19/12; F02D19/0694; F02M25/14; F02M43/00; F02M43/04	7/5/2017	LT

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor search	7/5/2017	LT
PLUS search	7/5/2017	LT
Reviewed with John Kwon	7/5/2017	LT
Text search	7/5/2017	LT

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Doc Code: Oath

Document Description: Oath or declaration filed

PTO/AIA/08 (11-15)
Approved for use through 4/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing OR ☐ Declaration Submitted After Initial Filing (surcharge (37 CFR 1.16(f)) required)

Attorney Docket Number	11381.122997
First Named Inventor	Leslie Bromberg
COMPLETE IF KNOWN	
Application Number	15/463100
Filing Date	03-20-2017
Art Unit	3747
Examiner Name	-

OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

(Title of the Invention)

As a below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application,

OR

☒ United States Application Number or PCT International application number 15/463100

filed on 03-20-2017.

The above-identified application was made or authorized to be made by me.

I believe I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

Direct all correspondence to: ☒ The address associated with Customer Number: 91197 OR ☐ Correspondence address below

Name		
Address		
City	State	Zip
Country	Telephone	Email

PTO/AIA/08 (11-15)
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DECLARATION — Utility or Design Patent Application

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Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available. Petitioner/applicant is advised that documents which form the record of a patent application (such as the PTO/SB/01) are placed into the Privacy Act system of records DEPARTMENT OF COMMERCE, COMMERCE-PAT-7, System name: *Patent Application Files*. Documents not retained in an application file (such as the PTO-2038) are placed into the Privacy Act system of COMMERCE/PAT-TM-10, System name: *Deposit Accounts and Electronic Funds Transfer Profiles*.

LEGAL NAME OF SOLE OR FIRST INVENTOR:

(E.g., Given Name (first and middle if any) and Family Name or Surname)

Leslie Bromberg

Inventor's Signature	Date (Optional)
Leslie Bromberg	6/27/2017

Residence: City	State	Country
Sharon	MA	US

Mailing Address

176 Wilshire Drive

City	State	Zip	Country
Sharon	MA	02460-2444	US

☒ Additional inventors are being named on the 1 Supplemental sheet(s) PTO/AIA/10 attached hereto

PTO/AIA/10 (08-12)
Approved for use through 01/31/2014 OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

SUPPLEMENTAL SHEET FOR DECLARATION | **ADDITIONAL INVENTOR(S)** Supplemental Sheet (for PTO/AIA/08,09) Page 1 of 1

Legal Name of Additional Joint Inventor, if any:

(E.g., Given Name (first and middle (if any)) and Family Name or Surname)

Daniel R. Cohn

Inventor's Signature: Daniel R Cohn Date (Optional): 6/29/2017

Residence: City: Cambridge State: MA Country: US

Mailing Address: 100 Memorial Drive

City: Cambridge State: MA Zip: 02142 Country: US

Legal Name of Additional Joint Inventor, if any:

(E.g., Given Name (first and middle (if any)) and Family Name or Surname)

John B. Heywood

Inventor's Signature: Date (Optional):

Residence: City: Newtonville State: MA Country: US

Mailing Address: 218 Mill Street

City: Newtonville State: MA Zip: 02460 Country: US

Legal Name of Additional Joint Inventor, if any:

(E.g., Given Name (first and middle (if any)) and Family Name or Surname)

Inventor's Signature: Date (Optional):

Residence: City: State: Country:

Mailing Address:

City: State: Zip: Country:

PTO/AIA/10 (08-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

SUPPLEMENTAL SHEET FOR DECLARATION | **ADDITIONAL INVENTOR(S)**
Supplemental Sheet (for PTO/AIA/08,09) Page 1 of 1

Legal Name of Additional Joint Inventor, if any:

(*E.g.*, Given Name (first and middle (if any)) and Family Name or Surname)

Daniel R. Cohn

Inventor's Signature | Date (Optional)

Residence: City: Cambridge | State: MA | Country: US

Mailing Address: 100 Memorial Drive

City: Cambridge | State: MA | Zip: 02142 | Country: US

Legal Name of Additional Joint Inventor, if any:

(*E.g.*, Given Name (first and middle (if any)) and Family Name or Surname)

John B. Heywood

Inventor's Signature: John B. Heywood | Date (Optional): July 11 2017

Residence: City: Newtonville | State: MA | Country: US

Mailing Address: 218 Mill Street

City: Newtonville | State: MA | Zip: 02460 | Country: US

Legal Name of Additional Joint Inventor, if any:

(*E.g.*, Given Name (first and middle (if any)) and Family Name or Surname)

Inventor's Signature | Date (Optional)

Residence: City | State | Country

Mailing Address

City | State | Zip | Country

Electronic Acknowledgement Receipt

EFS ID:	29771593
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	13-JUL-2017
Filing Date:	20-MAR-2017
Time Stamp:	12:14:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	11381122997DEC.pdf	2992507 f17500d147ec78196ed12aa411561a86e4999945	no	4

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If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: PA..
Document Description: Power of Attorney

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Application Number	15/463,100
Filing Date	03-20-2017
First Named Inventor	Leslie Bromberg
Title	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
Art Unit	3747
Examiner Name	HUYNH, HAI H
Attorney Docket Number	11381.122997

SIGNATURE of Applicant or Patent Practitioner

Signature	Sam Pasternack	Date (Optional)	
Name	Sam Pasternack	Registration Number	29576
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Doc Code: PA..
Document Description: Power of Attorney

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date
15/463,100	03-20-2017

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 91197

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

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OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	July 26, 2017
Name	Theresa Latham		
Title	Massachusetts Institute of Technology; Manager of Patent Administration		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 2 forms are submitted.

Electronic Acknowledgement Receipt

EFS ID:	29904647
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	27-JUL-2017
Filing Date:	20-MAR-2017
Time Stamp:	10:58:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	11381122997POA.pdf	1774467 aff37bac5a2f7b61e3656ecfa5d94e347e5af92e	no	2

Warnings:

Information:	
Total Files Size (in bytes):	1774467

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	11381.122997

CONFIRMATION NO. 1002

POA ACCEPTANCE LETTER

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

OC000000093147410

Date Mailed: 08/02/2017

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/27/2017.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/khoang/

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15463100
Filing Date	2017-03-20
First Named Inventor	Leslie Bromberg
Art Unit	3747
Examiner Name	TRAN, LONG T
Attorney Docket Number	11381.122997

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2741230		1956-04-10	Reynolds et al.	
	2	3106194		1963-10-08	Cantwell et al.	
	3	3557763		1971-01-26	Probst, Stephen C.	
	4	4031864		1977-06-29	Crothers, William T.	
	5	4056087		1977-11-01	Boyce, Leonard D.	
	6	4230072		1980-10-28	Noguchi et al.	
	7	4312310		1982-01-26	Chivilo et al.	
	8	4402296		1983-09-06	Schwarz et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

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	10	4541383		1985-09-17	Jessel , Alfred J.	
	11	4594201		1986-06-10	Phillips et al.	
	12	4721081		1988-01-26	Krauja et al.	
	13	4958598		1990-09-25	Fossen, Dwayne	
	14	4967714		1990-11-06	Inoue, Ryuzaburo	
	15	4974416		1990-12-04	Taylor, Jack R.	
	16	5179923		1993-01-19	Tsurutanie et al.	
	17	5233944		1993-08-10	Mochizuki, Kenji	
	18	5560344		1996-10-01	Chan, Anthony K.	
	19	5911210		1999-06-15	Flach, Thomas A.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

	20	5937799		1999-08-17	Binion, Sidney	
	21	6076487		2000-06-20	Wulff et al.	
	22	6260525		2001-07-17	Moyer, David F.	
	23	6287351		2001-09-11	Wulff et al.	
	24	6298838		2001-10-09	Huff et al.	
	25	6332448		2001-12-25	Ilyama et al.	
	26	6359180		2002-03-19	Kuroda et al.	
	27	6508233		2003-01-21	Suhre et al.	
	28	6513505		2003-02-04	Watanabe er al.	
	29	6543423		2003-04-08	Dobryden et al.	
	30	6561157		2003-05-13	Zur Loye et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

	31	6575147		2003-06-10	Wulff et al.	
	32	6622663		2003-09-23	Weissman et al.	
	33	6668804		2003-12-30	Dobryden et al.	
	34	6725827		2004-04-27	Ueda et al.	
	35	6799551		2004-10-05	Nakakita et al.	
	36	6892691		2005-05-17	Uhl et al.	
	37	6951202		2005-10-04	Oda, Tomihisa	
	38	6990956		2006-01-31	Niimi, Kuniaki	
	39	7021277		2006-09-16	Kuo et al.	
	40	7156070		2006-09-19	Weissman et al.	
	41	7156070		2007-01-02	Strom et al	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

	42	7188607		2007-03-13	Kobayashi, Tatsuo	
	43	7320302		2008-01-22	Kobayashi, Tatsuo	
	44	3089470		1963-05-14	Payne, W.H.	
	45	4182278		1980-01-04	Coakwell, Charles A.	
	46	4993386		1991-02-19	Ozasa et al.	
	47	5497744		1996-03-12	Nagaosa et al.	
	48	5715788		1998-02-10	Tarr et al.	
	49	5983855		1999-11-16	Benedikt et al.	
	50	6073607		2000-06-13	Liber, Bruno.	
	51	6340015		2002-01-22	Benedikt et al.	
	52	6536406		2003-03-25	Rieger et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

	53	6745744		2004-06-08	Suckewer et al.	
	54	6748918		2004-06-15	Rieger et al.	
	55	6755175		2004-06-29	McKay et al.	
	56	6955154		2005-10-18	Douglas, Denis	
	57	7013847		2006-03-21	Auer, Gerhard	
	58	7077100		2006-06-18	Vogel et al.	
	59	7086376		2006-08-08	McKay, Michael	
	60	7201136		2007-04-10	McKay et al.	
	61	7225787		2007-06-05	Bromberg et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

	1	20050056264		2005-03-17	Weissman et al	
	2	20070119416		2007-05-31	Boyarski	
	3	20020139321		2002-10-03	Weissman et al	
	4	20060102145		2006-05-18	Cohn et al	
	5	20070119421		2007-05-31	Lewis et al	
	6	20070125321		2007-06-07	Ritter, Gregory	
	7					

