

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

## **Background of the Invention**

5           This application is a continuation of United States Patent Application Serial No. 11/100,026 filed April 6, 2005, which is a continuation-in-part of United States Patent Application Serial No. 10/991,774 filed November 18, 2004, the contents of both of which are incorporated herein by reference.

10           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.

15           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.

20           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**

25           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  
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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%.

It 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 Drawings**

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  $\beta$ , 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.

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### **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

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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  
5 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  
10 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  
15 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.  
20 Coltrin, J. F. Grcar, 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  
25 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  
30 engine compression ratio of 21 to represent the conditions of the end gas in an engine with an actual compression ratio of 10. 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  
5 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  
10 increase. The effect is modeled by assuming that the increase in temperature of the air charge into the cylinder  $\Delta T_{\text{charge}}$  is  $\Delta T_{\text{charge}} = \beta \Delta T_{\text{turbo}}$  where  $\Delta T_{\text{turbo}}$  is the temperature increase after the compressor due to boosting and beta is a constant. Values of  $\beta$  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.

15 Fig. 1 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  $\beta$ . 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  
20 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. 1. 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  $\beta$  (ratio of change of the cylinder air charge temperature due to turbocharging to the adiabatic temperature increase due to turbocharging  $\Delta T_{\text{charge}} = \beta \Delta T_{\text{turbo}}$ ). The engine speed is 1000 rpm.

$\beta$		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 ~120 K. 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 1 K (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  $\sim 1/3$  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.

5 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  
10 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  
15 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) are used to determine air, gasoline and ethanol flows for keeping substantially stoichiometric combustion in  
20 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 determined by the fuel management were not be corrected during the injection of ethanol, the  
25 mixture would no longer be stoichiometric. In contrast to the lean boost approach of Stokes *et 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.

There are certain regions in the engine operating map where the ECU 14 may operate  
30 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 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 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 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 1). The control system 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 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.

5 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  
10 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  
15 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  
20 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  
25 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  
30 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.

5           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  
10       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  
15       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  
20       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.  
25       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  
30       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 NO<sub>x</sub> 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.

5           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.

10           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.

15           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  
20 the desired octane enhancement (*e.g.*, to meet alternative fuel or CO<sub>2</sub> 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  
25 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  
30 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.

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  
10   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  
15   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 more larger than the temperature  
20   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.

25



**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	$\Delta T_{air}$ K
Gasoline					42.8	0.30	0.007	14.6	0.020	-28
Ethyl t-Butyl Ether	CH <sub>3</sub> CH <sub>2</sub> -O-C(CH <sub>3</sub> ) <sub>3</sub>	118	102	110	36.3	0.31	0.009	12.1	0.026	-35
t-Amyl Methyl Ether	C <sub>2</sub> H <sub>5</sub> C (CH <sub>3</sub> ) <sub>2</sub> -O-CH <sub>3</sub>	111	98	105	36.3	0.32	0.009	12.1	0.027	-36
Toluene	C <sub>7</sub> H <sub>8</sub>	111	95	103	40.5	0.36	0.009	13.5	0.027	-37
Methyl t-Butyl Ether	CH <sub>3</sub> -O-C(CH <sub>3</sub> ) <sub>3</sub>	116	103	110	35.2	0.32	0.009	11.7	0.028	-37
Diisopropyl Ether	(CH <sub>3</sub> ) <sub>2</sub> CH-O-CH(CH <sub>3</sub> ) <sub>2</sub>	110	97	103	38.2	0.34	0.009	12.1	0.028	-39
t-Butyl Alcohol	(CH <sub>3</sub> ) <sub>3</sub> C-OH	103	91	97	32.9	0.60	0.018	11.1	0.054	-74
Isopropanol	(CH <sub>3</sub> ) <sub>2</sub> CHOH	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	CH <sub>3</sub> CH <sub>2</sub> OH	129	102	115	26.7	0.91	0.034	9	0.102	-138
Methanol	CH <sub>3</sub> OH	133	105	119	20.0	1.16	0.058	6.4	0.181	-246

5 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,  $\Delta T_{air}$ , 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  
10 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  
15 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  
20 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  
5 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.

10 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,  
15 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  
20 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  
25 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:

5

1. A turbocharged, direct injection spark ignition engine which uses port fuel injection of gasoline from a first source in addition to direct injection of liquid denatured ethanol from a second source comprising:

a direct injection spark ignition engine;

a turbocharger;

means for port fuel injection of gasoline from the first source;

means for direct injection of liquid denatured ethanol from the second source;

wherein during part of engine operating time, the engine is powered both by gasoline that is port fuel injected and ethanol that is directly injected; and

wherein under some operating conditions the instantaneous energy ratio of ethanol to total fuel is at least 20%; and

wherein the ethanol is directly injected in such an amount that the fuel octane number is enhanced by at least 20 octane numbers relative to that of port fueled gasoline alone; and

a fuel management system including a microprocessor for increasing the ethanol/gasoline ratio to an amount that is sufficient to suppress knock as the turbocharger increases the manifold pressure; and

wherein the fuel management system uses closed loop control with information from a knock sensor to vary the ethanol/gasoline ratio;

wherein the fuel management system minimizes the amount of the ethanol that is used by determining when and how much ethanol must be used to prevent knock as the manifold pressure is increased by using a knock sensor and further wherein:

the fuel management system controls the amount of air to the turbocharger, the amount of gasoline and the amount of ethanol to obtain a substantially stoichiometric air/fuel ratio during all or part of the time that the ethanol is injected based on information from the

knock sensor, an oxygen sensor and a look up table thereby enabling use of a three way catalyst.

2. A turbocharged direct injection spark ignition engine which uses port fuel injection of gasoline from a first source in addition to direct injection of liquid denatured ethanol from a second source comprising:

a direct injection spark ignition engine;

a turbocharger;

means for port fuel injection of gasoline from the first source;

means for direct injection of liquid denatured ethanol from the second source;

wherein during part of engine operating time, the engine is powered both by gasoline that is port fuel injected and ethanol that is directly injected; and

wherein under some operating conditions the instantaneous energy ratio of ethanol to total fuel is at least 20%; and

wherein the ethanol is directly injected in such an amount that the fuel octane number is enhanced by at least 20 octane numbers relative to that of port fueled gasoline alone; and

wherein the ethanol is directly injected in such an amount as to provide evaporative cooling which prevents knock at a manifold pressure which is at least twice that at which knock occurs when the engine is operated with port fuel injected gasoline alone; and

a fuel management system including a microprocessor for increasing the ethanol /gasoline ratio in the engine an amount that is sufficient to suppress knock as the turbocharger increases the manifold pressure; and

the fuel management system uses the combination of open loop control with a look up table and closed loop control with information from a knock sensor to vary the ethanol /gasoline ratio; and

where the fuel management system minimizes the amount of the ethanol that is used by determining when and how much ethanol must be used to prevent knock as the manifold pressure is increased by using a knock sensor and further wherein:

the fuel management system controls the amount of air to the turbocharger, the amount of gasoline and the amount of ethanol to obtain a substantially stoichiometric air/fuel ratio during all or part of the time that the ethanol is injected based on information from the knock sensor, an oxygen sensor and a look up table thereby enabling use of a three way catalyst; and

where the level of ethanol in the second tank is used as input to the fuel management system microprocessor to control the turbocharging; and

where the turbocharging is reduced or eliminated when there is no ethanol in the second source.

3. A turbocharged, direct injection spark ignition engine which uses port fuel injection of gasoline from a first source in addition to direct injection of liquid denatured ethanol from a second source comprising:

a direct injection spark ignition engine;

a turbocharger;

means for port fuel injection of gasoline from the first source;

means for direct injection of liquid denatured ethanol from the second source;

wherein during part of engine operating time, the engine is powered both by gasoline that is port fuel injected and ethanol that is directly injected; and

wherein under some operating conditions the instantaneous energy ratio of ethanol to total fuel is at least 20% and:

wherein the ethanol is directly injected in such an amount that the fuel octane number is enhanced by at least 20 octane numbers relative to that of port fueled gasoline alone; and