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	MODAK, A. et al., Engine Cooling by Direct Injection of Cooling Water, Society of Automotive Engineers, Inc., 1970, SAE World Headquarters, Warrendale, PA.	☐
	2	LoRUSSO, J.A. et al., Direct Injection Ignition Assisted Alcohol Engine, Society of Automotive Engineers, Inc., 29 Feb-5 Mar 1998, International Contress and Exposition in Detroit, MI, SAE World Headquarters, Warrendale, PA.	☐
	3	GRANDIN, B. et al., Knock Suppression in a Turbocharged SI Engine by Using Cooled EGR, Society of Automotive Engineers, Inc., 19-22 Oct 1998, International Fall Fuels & Lubricants Meeting and Exposition in San Francisco, CA, SAE World Headquarters, Warrendale, PA.	☐
	4	GRANDIN, B. et al., Replacing Fuel Enrichment in a Turbo Charged SI Engine. Lean Burn or Cooled EGR, Society of Automotive Engineers, Inc., 1999, SAE World Headquarters, Warrendale, PA.	☐
	5	STAN, C. et al., Internal Mixture Formation and Combustion-from Gasoline to Ethanol, Society of Automotive Engineers, Inc., 2001, SAE World Headquarters, Warrendale, PA.	☐
	6	YUKSEL et al, The Use of Ethanol-Gasoline Blend as a Fuel in an SI Engine, Renewable Energy, 2004, pgs. 1181-1191, Elsevier B.V., Centro, Rio de Janeiro, Brazil.	☐
	7	HEYWOOD, Internal Combustion Engine Fundamentals, 1988, pg. 477, McGraw-Hill Book Company, Inc., New York, NY.	☐
	8	STOKES et al, A Gasoline Engine Concept for Improved Fuel Economy - The Lean Boost System, Society of Automotive Engineers, Inc., 2001, pgs. 1-12, SAE World Headquarters, Warrendale, PA.	☐
	9	CURRAN et al, A Comprehensive Modeling Study of Iso-Octane Oxidation, Combustion and Flame, 2002, pgs. 253-280, Elsevier B.V., Centro, Rio de Janeiro, Brazil.	☐
	10	LECOINTE et al, Downsizing a Gasoline Engine Using Turbocharging with Direct Injection, Society of Automotive Engineers, 2003, SAE World Headquarters, Warrendale, PA.	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

	11	BROMBERG, L. et al., Calculations of Knock Suppression in Highly Turbocharged Gasoline/Ethanol Engines Using Direct Ethanol Injection, 2006, pgs. 1-17, MIT Laboratory for Energy and the Environment Report, Cambridge, MA.	☐
	12	PCT International Search Report and Written Opinion, Application No. PCT/IB07/03004, July 9, 2008.	☐
	13	PCT International Search Report and Written Opinion, Application No. PCT/US07/05777, March 24, 2008.	☐
	14	PCT International Search Report and Written Opinion, Application No. PCT/US07/74227, February 25, 2008.	☐
	15	PCT International Search Report and Written Opinion, Application No. PCT/US08/69171, October 3, 2008.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15463100
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature		Date (YYYY-MM-DD)	2017-08-10
Name/Print	Sam Pasternack	Registration Number	29576

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

SP/Law

resp to Written Opinion

PATENT COOPERATION TREATY

Docketed
Due 5-25-08

From the INTERNATIONAL SEARCHING AUTHORITY

To:
SAM PASTERNACK
CHOATE, HALL & STEWART LLP
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

Amend Claims
Docketed
Due 4-25-08

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 25 FEB 2008
Applicant's or agent's file reference 2006734-0015	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US07/74227	International filing date *(day/month/year)* 24 July 2007 (24.07.2007)
Applicant ETHANOL BOOSTING SYSTEMS, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 338.82.70.

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

RECEIVED
FEB 27 2008
PATENT DEPARTMENT

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2006734-0015	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US07/74227	International filing date (*day/month/year*) 24 July 2007 (24.07.2007)	(Earliest) Priority Date (*day/month/year*) 24 July 2006 (24.07.2006)
Applicant ETHANOL BOOSTING SYSTEMS, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the Report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/74227

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **F02D 41/30**(2006.01);**F02B 1/08**(2006.01)

USPC: 123/1A,431,447,575
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 123/1A,300,304,431,447,478,575,577,198C,198A

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- P, Y	US 2007/0119416 A1 (Boyarski) 31 May 2007 (31.05.2007), figures 16, 17, 23, 28, 37, 44, paragraphs [0066], [0107]-[0117], [0284]-[0318], claims 3, 5, 11, 15.	1-23, 26, 42-48, 56 ---------- 24,25,27-41,49-55
X --- Y	US 2002/01393321 A1 (Weissman et al.) 3 October 2002 (03.10.2002), figure 2, paragraphs [0022]-[0046].	24-25, 27-56 ---------- 1-23, 26

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
07 December 2007 (07.12.2007)

Date of mailing of the international search report
25 FEB 2008

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
Facsimile No. (571) 273-3201

Authorized officer
Stephen K Cronin

Telephone No. (571) 272-4383

Form PCT/ISA/210 (second sheet) (April 2005)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
SAM PASTERNACK
CHOATE, HALL & STEWART LLP
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	25 FEB 2008
Applicant's or agent's file reference 2006734-0015	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US07/74227	24 July 2007 (24.07.2007)	24 July 2006 (24.07.2006)

International Patent Classification (IPC) or both national classification and IPC

IPC: **F02D 41/30**(2006.01);**F02B 1/08**(2006.01)
USPC: 123/1A,431,447,575

Applicant

ETHANOL BOOSTING SYSTEMS, LLC

1. This opinion contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis(b)* that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	18 February 2008 (18.02.2008)	Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US07/74227

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

a. type of material

☐ a sequence listing

☐ table(s) related to the sequence listing

b. format of material

☐ on paper

☐ in electronic form

c. time of filing/furnishing

☐ contained in the international application as filed.

☐ filed together with the international application in electronic form.

☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US07/74227

Box No. V Reasoned statement under Rule 43 *bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-56	YES
	Claims NONE	NO
Inventive step (IS)	Claims 1-56	YES
	Claims NONE	NO
Industrial applicability (IA)	Claims 1-56	YES
	Claims NONE	NO

2. Citations and explanations:

Claims 1-56 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest the claimed invention.

Claim1-56 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
SAM PASTERNACK
CHOATE, HALL & STEWART
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing (*day/month/year*) 09 JUL 2008
Applicant's or agent's file reference 2006734-0002	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/IB07/03004	International filing date (*day/month/year*) 06 March 2007 (06.03.2007)
Applicant ETHANOL BOOSTING SYSTEMS. LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 338.82.70.

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion ofthe International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of**30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2006734-0002	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below
International application No. PCT/IB07/03004	International filing date (*day/month/year*) 06 March 2007 (06.03.2007)	(Earliest) Priority Date (*day/month/year*) 08 March 2006 (08.03.2006)
Applicant ETHANOL BOOSTING SYSTEMS. LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the Report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 Rule 43.6 *bis(a)*
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB07/03004

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **F02M 17/00**(2006.01)

USPC: 123/447
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 123/447

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/0056264 A1, (WEISSMAN et al) 17 March 2005, Figure 2, claim 11.	1-15
A	US 5,560,344 A (CHAN) 1, October 1996 (01.10.1996), whole document.	1-15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 June 2008 (08.06.2008)	09 JUL 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/210 (second sheet) (April 2007)

PATENT COOPERATION TREATY

FILE COPY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
SAM PASTERNACK
CHOATE, HALL & STEWART
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing (*day/month/year*)
Applicant's or agent's file reference 2006734-0002	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/IB07/03004	International filing date (*day/month/year*) 06 March 2007 (06.03.2007)
Applicant ETHANOL BOOSTING SYSTEMS. LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 338.82.70.

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/220 (January 2004) *(See notes on accompanying sheet)*

PATENT COOPERATION TREATY FILE COPY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2006734-0002	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/IB07/03004	International filing date (*day/month/year*) 06 March 2007 (06.03.2007)	(Earliest) Priority Date (*day/month/year*) 08 March 2006 (08.03.2006)
Applicant ETHANOL BOOSTING SYSTEMS. LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of _____ sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the Report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 Rule 43.6 *bis(a)*
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB07/03004

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **F02M 17/00**(2006.01)

USPC: 123/447
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 123/447

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/0056264 A1, (WEISSMAN et al) 17 March 2005, Figure 2, claim 11.	1-15
A	US 5,560,344 A (CHAN) 1, October 1996 (01.10.1996), whole document.	1-15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 June 2008 (08.06.2008)	
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/210 (second sheet) (April 2007)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

FILE COPY

PCT

To:
SAM PASTERNACK
CHOATE, HALL & STEWART
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Applicant's or agent's file reference 2006734-0002	Date of mailing (*day/month/year*) **FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/IB07/03004	06 March 2007 (06.03.2007)	08 March 2006 (08.03.2006)

International Patent Classification (IPC) or both national classification and IPC

IPC: Please See Continuation Sheet
USPC: 123/447,1A,300,304,431,478,575,577,198C,198A;701/101

Applicant

ETHANOL BOOSTING SYSTEMS. LLC

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(*b*) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	08 June 2008 (08.06.2008)	Stephen K Cronin Telephone No. (571) 272-4383

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB07/03004

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

a. type of material

☐ a sequence listing

☐ table(s) related to the sequence listing

b. format of material

☐ on paper

☐ in electronic form

c. time of filing/furnishing

☐ contained in the international application as filed.

☐ filed together with the international application in electronic form.

☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB07/03004

Box No. V Reasoned statement under Rule 43 *bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-15	YES
	Claims NONE	NO
Inventive step (IS)	Claims 1-15	YES
	Claims NONE	NO
Industrial applicability (IA)	Claims 1-15	YES
	Claims NONE	NO

2. Citations and explanations:

Claims 1-15 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest claimed invention.

Claim 1-15 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB07/03004

Supplemental Box
In case the space in any of the preceding boxes is not sufficient.