means for direct fuel injection of gasoline; and

a fuel management system including a microprocessor for increasing the ethanol /gasoline ratio in the engine to an amount that is sufficient to meet the varying requirement to suppress knock as the turbocharger increases the manifold pressure; and

wherein the fuel management system uses the combination of open loop control with a look up table and closed loop control with information from a knock sensor to vary the ethanol- mixture/gasoline ratio; and

wherein the fuel management system minimizes the amount of the ethanol that is used by determining when and how much ethanol must be used to prevent knock as the manifold pressure is increased by using a knock sensor and further wherein:

the fuel management system controls the amount of air to the turbocharger, the amount of gasoline and the amount of the ethanol to obtain a substantially stoichiometric air/fuel ratio during all or part of the time that the ethanol is injected based on information from the knock sensor, an oxygen sensor and a lookup table thereby enabling use of a three way catalyst; and

wherein gasoline is directly injected if there is no ethanol in the second source

wherein the turbocharging is reduced or eliminated when there is no ethanol in the second source; and

wherein when no ethanol is used and the gasoline is directly injected the vehicle is operated at higher loads than is the case when it is operated with port fuel injection of gasoline alone.

4. A turbocharged direct injection spark ignition engine which uses port fuel injection of gasoline from a first source in addition to direct injection of E 85 from a second source comprising:

a direct injection spark ignition engine;

a turbocharger;

means for port fuel injection of gasoline from the first source;

means for direct injection of liquid E 85 from the second source;

wherein during part of engine operating time , the engine is powered both by gasoline that is port fuel injected and E 85 that is directly injected; and

where under some operating conditions the instantaneous energy ratio of ethanol to total fuel is at least 20%; and

wherein the E 85 is directly injected in such an amount that the fuel octane number is enhanced by at least 20 octane numbers relative to that of port fueled gasoline alone, and

a means for direct fuel injection of gasoline;

a fuel management system including a microprocessor for increasing the E 85 /gasoline ratio in the engine to an amount sufficient to prevent knock as the turbocharger increases the manifold pressure; and

wherein the fuel management system minimizes the amount of the E 85 by determining when and how much E 85 must be used to prevent knock as the manifold pressure is increased by using a knock sensor and further wherein:

the fuel management system controls the amount of air to the turbocharger, the amount of gasoline and the amount of the E 85 to obtain a substantially stoichiometric air/fuel ratio during all or part of the time that the ethanol is injected based on information from the



knock sensor, an oxygen sensor and a look up table thereby enabling use of a three way catalyst; and

wherein gasoline is directly injected if there is no E 85 in the second source; and

where when no ethanol is used and the gasoline is directly injected the vehicle is operated at higher loads than is the case when it is operated with port fuel injection of gasoline alone.

5. Spark ignition gasoline engine comprising:

a direct injection spark ignition gasoline engine;

means for port fuel injection of gasoline from a first source;

means for direct injection of liquid denatured ethanol from a second source; and

a fuel management control system for controlling injection of the liquid denatured ethanol into a cylinder of the engine to control knock.

**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.

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<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	0492611-0762
		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.			

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<input type="checkbox"/>	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.)
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<b>Citizenship under 37 CFR 1.41(b) i</b>		US			
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	John	B.	Heywood		
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<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	0492611-0762	
		Application Number		
Title of Invention	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES			
Citizenship under 37 CFR 1.41(b) i	US			
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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	0492611-0762	Small Entity Status Claimed	<input checked="" type="checkbox"/>
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	
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<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	0492611-0762
		Application Number	
Title of Invention	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES		
Customer Number	24280		

**Domestic Priority Information:**

This section allows for the applicant to claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c). 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(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending	<input type="button" value="Remove"/>	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation in part of	11/100026	2005-04-06
Prior Application Status	Pending	<input type="button" value="Remove"/>	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation in part of	10/991774	2004-11-18
Additional Domestic Priority Data may be generated within this form by selecting the <b>Add</b> button.			<input type="button" value="Add"/>

**Foreign Priority Information:**

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. 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(a).