Continuation of IPC:
F02M 63/00(2006.01),**43/00**(2006.01);**F02B 47/00**(2006.01),**47/04**(2006.01),**13/00**(2006.01),**13/10**(2006.01)

Form PCT/ISA/237 (Supplemental Box) (April 2007)

PATENT COOPERATION TREA. Y

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To: Sam Pasternack
Choate, Hall & Stewart
Two International Place
Boston, Massachusetts 02110

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 2006734-0003PC	Date of mailing *(day/month/year)* **FOR FUR[illegible] ACTION** See paragraphs 1 and 4 below
International application No. PCT/US 07/05777	International filing date *(day/month/year)* 08 March 2007 (08.03.2007)
Applicant Ethanol Boosting Systems, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (January 2004)

(See notes on accompanying sheet)

2006734-0013 SP

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: Sam Pasternack
Choate, Hall & Stewart
Two International Place
Boston, Massachusetts 02110

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 24 MAR 2008
Applicant's or agent's file reference 2006734-0003PC	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US 07/05777	International filing date *(day/month/year)* 08 March 2007 (08.03.2007)
Applicant Ethanol Boosting Systems, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes, 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

   For more detailed instructions, see the notes on the accompanying sheet.

   Docketed Due Article 19 Amend. 5/24/08 MPL

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

RECEIVED MAR 26 2008 PATENT DEPARTMENT

Form PCT/ISA/220 (January 2004) (See notes on accompanying sheet)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2006734-0003PC	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 07/05777	International filing date *(day/month/year)* 08 March 2007 (08.03.2007)	(Earliest) Priority Date *(day/month/year)* 10 March 2006 (10.03.2006)
Applicant Ethanol Boosting Systems, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 07/05777

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F02B 77/04 (2007.10)
USPC - 123/198A
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 123/198A

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 123/198R, 406.29, 406.47 (text search - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(USPT,PGPB,EPAB,JPAB); Google Patents; Google Scholar
Search Terms: gasoline engine, ethanol, direct injection, engine knock, emissions, restart, control system, shut down, deceleration, port injection, motor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Calculations of Knock Suppression in Highly Turbocharged Gasolin/Ethanol Engines Using Direct Ethanol Injection (L. Bromberg et al.) 23 February 2006 (23.02.2006), entire document especially Abstract, Section I, para [0003], Section II, para [0001], [0003], [0006]	1-18
Y	US 4,312,310 A (Chivilo' et al.) 26 January 1982 (26.01.1982), col 2, ln 20-26 and ln 36-54	1-18
Y	US 6,358,180 B1 (Kuroda et al.) 19 March 2002 (19.03.2002), Fig 4, col 3, ln 65-67 to col 4, ln 1 -15, col 8, ln 3-27col 12, ln 54-56	2, 9-10, 13-18
Y	US 4,974,416 A (Taylor) 04 December 1990 (04.12.1990), col 4, ln 15-21	5
Y	US 6,260,525 B1 (Moyer) 17 July 2001 (17.07.2001), col 3, ln 5-8	6, 8, 13-18
Y	US 4,967,714 A (Inoue) 06 November 1990 (06.11.1990), col 3, ln 27-30 and ln 66-67	11

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 December 2007 (03.12.2007)	24 MAR 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: Sam Pasternack
Choate, Hall & Stewart
Two International Place
Boston, Massachusetts 02110

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	24 MAR 2008
Applicant's or agent's file reference 2006734-0003PC	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 07/05777	08 March 2007 (08.03.2007)	10 March 2006 (10.03.2006)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - F02B 77/04 (2007.10)
USPC - 123/198A

Applicant Ethanol Boosting Systems, LLC

1. This opinion contains indications relating to the following items:

Docketed
Due Response to Written Opinion 6/24/08 MPL

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

RECEIVED
MAR 26 2008
PATENT DEPARTMENT

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	03 December 2007 (03.12.2007)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 07/05777

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing

      ☐ contained in the international application as filed

      ☐ filed together with the international application in electronic form

      ☐ furnished subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 07/05777

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-18	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-18	NO
Industrial applicability (IA)	Claims	1-18	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 3-4, 7 and 12 lack an inventive step under PCT Article 33(3) as being obvious over the article entitled "Calculations of Knock Suppression in Highly Turbocharged Gasoline/Ethanol Engines Using Direct Ethanol Injection" by L. Bromberg et al. (hereinafter 'Bromberg') in view of US 4,312,310 A to Chivilo et al. (hereinafter 'Chivilo').

As per claim 1, Bromberg discloses a fuel management system for operation of a spark ignition gasoline engine in a vehicle comprising: a gasoline engine powering the vehicle (see Abstract); a source of gasoline for introduction into the engine (see Section II, para [0003]); a separate source of ethanol (see Section II, para [0003]); an injector for direct injection of the ethanol into a cylinder of the engine (see Section II, para [0001]). Bromberg does not disclose a control system for shutting down the engine by stopping gasoline and ethanol flow into the engine during vehicle deceleration and idling and restarting the engine upon driver demand. Chivilo discloses a control system for shutting down the engine by stopping gasoline flow into the engine during vehicle deceleration and idling and restarting the engine upon driver demand (col 2, ln 20-26 and ln 36-54). It would have been obvious to one of ordinary skill in the art to modify the fuel management system as disclosed by Bromberg with the control system as taught by Chivilo since a major development in the system disclosed by Bromberg is fuel conservation and an obvious way to conserve fuel is to shut down the engine during idle or deceleration.

As per claim 3, Bromberg further discloses the system wherein the engine uses direct ethanol injection during a range of engine operating conditions to prevent engine knock (see Section I, para [0003]). Bromberg does not specifically disclose direct ethanol injection during engine restart to prevent engine knock. However, it would have been obvious to one of ordinary skill in the art to include ethanol injection during engine restart as one of the operating conditions since engine knock often occurs during restart and one of the objects of Bromberg is to prevent engine knock.

As per claim 4, Bromberg discloses the system wherein the engine uses direct ethanol injection to minimize hydrocarbon emissions (see Section II, para [0006]). Bromberg does not specifically disclose direct ethanol injection during engine restart to minimize hydrocarbon emissions. However, it would have been obvious to one of ordinary skill in the art to include ethanol injection during engine restart to minimize hydrocarbon emissions since hydrocarbon emissions can be high during restart and one of the objects of Bromberg is to minimize hyrdrocarbon emissions.

As per claim 7, Bromberg further discloses the system wherein the engine is turbocharged or supercharged (see Section II, para [0001]).

As per claim 12, Bromberg further disclose the system wherein gasoline is not used and ethanol, E85, methanol, other alcohols or a blend thereof are used as the only fuel (see Abstract). Bromberg states direct ethanol injection could be be used to displace gasoline.

Claims 2, 9 and 10 lack an inventive step under PCT Article 33(3) as being obvious over Bromberg in view of Chivilo, further in view of US 6,358,180 B1 to Kuroda et al. (hereinafter 'Kuroda').

As per claim 2, Chivilo discloses a control system for shutting down the engine by stopping gasoline flow into the engine during vehicle deceleration and idling and restarting the engine upon driver demand (col 2, ln 20-26 and ln 36-54). Chivilo does not specifically disclose wherein the control system disables the shutting down of the engine during deceleration and idling when an auxiliary power or energy requirement exceeds a selected level. Kuroda discloses wherein the control system disables the shutting down of the engine during deceleration and idling when an auxiliary power or energy requirement exceeds a selected level (col 3, ln 65-67 to col 4, ln 1-15). It would have been obvious to one of ordinary skill in the art to modify the control system as disclosed by Chivilo with the system as taught by Kuroda, since both relate to the technology of shutting engines down to conserve fuel and since such would avoid having the engine shut down when the batteries are unable to perform important functions such as restarting.

As per claim 9, Kuroda further discloses the system further including a 12V motor to restart the engine after shutdown during deceleration and/or idle (Fig 4; col 12, ln 54-56).

--- Please See Continuation Sheet ---

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Box V. 2. Citations and explanations:

As per claim 10, Kuroda further discloses the system including a restart motor (Fig 4; col 12, ln 54-56), wherein the low voltage motor is a low voltage motor (Fig 4 - the motor used for restarting the engine is a low voltage motor operating on 12 V).

Claim 5 lacks an inventive step under PCT Article 33(3) as being obvious over Bromberg in view of Chivilo, further in view of US 4,974,416 A (Taylor).

As per claim 5, Bromberg discloses the system wherein the engine uses direct injection (see Section II, para [0001]). Bromberg does not specifically disclose the system wherein the engine uses direct injection during engine restart to supplement port fuel injection while a fuel film that feeds the engine is established so as to minimize energy, emissions and time required for engine restart. Taylor discloses a system wherein the engine includes port fuel injection while a fuel film that feeds the engine is established (col 4, ln 15-21). It would have been obvious to one of ordinary skill in the art to modify the system as disclosed by Bromberg with the port fuel injection and fuel film as taught by Taylor, since it is well known in the art to supplement port injection with direct injection and since fuel films are well known and the use of such would have minimized energy, emissions and time required for engine restart.

Claims 6 and 8 lack an inventive step under PCT Article 33(3) as being obvious over Bromberg in view of Chivilo, further in view of US 6,260,525 B1 (Moyer).

As per claim 6, Chivilo discloses a control system for shutting down the engine by stopping gasoline flow into the engine (col 2, ln 20-26 and ln 36-54). Chivilo does not specifically disclose the system further including a valve disabler for all engine valves. Moyer discloses the system further including a valve disabler for all engine valves (col 3, ln 5-8). It would have been obvious to one of ordinary skill in the art to modify the system as disclosed by Chivilo and Bromberg with the valve disabler as taught by Moyer, since all relate to the technology of shutting engines down to conserve fuel and since such would have enagled the engine to be a variable displacement engine so that when less than maximum power is required some cylinders can be shut down and power increased in the remaining cylinders which will then operate at greater efficiency.

As per claim 8, Bromberg further discloses the system wherein maximum manifold pressure is increased by at least a factor of two over a non-pressure-boosted engine (see Abstract).

Claims 11 lacks an inventive step under PCT Article 33(3) as being obvious over Bromberg in view of Chivilo, further in view of US 4,967,714 A (Inoue).

As per claim 11, Bromberg further discloses the system wherein the ethanol is injected through a fuel injector (see Section II, para [0001]). Bromber does not specifically disclose wherein the gasoline and the ethanol are injected through the same fuel injector. Inoue discloses the system wherein the gasoline and the ethanol are injected through the same fuel injector (col 3, ln 27-30 and ln 66-67). It would have been obvious to one of ordinary skill in the art to modify the system as disclosed by Bromberg to enable the system to inject ethanol and gasoline through the same fuel injector as taught by Inoue, since both relate to the technology of ethanol burning systems and since such would have enabled the system to operate using only one fuel injector per cylinder which is a well known design to one of ordinary skill in the art.

Claims 13-18 lack an inventive step under PCT Article 33(3) as being obvious over Bromberg in view of Chivilo, further in view of Kuroda, further in view of Moyer.

As per claim 13, Bromberg discloses a turbocharged spark ignition engine which uses separately controlled direct injection of ethanol and port fuel injection of gasoline (see Abstract). Bromberg does not specifically disclose where the engine is shut down during periods of deceleration and idle. Kuroda discloses where the engine is shut down during periods of deceleration and idle (col 8, ln 3-27). Bromberg further discloses the engine comprising a first source of gasoline (see Section II, para [0003]); a second source of ethanol (see Section II, para [0003]); a gasoline engine (see Abstract). Bromberg does not specifically disclose a means to engine cylinder deactivation through valve disabling during engine deceleration and idling. Moyer discloses a means to engine cylinder deactivation through valve disabling (col 3, ln 5-8). It would have been obvious to one of ordinary skill in the art to modify the engine as disclosed by Bromberg with the shut down during deceleration and idle as taught by Kuroda and the disabling of the valves as taught by Moyer, since all relate to the technology of improving fuel economy and since the disabling of the valves is well known in the art as an effective way to shut down the engine and since shutting down the engine during deceleration and idle is an obvious means to conserving fuel.

As per claim 14, Bromberg further discloses the turbocharged spark ignition engine (see Section II, para [0001]) wherein the engine uses direct ethanol injection during a range of engine operating conditions to prevent engine knock (see Section I, para [0003]). Bromberg does not specifically disclose direct ethanol injection during engine restart to prevent engine knock. However, it would have been obvious to one of ordinary skill in the art to include ethanol injection during engine restart as one of the operating conditions since engine knock often occurs during restart and one of the objects of Bromberg is to prevent engine knock.

---- Please See Continuation Sheet ---

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of:
Suplemental Box 1:

As per claim 15, Bromberg discloses the turbocharged spark ignition engine (see Section II, para [0001]) wherein the engine uses direct ethanol injection to minimize hydrocarbon emissions (see Section II, para [0006]). Bromberg does not specifically disclose direct ethanol injection during engine restart to minimize hydrocarbon emissions. However, it would have been obvious to one of ordinary skill in the art to include ethanol injection during engine restart to minimize hydrocarbon emissions since hydrocarbon emissions can be high during restart and one of the objects of Bromberg is to minimize hyrdrocarbon emissions.

As per claim 16, Bromberg discloses the turbocharged spark ignition engine (see Section II, para [0001]). Bromberg does not specifically disclose the turbocharged spark ignition engine where a low voltage motor is used to restart the engine. Kuroda discloses the system wherein the low voltage motor is a low voltage motor (Fig 4; col 12, ln 54-56). Furthermore, it would have been obvious to one of ordinary skill in the art to modify the engine as disclosed by Bromberg and Chivilo with the low voltage motor for restart since most vehicles currently operate with a 12 V battery and using a low voltage motor for restart would not require an additional battery for operating the restart motor.

As per claim 17, Bromberg discloses a turbocharged spark ignition engine which uses separately controlled direct injection of ethanol and port fuel injection of gasoline (see Abstract). Bromberg does not specifically disclose where the engine is shut down during periods of deceleration and idle. Kuroda discloses where the engine is shut down during periods of deceleration and idle (col 8, ln 3-27). Bromberg further discloses the engine comprising a first source of gasoline (see Section II, para [0003]); a second source of ethanol (see Section II, para [0003]); a gasoline engine (see Abstract). Bromberg does not specifically disclose a means to disable the engine cylinders and where direct ethanol injection is used during engine restart and further where a low voltage motor is used for engine restart. Moyer discloses a means to engine cylinder deactivation through valve disabling (col 3, ln 5-8). Kuroda further discloses where a low voltage motor is used for engine restart (Fig 4; col 12, ln 54-56). It would have been obvious to one of ordinary skill in the art to modify the engine as disclosed by Bromberg with the shut down during deceleration and idle and low voltage restart motor as taught by Kuroda and the disabling of the valves as taught by Moyer, since all relate to the technology of improving fuel economy and since the disabling of the valves is well known in the art as an effective way to shut down the engine and since shutting down the engine during deceleration and idle is an obvious means to conserving fuel.

As per claim 18. Bromberg discloses a turbocharged spark ignition engine which uses direct injection of ethanol (see Abstract). Bromberg does not specifically disclose where the engine is shut down during periods of deceleration and idle comprising a turbocharged spark ignition engine; and a means to shutdown the engine cylinders and where direct ethanol injection is used during engine restart and further where a low voltage motor is used for engine restart. Kuroda discloses where the engine is shut down during periods of deceleration and idle (col 8, ln 3-27). Moyer discloses a means to engine cylinder deactivation through valve disabling (col 3, ln 5-8). Kuroda further discloses where a low voltage motor is used for engine restart (Fig 4; col 12, ln 54-56). It would have been obvious to one of ordinary skill in the art to modify the engine as disclosed by Bromberg with the shut down during deceleration and idle and low voltage restart motor as taught by Kuroda and the disabling of the valves as taught by Moyer, since all relate to the technology of improving fuel economy and since the disabling of the valves is well known in the art as an effective way to shut down the engine and since shutting down the engine during deceleration and idle is an obvious means to conserving fuel.

Claims 1-18 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

SP/JDL/JGG
SKS

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: SAM PASTERNACK
Choate, Hall & Stewart LLP
Two International Place
Boston, Massachusetts 02110

Action: Amend Claims cite Art in US. Resp to Writ. Opin.
Due Date
Final Due Date 12/3/08 - 1/3/09 - 5/10/09
Docket Administrator NH Date: 10/6/08
Attorney

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 2006734-0021	Date of mailing *(day/month/year)* 03 OCT 2008 **FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2008/069171	International filing date *(day/month/year)* 03 July 2008
Applicant ETHANOL BOOSTING SYSTEMS LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 740 14 35

   For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver Telephone No. 571-272-7774

Form PCT/ISA/220 (January 2004)

(See notes on accompanying sheet)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 2006734-0021	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2008/069171	International filing date *(day/month/year)* 03 July 2008	(Earliest) Priority Date *(day/month/year)* 10 July 2007
Applicant ETHANOL BOOSTING SYSTEMS LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

   b. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☒ **Certain claims were found unsearchable** (see Box No. II)

3. ☐ **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☒ the text is approved as submitted by the applicant

   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

   a. the figure of the **drawings** to be published with the abstract is Figure No. 1

   ☐ as suggested by the applicant

   ☒ as selected by this Authority, because the applicant failed to suggest a figure

   ☐ as selected by this Authority, because this figure better characterizes the invention

   b. ☐ none of the figures is to be published with the abstract

Form PCT/ISA/210 (first sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/069171

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 15-17, 31-33
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/069171

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F02B 77/04 (2008.04)
USPC - 123/198A
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - F02B 77/04 (2008.04)
USPC - 123/198A, 406.29, 435

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent, DialogPro, IP.com

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7,225,787 B2 (BROMBERG et al) 05 June 2007 (05.06.2007) entire document	1-14, 18-30, 34-35
Y	US 2006/0102145 A1 (COHN et al) 18 May 2006 (18.05.2006) entire document	1-14, 18-30, 34-35
Y	US 6,561,157 B2 (ZUR LOYE et al) 13 May 2003 (13.05.2003) entire document	6, 23, 35
A	US 3,557,763 A (PROBST) 26 January 1971 (26.01.1971) entire document	1-35
A	US 4,056,087 A (BOYCE) 01 November 1977 (01.11.1977) entire document	1-35
A	US 4,230,072 A (NOGUCHI et al) 28 October 1980 (28.10.1980) entire document	1-35
A	US 4,594,201 A (PHILLIPS et al) 10 June 1986 (10.06.1986) entire document	1-35
A	US 5,179,923 A (TSURUTANI et al) 19 January 1993 (19.01.1993) entire document	1-35
A	US 7,156,070 B2 (STROM et al) 02 January 2007 (02.01.2007) entire document	1-35
A	US 2007/0119421 A1 (LEWIS et al) 31 May 2007 (31.05.2007) entire document	1-35
A	US 2007/0125321 A1 (RITTER) 07 June 2007 (07.06.2007) entire document	1-35

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 2008	03 OCT 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2005)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: SAM PASTERNACK
Choate, Hall & Stewart LLP
Two International Place
Boston, Massachusetts 02110

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* 03 OCT 2008	
Applicant's or agent's file reference 2006734-0021	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2008/069171	03 July 2008	10 July 2007

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - F02B 77/04 (2008.04)
USPC - 123/198A

Applicant
ETHANOL BOOSTING SYSTEMS LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	25 September 2008	Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2008/069171

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing

      ☐ contained in the international application as filed

      ☐ filed together with the international application in electronic form

      ☐ furnished subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No. PCT/US2008/069171

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of

☐ the entire international application

☒ claims Nos. 15-17, 31-33

because:

☐ the said international application, or the said claims Nos. _____ relate to the following subject matter which does not require an international search *(specify)*:

☒ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. 15-17, 31-33 are so unclear that no meaningful opinion could be formed *(specify)*:

Claims 15-17, 31-33 are multiple dependent claims not drafted in accordance with the second and third sentences of Rule 6.4(a).

☐ the claims, or said claims Nos. _____ are so inadequately supported by the description that no meaningful opinion could be formed *(specify)*:

☒ no international search report has been established for said claims Nos. 15-17, 31-33

☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

- ☐ furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.
- ☐ furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.
- ☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rule 13*ter*.1(a) or (b).

☐ a meaningful opinion could not be formed without the tables related to the sequence listings; the applicant did not, within the prescribed time limit, furnish such tables in electronic form complying with the technical requirements provided for in Annex C-*bis* of the Administrative Instructions, and such tables were not available to the International Searching Authority in a form and manner acceptable to it.

☐ the tables related to the nucleotide and/or amino acid sequence listing, if in electronic form only, do not comply with the technical requirements provided for in Annex C-*bis* of the Administrative Instructions.

☐ See Supplemental Box for further details.