<input type="button" value="Remove"/>			
Application Number	Country <sup>i</sup>	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			<input checked="" type="radio"/> Yes <input type="radio"/> No
Additional Foreign Priority Data may be generated within this form by selecting the <b>Add</b> button.			<input type="button" value="Add"/>

**Assignee Information:**

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

<input type="button" value="Remove"/>			
<b>Assignee 1</b>			
If the Assignee is an Organization check here. <input checked="" type="checkbox"/>			
Organization Name	Massachusetts Institute of Technology		
<b>Mailing Address Information:</b>			
Address 1	77 Massachusetts Avenue		
Address 2			
City	Cambridge	State/Province	MA
Country <sup>i</sup>	US	Postal Code	02139
Phone Number		Fax Number	
Email Address			
Additional Assignee Data may be generated within this form by selecting the <b>Add</b> button.			<input type="button" value="Add"/>

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	0492611-0762
		Application Number	
Title of Invention	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES		

**Signature:**

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.					
<b>Signature</b>	/SamPasternack/		Date (YYYY-MM-DD)	2007-06-05	
First Name	Sam	Last Name	Pasternack	Registration Number	29576

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.**

## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

**DECLARATION**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention titled: **OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES**, the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulation, § 1.56. I hereby claim foreign priority benefits under Title 35, United States Code, §119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate disclosing the subject matter claimed in their application and having a filing date (1) before that of the application on which priority is claimed, or (2) if no priority is claimed, before the filing date of this application.

<u>Prior Foreign Application(s)</u>			
<u>Number</u>	<u>Country</u>	<u>Day/Month/Year Filed</u>	<u>Priority Claimed</u>
			( ) Yes ( ) No

I hereby claim the benefit under Title 35, United States Code, §120/365 of any United States application(s) listed below and PCT International Applications listed above or below, and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

<u>10/991,774</u>	<u>November 18, 2004</u>	<u>Pending</u>
(Application Number)	Day/Month/Year Filed	Status (Patented, Pending, Abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor's signature *Leslie Bromberg* Date 6/29/05

Full name of first inventor (given name, family name): Leslie Bromberg

Residence: 16 Wilshire Drive, Sharon, MA 02067 Citizenship: U.S.

Post Office Address (include zip code): Same

Inventor's signature *Daniel Cohn* Date 6/29/05

Full name of second inventor (given name, family name): Daniel R. Cohn

Residence: 100 Memorial Drive, Apt. # 11-228 Cambridge, MA 02142 Citizenship: U.S.

Post Office Address (include zip code): Same

( X ) Additional inventors are being named on separately numbered sheets attached hereto.



**DECLARATION**  
**(continued)**

Inventor's signature *John B. Heywood* Date 6/29/05  
Full name of third inventor (given name, family name): John B. Heywood  
Residence: 218 Mill Street, Newton, MA 02460 Citizenship: U.S.  
Post Office Address (include zip code): Same

**ATTORNEY'S DOCKET NUMBER: 0492611-0617 (MIT 11381 CIP)  
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Bromberg, et al. Examiner: Not assigned yet  
Serial Number: 11/100,026 Art Unit: 1714  
Filed: April 6, 2005  
Title: Optimized Fuel Management System for Direct Injection Ethanol  
Enhancement of Gasoline Engines

MAIL STOP: MISSING PARTS  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

**APPOINTMENT OF ATTORNEY**

The undersigned hereby appoints:

The attorneys/agents associated with **Customer No. 24280** as its attorneys and agents for prosecution of matters relating to the above-identified patent application and to conduct all business in the United States Patent and Trademark Office.

All correspondence should be sent to:

Sam Pasternack  
Patent Department  
Choate, Hall & Stewart LLP  
Exchange Place, 53 State Street  
Boston, Massachusetts 02109

Respectfully Submitted,



Name: **KARIN K. RIVARD**  
Title: **ASSISTANT DIRECTOR AND COUNSEL**  
Date: **July 7, 2005**  
On Behalf of: **TECHNOLOGY LICENSING OFFICE**  
**Massachusetts Institute of**  
**Technology**

**ATTORNEY DOCKET NO.: 0492611-0617 (MIT 11381 CIP)  
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Bromberg, et al. Examiner: Not assigned yet  
Serial No.: 11/100,026 Art Unit: 1714  
Filing Date: April 6, 2005  
Title: Optimized Fuel Management System for Direct Injection Ethanol Enhancement of Gasoline Engines

Commissioner For Patents  
P. O. Box 1450  
Alexandria, VA 22313-1450

Sir:

**ESTABLISHING RIGHT OF ASSIGNEE TO TAKE ACTION**  
**(37 CFR § 3.73(b))**

The inventors of the above-referenced United States patent application have assigned their entire right, title, and interest in the inventions disclosed therein according to the following table:

Inventor	Assignee
<b>Leslie BROMBERG</b>	<b>Massachusetts Institute of Technology</b>
<b>Daniel R. COHN</b>	<b>Massachusetts Institute of Technology</b>
<b>John B. HEYWOOD</b>	<b>Massachusetts Institute of Technology</b>

Thus, the Assignees of the inventors' entire right, title, and interest are:

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**

According to 37 CFR § 3.73(b), the Assignee is entitled to take action relating to the application in the Patent and Trademark Office if the Assignee establishes ownership to the satisfaction of the Commissioner.

Ownership by the assignee is established as follows:

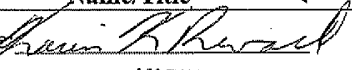
\_\_\_ documents already recorded in the PTO on \_\_\_\_\_.

Reel \_\_\_\_\_ Frame \_\_\_\_\_; or

X documents separately submitted for recordal to the PTO (a copy of these documents is attached).

**STATEMENT**

I, person(s) authorized to sign on behalf of the Assignee, have reviewed the evidentiary documents referred to above and certify that, to the best of my knowledge and belief, title is mine/ours as Assignee who seeks to take further action.

Name/Title	Assignee	Date
Signature:  Name: <b>KARIN K. RIVARD</b> Title: <b>ASSISTANT DIRECTOR AND COUNSEL</b> <b>TECHNOLOGY LICENSING OFFICE</b>	<b>Massachusetts Institute of Technology</b> <b>77 Massachusetts Avenue</b> <b>Cambridge, MA 02139</b>	<u>July 7, 2005</u>

ASSIGNMENT

WHEREAS, **LESLIE BROMBERG** of Sharon, Massachusetts; **DANIEL R. COHN** of Cambridge, Massachusetts; and **JOHN B. HEYWOOD** of Newton, Massachusetts, have developed certain inventions described in U.S. patent application entitled **OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES**, U.S. Patent Application No. 11/100,026, filed on April 6, 2005, and have full right to convey the entire right, title and interest, both legal and equitable, in and to said inventions, free from all prior assignments, agreements, licenses, mortgages, security interests, or other encumbrances whatsoever; and

WHEREAS, Massachusetts Institute of Technology ("Assignee"), having offices in Cambridge, Massachusetts, is desirous of acquiring the entire right, title and interest in and to said invention or inventions and any and all patents to be obtained therefor;

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged by the undersigned, the undersigned do hereby sell, assign, transfer and set over unto said Assignee, its successors and assigns, the entire right, title and interest throughout the world in and to said invention or inventions, as described in the aforesaid application, in any form or embodiment thereof, and in and to the aforesaid application; and in and to any application filed in the U.S. or any foreign country based thereon, including the right to file said applications and claim priority under the provisions of any U.S. or international convention or treaty; also the entire right, title and interest throughout the world in and to any and all patents or reissues or extensions thereof to be obtained in this or any foreign country upon said invention or inventions and any divisional, continuation, continuation-in-part or substitute applications which may be filed upon said invention or inventions in this or any foreign country; and the undersigned hereby authorize and request the issuing authority to issue any and all patents on said application or applications to said Assignee or its successors and assigns.

The undersigned further agree, without any further payment or compensation by said Assignee or its successors and assigns, to communicate to said Assignee, its representatives or agents or its successors and assigns, any facts relating to said invention or inventions including evidence for interference purposes or for other legal proceedings whenever requested; testify in any interference or other legal proceedings, whenever requested; execute and deliver, on request, all lawful papers required to make any of the foregoing provisions effective; and generally do everything possible to aid said Assignee, its successors or assigns and nominees to secure, obtain and enforce proper patent protection for said invention or inventions in this or any foreign country.