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2008/069171

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-14, 18-30, 34-35	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-14, 18-30, 34-35	NO
Industrial applicability (IA)	Claims	1-14, 18-30, 34-35	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-5, 7-14, 18-22, 24-30, and 34 lack an inventive step under PCT Article 33(3) as being obvious over Bromberg et al. in view of Cohn et al.

Regarding claim 1, Bromberg et al. disclose a fuel management system for a spark ignition gasoline engine (Abstract) comprising: a gasoline engine (18); a source of gasoline (Fig. 4a); a source of a second liquid fuel (Fig. 4a); a means for introducing gasoline (Fig. 4b) into the cylinders of the engine (18); injectors for direct injection of the second liquid fuel (Col. 11, lines 23-50) into the cylinders of the engine (18); a fuel management control system (Col. 1, lines 45-50) for controlling injection of the second fuel into the cylinder so that it is provided in an amount needed to prevent knock (Fig. 3) as other conditions require; and a means for providing fast flame speed (Col. 10, lines 45-55). Bromberg et al. do not show controlling injection of the second fuel into the cylinder so that it is provided in an amount needed to prevent knock as torque increases; and a means for providing fast burn. It is deemed obvious that a fast flame speed produces a fast burn. Cohn et al. show a fuel management control system (14) for controlling injection of a second fuel into a cylinder so that it is provided in an amount needed to prevent knock as torque increases (paragraph 32). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 2, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the 10% - 90% burn occurs in 15-20 crank angle degrees. It is obvious from Bromberg et al. (Figs. 2A-2B) that a significant portion of the energy fraction (burn) occurs in a small crank angle range including that claimed.

Regarding claim 3, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the fast burn (Col. 10, lines 45-55) in the engine is provided by charge motion (Col. 10, lines 15-20).

Regarding claim 4, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the fast burn (Col. 10, lines 45-55) in the engine is provided by increased temperature (Col. 4, lines 1-10) in the unburned zone of air/fuel mixture zone that burns early in the cycle after the firing of the spark (Col. 4, lines 30-45).

Regarding claim 5, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where there are dual ignition sites on either side of the cylinder but show two ignition sources (Col. 1, lines 13-15, Col. 6, lines 23-30). It is obvious that the dual sites can be on opposite cylinder sides to promote complete combustion.

Regarding claim 7, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the spray of the second fuel is aimed toward the end gas on the exhaust valve side of the cylinder and the injector is located near the periphery. Cohn et al. show where spray of the second fuel is aimed toward an end gas on an exhaust valve side of the cylinder and an injector is located near the periphery (paragraph 7). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 8, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the time of the direct injection of the second fuel is adjusted to minimize the ethanol consumption (Col. 6, lines 48-52, Col. 10, lines 25-35).

Regarding claim 9, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where turbulence is created at or near the intake port. Cohn et al. show where turbulence is created at or near an intake port (paragraph 28). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 10, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where combustion is retarded by means of spark retard relative to what it would be if fast burn were not employed (Col. 8, lines 20-25).

Regarding claim 11, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where combustion, as measured by the 50% burn crank angle, is retarded using appropriate spark retard by an amount between 5 and 10 degrees but show spark retard (Col. 8, lines 20-25). It is deemed obvious that spark retard is a small but significant amount including that claimed.

(Continued in Supplemental Box)

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Box V

Regarding claim 12, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the amount of second fuel that is used is reduced when the fast burn is provided (Col. 3, lines 25-30).

Regarding claim 13, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the amount of combustion retard is varied as a function of load (Col. 1, lines 20-25) and speed by means of appropriate spark retard (Col. 8, lines 20-25).

Regarding claim 14, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the degree of combustion retard is chosen so as to optimize the combination of efficiency gain and minimization of the required amount of the second fluid fuel. Cohn et al. show where a degree of combustion retard is chosen so as to optimize the combination of efficiency gain and minimization of the required amount of the second fluid fuel (Fig. 5, paragraphs 14 and 35). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 18, Bromberg et al. disclose a fuel management system for a spark ignition gasoline engine (Abstract) comprising: a gasoline engine (18) of compression ratio between 13 and 14 (Col. 7, lines 55-60); a source of a second liquid fuel (Fig. 4a); a means for introducing gasoline (Fig. 4b) into the cylinders of the engine (18); injectors for direct injection of the second liquid fuel (Col. 11, lines 23-50) into the cylinder of the engine (18); a fuel management control system (Col. 1, lines 45-50) for controlling injection of the second fuel into the cylinder so that it is provided in an amount needed to prevent knock (Fig. 3) as torque increases or other conditions require; and a means for fast flame speed (Col. 10, lines 45-55). Bromberg et al. do not show controlling injection of the second fuel into the cylinder so that it is provided in an amount needed to prevent knock as torque increases; and a means for providing fast burn. It is deemed obvious that a fast flame speed produces a fast burn. Cohn et al. show a fuel management control system (14) for controlling injection of a second fuel into a cylinder so that it is provided in an amount needed to prevent knock as torque increases (paragraph 32). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 19, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the 10% - 90% burn occurs in 15-20 crank angle degrees. It is obvious from Bromberg et al. (Figs. 2A-2B) that a significant portion of the energy fraction (burn) occurs in a small crank angle range including that claimed.

Regarding claim 20, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the fast burn (Col. 10, lines 45-55) in the engine is provided by charge motion (Col. 10, lines 15-20).

Regarding claim 21, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the fast burn (Col. 10, lines 45-55) in the engine is provided by increased temperature (Col. 4, lines 1-10) in the unburned zone of air/fuel mixture zone that burns early in the cycle after the firing of the spark (Col. 4, lines 30-45).

Regarding claim 22, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where there are dual ignition sites on either side of the cylinder but show two ignition sources (Col. 1, lines 13-15, Col. 6, lines 23-30). It is obvious that the dual sites can be on opposite cylinder sides to promote complete combustion.

Regarding claim 24, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the spray of the second fuel is aimed toward the end gas on the exhaust valve side of the cylinder. Cohn et al. show where spray of the second fuel is aimed toward an end gas on the exhaust valve side of the cylinder (paragraph 7). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 25, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where turbulence is created at or near the intake port. Cohn et al. show where turbulence is created at or near an intake port (paragraph 28). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 26, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where combustion is retarded by means of spark retard relative to what it would be if fast burn were not employed (Col. 8, lines 20-25).

Regarding claim 27, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where combustion, as measured by the 50% burn crank angle, is retarded using appropriate spark retard by an amount between 5 and 15 degrees but show spark retard (Col. 8, lines 20-25). It is deemed obvious that spark retard is a small but significant amount including that claimed.

Regarding claim 28, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the amount of second fuel that is used is reduced when the fast burn is provided (Col. 3, lines 25-30).

Regarding claim 29, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. show where the amount of combustion retard is varied as a function of load (Col. 1, lines 20-25) and speed by means of appropriate spark retard (Col. 8, lines 20-25).

(Continued in next Supplemental Box)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2008/069171

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Previous Supplemental Box

Regarding claim 30, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the degree of combustion retard is chosen so as to optimize the combination of efficiency gain and minimization of the required amount of the second fluid fuel. Cohn et al. show where a degree of combustion retard is chosen so as to optimize the combination of efficiency gain and minimization of the required amount of the second fluid fuel (Fig. 5, paragraphs 14 and 35). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 34, Bromberg et al. disclose a spark ignition gasoline engine (18) where alcohol and gasoline are both directly injected (Col. 1, lines 55-60) and where the alcohol/gasoline ratio needed to prevent knock uses fast burn. Bromberg et al. do not show where the alcohol/gasoline ratio needed to prevent knock is reduced by using fast flame speed. It is deemed obvious that a fast flame speed (Bromberg - Col. 10, lines 45-55) produces a fast burn. Cohn et al. show where an alcohol/gasoline ratio needed to prevent knock is reduced (paragraph 19). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. in the device of Bromberg et al. in order to provide improved engine performance.

Claims 6, 23, 35 lack an inventive step under PCT Article 33(3) as being obvious over Bromberg et al. in view of Cohn et al. and zur Loye et al.

Regarding claim 6, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the direct injector is located in the center of the cylinder. zur Loye et al. show where a direct injector (62) is located in a center of a cylinder (Fig. 1). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. and zur Loye et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 23, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where the direct injector is located in the center of the cylinder. zur Loye et al. show where a direct injector (62) is located in a center of a cylinder (Fig. 1). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. and zur Loye et al. in the device of Bromberg et al. in order to provide improved engine performance.

Regarding claim 35, Bromberg et al. and Cohn et al. disclose that as applied above. Bromberg et al. do not show where a high energy spark plug is used to provide fast burn. zur Loye et al. show where a high energy spark plug (52) is used to provide fast burn. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to employ the structures and processes as taught by Cohn et al. and zur Loye et al. in the device of Bromberg et al. in order to provide improved engine performance.

Claims 1-14, 18-30, and 34-35 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

(i) the claim is unchanged;
(ii) the claim is cancelled;
(iii) the claim is new;
(iv) the claim replaces one or more claims as filed;
(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under Article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments and any accompanying statement, under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the time of filing the amendments (and any statement) with the International Bureau, also file with the International Preliminary Examining Authority a copy of such amendments (and of any statement) and, where required, a translation of such amendments for the procedure before that Authority (see Rules 55.3(a) and 62.2, first sentence). For further information, see the Notes to the demand form (PCT/IPEA/401).

If a demand for international preliminary examination is made, the written opinion of the International Searching Authority will, except in certain cases where the International Preliminary Examining Authority did not act as International Searching Authority and where it has notified the International Bureau under Rule 66.1*bis*(b), be considered to be a written opinion of the International Preliminary Examining Authority. If a demand is made, the applicant may submit to the International Preliminary Examining Authority a reply to the written opinion together, where appropriate, with amendments before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later (Rule 43*bis*.1(c)).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see the *PCT Applicant's Guide*, Volume II.

Electronic Acknowledgement Receipt

EFS ID:	30052575
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Sam Pasternack/Abram Barrett
Filer Authorized By:	Sam Pasternack
Attorney Docket Number:	11381.122997
Receipt Date:	11-AUG-2017
Filing Date:	20-MAR-2017
Time Stamp:	11:23:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	11381122997IDS.pdf	7036815 6b28bcca981e8d984093d8eac5b777cb5d7e2bf4	no	10

Warnings:

Information:					
This is not an USPTO supplied IDS fillable form					
2	Non Patent Literature	modak_a.pdf	1322225 7dec00e5afd11acb9075273535a3aa99dcfd5194	no	7
Warnings:					
Information:					
3	Non Patent Literature	loRusso_j.pdf	1808852 850df485fce66aa4fe9c89ca77e3d3249d6aa390	no	21
Warnings:					
Information:					
4	Non Patent Literature	grandin_b.pdf	123921 8b72985ea461e4bd5ea9b0e183802788735a20b0	no	11
Warnings:					
Information:					
5	Non Patent Literature	grandin_b1.pdf	200452 d53b187bb51239f3e9413633046 5a8a733f0f3bb	no	11
Warnings:					
Information:					
6	Non Patent Literature	stan_c.pdf	828776 2090891b69e2fea4ec56dab8d19070c554665e88	no	13
Warnings:					
Information:					
7	Non Patent Literature	yuksel_f.pdf	614671 cc2287df9c08bc0167c5580e17007a2836c92bd2	no	9
Warnings:					
Information:					
8	Non Patent Literature	heywood_j.pdf	135983 6e46c0620d40478a2fea63c3b1eaa6e94004470b	no	3
Warnings:					
Information:					

9	Non Patent Literature	stokes_j.pdf	1170892 fa5571c9c7684e54fca691d23adb2d8f6a3c726e	no	12
Warnings:					
Information:					
10	Non Patent Literature	curran_h.pdf	2577264 c95abeac97fb21a50c15c2e1f0f4398023f724f0	no	28
Warnings:					
Information:					
11	Non Patent Literature	Lecointe_b.pdf	1315777 e386092ebfc33bb818af2c886b3c7ef40a21a897	no	12
Warnings:					
Information:					
12	Non Patent Literature	bromberg_L.pdf	221920 27f24730e31790a3ad647e2036fc5d1c73b5c0b3	no	17
Warnings:					
Information:					
13	Non Patent Literature	search2.pdf	425265 929450788906e524c537a57944546335c2889e10	no	6
Warnings:					
Information:					
14	Non Patent Literature	search3.pdf	677712 b84ee4e5d1cc855a6766ebbb6f6a30d7f13c9e68	no	10
Warnings:					
Information:					
15	Non Patent Literature	search4.pdf	918177 72486a8dbcad1cd5e8934468e12cacbe5c4456dc	no	9
Warnings:					
Information:					

16	Non Patent Literature	search5.pdf	922356 4c895e0178a7397480bab8edc24cd3a83fbe6934	no	11
Warnings:					
Information:					
			Total Files Size (in bytes):	20301058	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Document code: WFEE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/463,100	03/20/2017	Leslie Bromberg	11381.122997	1002

91197 7590 11/13/2017

MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

EXAMINER	
TRAN, LONG T	

ART UNIT	PAPER NUMBER
3747	

NOTIFICATION DATE	DELIVERY MODE
11/13/2017	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mitdocket@mit.edu

Office Action Summary	Application No. 15/463,100	Applicant(s) BROMBERG ET AL.	
	Examiner LONG T. TRAN	Art Unit 3747	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *5 July 2017*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *32-67* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *32-67* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *20 March 2017* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *see attached*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. The previous Office Action has been withdrawn in light of the wrong set of claims being examined.

3. Claims 32 - 67 remain pending in the application and have been fully considered.

Priority

4. Applicant's claim for the benefit of a prior-filed application under 35 U.S.C. 119(e) or under 35 U.S.C. 120, 121, 365(c), or 386(c) is acknowledged. Applicant has not complied with one or more conditions for receiving the benefit of an earlier filing date under 35 U.S.C. 119(e) as follows: The later-filed application must be an application for a patent for an invention which is also disclosed in the prior application (the parent or original nonprovisional application or provisional application). The disclosure of the invention in the parent application and in the later-filed application must be sufficient to comply with the requirements of 35 U.S.C. 112(a) or the first paragraph of pre-AIA 35 U.S.C. 112, except for the best mode requirement. See *Transco Products, Inc. v. Performance Contracting, Inc.*, 38 F.3d 551, 32 USPQ2d 1077 (Fed. Cir. 1994)

The disclosure of the prior-filed application, Application No. 14/807,125, 14/220,529, 13/546,220, 11/758,157, 11/100,023, and 10/991,774 fails to provide adequate support or enablement in the manner provided by 35 U.S.C. 112(a) or pre-AIA 35 U.S.C. 112, first paragraph for one or more claims of this application. The claims do

not overlap in scope since the current claims of the Applicant are much broader and do not require alcohol-based fuel and amount of fuel as required in the previous claims of the cited applications.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

> (a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 32 - 67 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention.

7. Claims 32, 44, 49, 59, and 66 contain the term “torque range,” which is not clearly defined by the specification or drawings. Having a first and second torque range is considered arbitrary by the Examiner since no specific range of value or amount is

defined by the Applicant. For examination purposes, the Examiner will understand that the ranges apply to any amount within a normal working load and condition of a vehicle.

8. Claims 33 - 43, 45 - 49, 50 - 58, and 60 - 65, and 67 are rejected for being dependent on a rejected base claim.

9. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 32 - 67 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being incomplete for omitting essential elements, such omission amounting to a gap between the elements. See MPEP § 2172.01. The omitted elements are: a controller, sensors for detecting torque, valve or element for controlling fuel amounts.

11. Claim 39 contains the phrase "in such a way" that is indefinite because there is no clear step or element that prevents knock.

12. Claims 32 - 67 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claims 32, 44, 49, and 59 recites the limitation "the fraction of fuel". There is insufficient antecedent basis for this limitation in the claim. Correction is required.

Claims 32, 44, 49, and 59 recites the limitation "the highest torque". There is insufficient antecedent basis for this limitation in the claim. Correction is required.

Claims 32, 44, 49, and 59 recites the limitation "the lowest". There is insufficient antecedent basis for this limitation in the claim. Correction is required.

13. Claims 33 - 43, 45 - 49, 50 - 58, 60 - 65, and 67 are rejected for being dependent on a rejected base claim.

Claim Rejections - 35 USC § 102

14. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

15. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

16. Claims 32, 44, 49, 59, and 66 as best understood, are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Zur Loye et al. (US 2002/0007816).

Regarding Claims 32, 44, 49, and 59:

The claim recites specific operating requirements during distinct engine conditions, of which the Examiner has understood is only required during these "conditions."

Therefore, in periods outside of these operating conditions, Zur Loye et al. teaches a fuel management system (56) for a turbocharged spark ignition engine (10) where the fuel management system controls fueling from a first fueling system that directly injects fuel (62) into at least one cylinder (12) as a liquid and from a second fueling system that uses port fuel injection (68).

17. Claims 32, 38 - 40, 50 - 53, 44, 49, 59, and 66 as best understood, are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Russell (US 23011/0126797).

Regarding Claims 32, 38 - 40, 50 - 53, 44, 49, 59, and 66:

Russell teaches a fuel management system (12) for a turbocharged spark ignition engine (10) where the fuel management system controls fueling from a first fueling system that directly injects fuel (166, ethanol) into at least one cylinder as a liquid and from a second fueling system that uses port fuel injection (172, see paragraph 0038); and where the engine operates in a first torque range (economy mode, Fig 4) wherein throughout this torque range both fueling systems are used; and wherein the fraction of fuel provided by the first fueling system is higher at the highest torque in the first torque range than at the lowest torque in the first torque range (Fig 4, 404B > 404A at highest torque); and wherein direct injection [is needed at the highest torque in the first torque rangein

order to prevent knock]; and wherein during at least part of the first torque range the fraction of fuel (Fig 4) provided by the first fooling system is increased [so as to prevent knock]; and where when the torque is decreased below lowest torque in the first torque range the fueling is provided by only the second fueling system (Fig 4); and where there is a second torque range (performance mode, Fig 4) between zero torque and a higher value of torque where only the second fading system is employed.

Please note the limitations in brackets above are considered an intended use recitation. It has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. ***Ex parte Masham, 2 USPQ2d 1647 (1987).***

Claim Rejections - 35 USC § 103

18. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

19. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the

> time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

20. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

21. This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

22. Claims 33 - 37, 41 - 43, 45 - 48, 54 - 58, 60 - 65, as best understood, are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Russell (US 23011/0126797).

Regarding Claims 33 - 37, 45, 51:

Because the first and second torque ranges are considered arbitrary ranges by the Examiner (e.g. the specification provides no clarity on the values of these ranges), it would have been an obvious matter of design choice to alter the fuel map (shown in Fig 4 of Russell) to meet the intended first and second torque ranges since both the Applicant and Russell seek to reduce knock (se Fig 3 of Russell).

Regarding Claims 42 - 43, 45, 56, 58, 60 - 65, 67:

Russell is silent to fueling with the first fueling system begins after the inlet valve has closes.

However, Russell teaches an inlet valve (150) and fuel injection controlled by ECU (12), and therefore, is capable of varying the timing of the opening and closing of the valve with the fuel injection.

Therefore, it would have been an obvious matter of design choice to being fueling after the inlet valve has closed since both the Applicant and Russell seek to reduce knock (se Fig 3 of Russell).

Regarding Claim 41, 46 - 48, 54 - 55, 57:

The limitation "used so as to reduce wall wetting" is an intended use recitation. It has been held that a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. ***Ex parte Masham, 2 USPQ2d 1647 (1987).***

Conclusion

23. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

24. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LONG T. TRAN whose telephone number is (571)270-1899. The examiner can normally be reached on M-F, 7:30am - 5:00pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lindsay Low can be reached on 571-272-1196. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/LONG T TRAN/
Examiner, Art Unit 3747

Notice of References Cited	Application/Control No. 15/463,100	Applicant(s)/Patent Under Reexamination BROMBERG ET AL.	
	Examiner LONG T. TRAN	Art Unit 3747	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-8,495,983 B2	07-2013	Zubeck; Michael W.	F02B1/02	123/304
*	B	US-8,413,643 B2	04-2013	Pursifull; Ross Dykstra	F02D13/0203	123/399
*	C	US-8,342,158 B2	01-2013	Ulrey; Joseph Norman	F02D19/0694	123/431
*	D	US-8,275,538 B2	09-2012	Surnilla; Gopichandra	F02B17/005	123/179.16
*	E	US-8,165,780 B2	04-2012	Russell; John D.	F02D35/027	701/103
*	F	US-2011/0126797 A1	06-2011	Russell; John D.	F02D35/027	123/294
*	G	US-2010/0318284 A1	12-2010	Surnilla; Gopichandra	F02B17/005	701/113
*	H	US-7,707,988 B2	05-2010	Irisawa; Yasuyuki	F02D13/0226	123/299
*	I	US-7,426,925 B2	09-2008	Leone; Thomas G.	F02D19/0684	123/1A
*	J	US-7,424,881 B2	09-2008	Kerns; James Michael	F02D19/084	123/431
*	K	US-2008/0127933 A1	06-2008	Blumberg; Paul	F02B11/00	123/304
*	L	US-2007/0289573 A1	12-2007	Leone; Thomas G.	F02D19/0684	123/305
*	M	US-6,907,870 B2	06-2005	zur Loye; Axel O.	F02B1/04	123/27R

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
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	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15463100	BROMBERG ET AL.
	Examiner	Art Unit
	LONG T TRAN	3747

CPC- SEARCHED		
Symbol	Date	Examiner
F02D41/0025; F02D19/081; F02D19/084; F02D19/08; F02D41/3094; F02D19/0655; F02D19/12; F02D19/0694; F02M25/14; F02M43/00; F02M43/04	7/5/2017	LT

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor search	7/5/2017	LT
PLUS search	7/5/2017	LT
Reviewed with John Kwon	7/5/2017	LT
Text search	7/5/2017	LT
Updated text search	11/6/2017	LT

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S60	51	engine and ((direct$4 cylinder) near10 inject$4) and (port near4 inject$4) and ((dual both all bi) near5 fuel near20 torque) and (alcohol methanol ethanol) and knock$4 and gasoline	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 10:21
S59	27	engine and ((direct$4 cylinder) near10 inject$4) and (port near4 inject$4 same gasoline) and ((dual both all bi) near5 fuel near20 torque) and (alcohol methanol ethanol) and knock$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 10:15
S58	3	"14807125"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 10:14
S57	18	"11758157"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 10:13
S56	126	"7225787"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 10:12
S55	117	engine and ((direct$4 cylinder) near10 inject$4) and (port near4 inject$4 same gasoline) and ((dual both all bi) near5 fuel same torque) and (alcohol methanol ethanol) and knock$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 10:09
S54	102	engine and ((methanol alcohol ethanol) near10 inject$4) and (port near4 inject$4 same gasoline) and ((dual both all bi) near5 fuel same torque)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 09:53
S53	85	engine and ((methanol alcohol ethanol) near20 (cylinder direct$4) near10 inject$4) and (port near4 inject$4 near5 gasoline) and ((dual both all bi) near5 fuel same torque)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 09:48
S52	88	"7314033"	US-PGPUB; USPAT;	OR	ON	2017/11/06 09:45

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S51	35	engine and (ethanol near20 direct$4 near10 inject$4) and (port near4 inject$4 near5 gasoline) and (fuel same inject$4 same torque near2 (range amount high$4 low$4)) and ((dual both) near5 fuel same torque)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 09:42
S50	6	engine and (ethanol near20 direct$4 near10 inject$4) and (port near4 inject$4 near5 gasoline) and (fuel same inject$4 same torque near2 (range amount high$4 low$4)) and ((dual both) near5 fuel near20 torque)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 09:37
S49	6	engine and (ethanol near20 direct$4 near10 inject$4) and (port near4 inject$4 near5 gasoline) and (fuel same inject$4 same torque near2 (range amount high$4 low$4) same knock$4) and ((dual both) near5 fuel near20 torque)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/06 09:26

11/6/2017 2:59:47 PM
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BIB DATA SHEET

CONFIRMATION NO. 1002

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/463,100	03/20/2017 RULE	123	3747	11381.122997

APPLICANTS
Massachusetts Institute of Technology, Cambridge, MA

INVENTORS
Leslie Bromberg, Sharon, MA;
Daniel R. Cohn, Cambridge, MA;
John B. Heywood, Newtonville, MA;

**** CONTINUING DATA ***************************
This application is a CON of 14/807,125 07/23/2015 PAT 9708965
and is a CON of 14/220,529 03/20/2014 ABN
and is a CON of 13/546,220 07/11/2012 ABN
and is a CON of 12/701,034 02/05/2010 PAT 8468983
and is a CON of 11/758,157 06/05/2007 ABN
and is a CON of 11/100,026 04/06/2005 PAT 7225787
and is a CON of 10/991,774 11/18/2004 PAT 7314033

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
03/27/2017

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /LONG T TRAN/ Examiner's Signature	☐ Met after Allowance LT Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		MA	5	31	4

ADDRESS
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493
UNITED STATES

TITLE
OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

FILING FEE RECEIVED		
3980	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15463100
Filing Date	2017-03-20
First Named Inventor	Leslie Bromberg
Art Unit	3747
Examiner Name	TRAN, LONG T
Attorney Docket Number	11381.122997

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/L.T.T/	1	2741230		1956-04-10	Reynolds et al.	
/L.T.T/	2	3106194		1963-10-08	Cantwell et al.	
/L.T.T/	3	3557763		1971-01-26	Probst, Stephen C.	
/L.T.T/	4	4031864		1977-06-29	Crothers, William T.	
/L.T.T/	5	4056087		1977-11-01	Boyce, Leonard D.	
/L.T.T/	6	4230072		1980-10-28	Noguchi et al.	
/L.T.T/	7	4312310		1982-01-26	Chivilo et al.	
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.T/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15463100
Filing Date	2017-03-20
First Named Inventor	Leslie Bromberg
Art Unit	3747
Examiner Name	TRAN, LONG T
Attorney Docket Number	11381.122997

/L.T.T/	9	4480616		1984-11-06	Takeda, Keiso	
/L.T.T/	10	4541383		1985-09-17	Jessel , Alfred J.	
/L.T.T/	11	4594201		1986-06-10	Phillips et al.	
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/L.T.T/	13	4958598		1990-09-25	Fossen, Dwayne	
/L.T.T/	14	4967714		1990-11-06	Inoue, Ryuzaburo	
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/L.T.T/	17	5233944		1993-08-10	Mochizuki, Kenji	
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.T/

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Art Unit	3747
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/L.T.T/	20	5937799		1999-08-17	Binion, Sidney	
/L.T.T/	21	6076487		2000-06-20	Wulff et al.	
/L.T.T/	22	6260525		2001-07-17	Moyer, David F.	
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Receipt date: 08/11/2017

15/463,100 - GAU: 3747

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Art Unit	3747
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Attorney Docket Number	11381.122997

/L.T.T/	31	6575147		2003-06-10	Wulff et al.	
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Receipt date: 08/11/2017

15/463,100 - GAU: 3747

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Attorney Docket Number	11381.122997

/L.T.T/	42	7168607		2007-03-13	Kobayashi, Tatsuo	
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/L.T.T/	44	3089470		1963-05-14	Payne, W.H.	
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/L.T.T/	46	4993386		1991-02-19	Ozasa et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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First Named Inventor	Leslie Bromberg
Art Unit	3747
Examiner Name	TRAN, LONG T
Attorney Docket Number	11381.122997

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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Art Unit	3747
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	7					

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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First Named Inventor	Leslie Bromberg
Art Unit	3747
Examiner Name	TRAN, LONG T
Attorney Docket Number	11381.122997

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
/L.T.T/	1	MODAK, A. et al., Engine Cooling by Direct Injection of Cooling Water, Society of Automotive Engineers, Inc., 1970, SAE World Headquarters, Warrendale, PA.	☐
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.T/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15463100 15/463,100 - GAU: 3747
Filing Date	2017-03-20
First Named Inventor	Leslie Bromberg
Art Unit	3747
Examiner Name	TRAN, LONG T
Attorney Docket Number	11381.122997

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/L.T.T/	15	PCT International Search Report and Written Opinion, Application No. PCT/US08/69171, October 3, 2008.	☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/LONG T TRAN/	Date Considered	11/06/2017

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.T/

Receipt date: 08/11/2017

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15463100 15/463,100 - GAU: 3747
	Filing Date	2017-03-20
	First Named Inventor	Leslie Bromberg
	Art Unit	3747
	Examiner Name	TRAN, LONG T
	Attorney Docket Number	11381.122997

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Sam Pasternack/	Date (YYYY-MM-DD)	2017-08-10
Name/Print	Sam Pasternack	Registration Number	29576

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15463100	BROMBERG ET AL.
	Examiner	Art Unit
	LONG T TRAN	3747

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/05/2017	11/06/2017							
	1	✓	-							
	2	✓	-							
	3	✓	-							
	4	✓	-							
	5	✓	-							
	6	✓	-							
	7	✓	-							
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	28	✓	-							
	29	✓	-							
	30	✓	-							
	31	✓	-							
	32		✓							
	33		✓							
	34		✓							
	35		✓							
	36		✓							

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15463100	BROMBERG ET AL.
	Examiner	Art Unit
	LONG T TRAN	3747

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/05/2017	11/06/2017							
	37		✓							
	38		✓							
	39		✓							
	40		✓							
	41		✓							
	42		✓							
	43		✓							
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	64		✓							
	65		✓							
	66		✓							
	67		✓							

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Application Number	15/463,100
Filing Date	March 20, 2017
First Named Inventor	Leslie Bromberg
Title	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
Art Unit	3747
Examiner Name	Long T. Tran
Attorney Docket Number	101328-422 (MIT11381K)

SIGNATURE of Applicant or Patent Practitioner

Signature	/Rory P. Pheiffer/	Date (Optional)	2018-01-16
Name	Rory P. Pheiffer	Registration Number	59,659
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

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I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

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☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 21125

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I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

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SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	2/9/17
Name	Theresa Latham		
Title	Intellectual Property Officer, Massachusetts Institute of Technology		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

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Docket No.: 101328-422
(MIT11381K) (PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of: Massachusetts Institute of Technology	
Application No.: 15/463,100	Confirmation No.: 1002
Filed: March 20, 2017	Art Unit: 3747
For: OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES	Examiner: Long T. Tran

TRANSMITTAL LETTER

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant respectfully submits a Power of Attorney for the above-referenced patent application, which also serves to revoke all previous powers of attorney given in this application. In support of the Intellectual Property Officer's authority to sign on behalf of the Massachusetts Institute of Technology, Applicant provides both a letter dated June 10, 2008, authorizing the "Intellectual Property Manager" to sign documents of this nature, and a letter dated July 10, 2017, indicating the position of "Intellectual Property Manager" has been renamed to "Intellectual Property Officer." Applicant respectfully requests confirmation of acceptance of the Power of Attorney for the present application.

The Director is hereby authorized to charge any deficiency in the fees filed with this paper, asserted to be filed with this paper, or which should have been filed with this paper to our Deposit Account No. 141449, under Client/Matter No. 101328-422 (MIT11381K).

Dated: January 16, 2018

Respectfully submitted,

Electronic signature: /Rory P. Pheiffer/
Rory P. Pheiffer
Registration No.: 59,659
NUTTER MCCLENNEN & FISH LLP
Seaport West
155 Seaport Boulevard
Boston, Massachusetts 02210-2604
(617) 439-2879
Attorney for Applicant

3778565.1

Massachusetts Institute of Technology

Kirk D. Kolenbrander
Vice President for Institute Affairs and Secretary of the Corporation

Office of the President
77 Massachusetts Avenue, Building 3-207
Cambridge, MA 02139-4307
Phone 617-253-3365

10 June 2008

Ms. Theresa M. Stone
Room 3-221
MIT

Dear Terry:

I am writing to confirm for your records that at its June 5 meeting, the Executive Committee

VOTE: That, effective on or after June 5, 2008, the individuals from time to time holding the following positions at the Institute are, and each of them acting singly is, hereby authorized to sign in the name and on behalf of the Institute any contracts, agreements, filings and other documents which correspond to the description set forth below the name of the position and which any such individual deems advisable and in the interests of the Institute:

Vice President for Research;
Director, Technology Licensing Office;
Associate Director, Technology Licensing Office

all documents and things necessary to apply for, obtain and maintain patents and trademarks in the United States Patent and Trademark Office and in the appropriate offices of all other countries of the world, including without limitation, Powers of Attorney appointing outside legal counsel to act on behalf of the Institute in procuring and maintaining such patents and trademarks; and

all documents and things necessary to apply for, obtain, and maintain registered copyrights in the United States Copyright Office and in the appropriate offices of all other countries of the world, including, without limitation, Powers of Attorney appointing outside legal counsel to act on behalf of the Institute in procuring and maintaining such registered copyrights; and

license agreements and all documents relating to the licensing of intellectual property (including, without limitation patents, trademarks, copyrights, and know-how) to third parties and to the United States government, including, without limitation, faculty royalty-sharing agreements and inter-institutional royalty-sharing agreements, incoming and outgoing material transfer

agreements, option agreements, non-disclosure agreements, and initial equity issuance and transfer documents issued pursuant to a license grant, provided that such documents do not include sponsored research agreements, provided that if the Director or Associate Director of the Technology Licensing Office wishes to sign any license agreement in which equity is issued to the Institute as consideration for the license or an individual who is an Institute employee is also an inventor and owns or anticipates owning significant equity in the licensee, then the Vice President for Research or the Provost of the Institute must co-sign the license agreement

Assistant Director for Biotechnology

all incoming and outgoing material transfer agreements

Intellectual Property Manager

all documents and things necessary to apply for, obtain and maintain patents and trademarks in the United States Patent and Trademark Office and in the appropriate offices of all other countries of the world, including without limitation, Powers of Attorney appointing outside legal counsel to act on behalf of the Institute in procuring and maintaining such patents and trademarks; and

all documents and things necessary to apply for, obtain, and maintain registered copyrights in the United States Copyright Office and in the appropriate offices of all other countries of the world, including, without limitation, Powers of Attorney appointing outside legal counsel to act on behalf of the Institute in procuring and maintaining such registered copyrights;

Patent Compliance Manager; Patent Compliance Administrator

all agreements licensing intellectual property to the United States government;

that any action taken before June 5, 2008 by an individual holding any of the above-listed positions which is within the scope of the authority granted by this vote is hereby ratified as approved by the Executive Committee; and

that the signing and delivery of any contract, agreement, filing or other document by an individual holding any of the above-listed positions in order to carry out the purpose this vote shall be conclusive as to the authority of such individual.

If you have any questions, please give me a call.

Sincerely,

Kirk D. Kolenbrander

KDK/acb
cc: Claude Canizares
Lauren Foster
Rolande Johndro
Lita Nelson
Richelle A. Nessralla, Esq.
Daniel O'Brien
L. Rafael Reif
Israel Ruiz
Jack Turner

Technology Licensing Office

Massachusetts Institute of Technology
255 Main Street, Kendall Square, NE18-501
Cambridge, Massachusetts 02142-1601

Phone 617-253-6966
Fax 617-258-6790
http://web.mit.edu/tlo

To: File

From: Lesley Millar-Nicholson, Director

Subject: TLO Signatory Authority
June 10, 2008 Letter from Kirk Kolenbrander

Date: July 10, 2017

This is to confirm that, with respect to the June 10, 2008 letter from Kirk Kolenbrander to Theresa Stone, the "Intellectual Property Manager" position within the Technology Licensing Office has been renamed to "Intellectual Property Officer". Therefore, the Intellectual Property Officer shall have the authority to sign documents related to applying for, obtaining and maintaining patents, trademarks and copyrights in the U.S. Patent and Trademark Office and the appropriate patent offices of other countries of the world as set forth in the above referenced letter.

Lesley Millar-Nicholson

Technology Licensing Office

Massachusetts Institute of Technology
255 Main Street, Kendall Square, NE18-501
Cambridge, Massachusetts 02142-1601

Phone 617-253-6966
Fax 617-258-6790
http://web.mit.edu/tlo

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Lesley Millar-Nicholson

Electronic Acknowledgement Receipt

EFS ID:	31508317
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	91197
Filer:	Rory P. Pheiffer
Filer Authorized By:	
Attorney Docket Number:	11381.122997
Receipt Date:	16-JAN-2018
Filing Date:	20-MAR-2017
Time Stamp:	18:16:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	422PowerofAttorney.pdf	485583 d7d9472a9183f842f47be436fb0e7382db87da13	no	2
Warnings:					

Information:					
2	Transmittal Letter	422Transmittal.pdf	109114 62e6176db764e21b91e373e393f3799b09858044	no	1
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	MIT_Authorization_Letter.pdf	291104 58ac30d6b79e3edc54bee2ed3290f4798303b65d	no	4
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	MIT_IP_Manager_Now_Called_IP_Officer.pdf	142073 a4822d9ad1e3b697c8c863e192e41c539c6cbee3	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	1027874		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	11381.122997

CONFIRMATION NO. 1002

POWER OF ATTORNEY NOTICE

91197
MIT"s Technology Licensing Office
255 Main Street
NE 18-501
Cambridge, MA 02142-1493

OC000000096763831

Date Mailed: 01/19/2018

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/16/2018.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/agizaw/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/463,100	03/20/2017	Leslie Bromberg	101328-422 (MIT11381K)

CONFIRMATION NO. 1002

POA ACCEPTANCE LETTER

21125
NUTTER MCCLENNEN & FISH LLP
SEAPORT WEST
155 SEAPORT BOULEVARD
BOSTON, MA 02210-2604

OC000000096763858

Date Mailed: 01/19/2018

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/16/2018.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/agizaw/

Electronic Patent Application Fee Transmittal

Application Number:	15463100
Filing Date:	20-Mar-2017
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Filer:	Rory P. Pheiffer/Jessica Ferrara
Attorney Docket Number:	101328-422 (MIT11381K)

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
		Total in USD ($)		**200**

Electronic Acknowledgement Receipt	
EFS ID:	32024638
Application Number:	15463100
International Application Number:	
Confirmation Number:	1002
Title of Invention:	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
First Named Inventor/Applicant Name:	Leslie Bromberg
Customer Number:	21125
Filer:	Rory P. Pheiffer
Filer Authorized By:	
Attorney Docket Number:	101328-422 (MIT11381K)
Receipt Date:	12-MAR-2018
Filing Date:	20-MAR-2017
Time Stamp:	22:28:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$200
RAM confirmation Number	031318INTEFSW22285800
Deposit Account	141449
Authorized User	Rory Pheiffer
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Fee Worksheet (SB06)	fee-info.pdf	31205 f3546d67fc1770aa87a0f839aee3021afe0f8391	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	31205		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/463,100	03/20/2017	Leslie Bromberg	101328-422 (MIT11381K)	1002

21125 7590 05/18/2018
NUTTER MCCLENNEN & FISH LLP
SEAPORT WEST
155 SEAPORT BOULEVARD
BOSTON, MA 02210-2604

EXAMINER	
TRAN, LONG T	

ART UNIT	PAPER NUMBER
3747	

NOTIFICATION DATE	DELIVERY MODE
05/18/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docket@nutter.com

Notice of Abandonment	Application No.	Applicant(s)
	15/463,100	BROMBERG ET AL.
	Examiner	Art Unit
	LONG T. TRAN	3747

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

This application is abandoned in view of:

1. ☒ Applicant's failure to timely file a proper reply to the Office letter mailed on *13 November 2017*.
   (a) ☐ A reply was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply (including a total extension of time of _____ month(s)) which expired on _____.
   (b) ☐ A proposed reply was received on _____, but it does not constitute a proper reply under 37 CFR 1.113 to the final rejection.
   (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) if this is utility or plant application, a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. Note that RCEs are not permitted in design applications.)
   (c) ☐ A reply was received on _____ but it does not constitute a proper reply, or a bona fide attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 7 below).
   (d) ☒ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
   (a) ☐ The issue fee and publication fee, if applicable, was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
   (b) ☐ The submitted fee of $_____ is insufficient. A balance of $_____ is due.
   The issue fee required by 37 CFR 1.18 is $_____. The publication fee, if required by 37 CFR 1.18(d), is $_____.
   (c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
   (a) ☐ Proposed corrected drawings were received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply.
   (b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record or other party authorized under 37 CFR 1.33(b). See 37 CFR 1.138(b).

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34) upon the filing of a continuing application.

6. ☐ The decision by the Board of Patent Appeals and Interference rendered on _____ and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☒ The reason(s) below:

no reply

/LONG T TRAN/
Primary Examiner, Art Unit 3747

Petitions to revive under 37 CFR 1.137, or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.