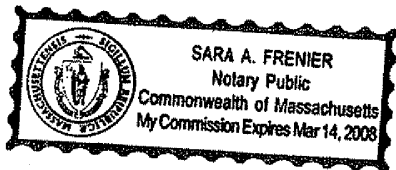
IN TESTIMONY WHEREOF, the undersigned has hereunto set their hands and seals on the date after their signatures.

June 29, 2005  
Date

*Leslie Bromberg*  
LESLIE BROMBERG

State of Massachusetts )  
County of Middlesex )

On this 29<sup>th</sup> day of June, 2005 before me personally appeared **LESLIE BROMBERG**, to me personally known, and known to me to be the person who signed the foregoing assignment, and acknowledged the signing of same as her free act and deed.



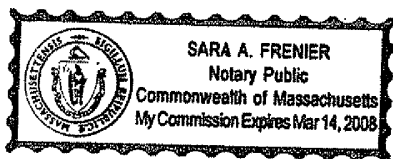
*Sara A. Frenier*  
Notary Public  
My commission expires March 14, 2008

June 29, 2005  
Date

Daniel R. Cohn  
DANIEL R. COHN

State of Massachusetts )  
County of Middlesex )

On this 29<sup>th</sup> day of June, 2005 before me personally appeared DANIEL R. COHN, to me personally known, and known to me to be the person who signed the foregoing assignment, and acknowledged the signing of same as his free act and deed.



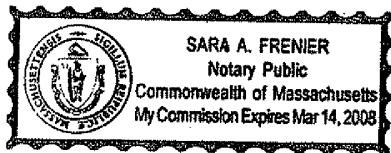
Sara A. Frier  
Notary Public  
My commission expires March 14, 2008

June 29, 2005  
Date

John B. Heywood  
JOHN B. HEYWOOD

State of Massachusetts )  
County of Middlesex )

On this 29<sup>th</sup> day of June, 2005 before me personally appeared JOHN B. HEYWOOD, to me personally known, and known to me to be the person who signed the foregoing assignment, and acknowledged the signing of same as his free act and deed.



Sara A. Frier  
Notary Public  
My commission expires March 14, 2008

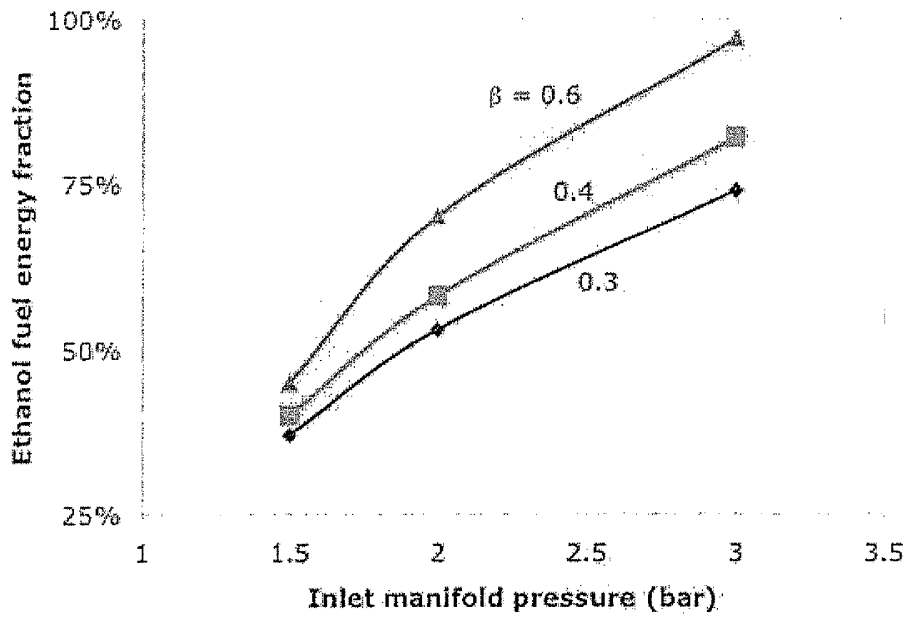


FIG. 1

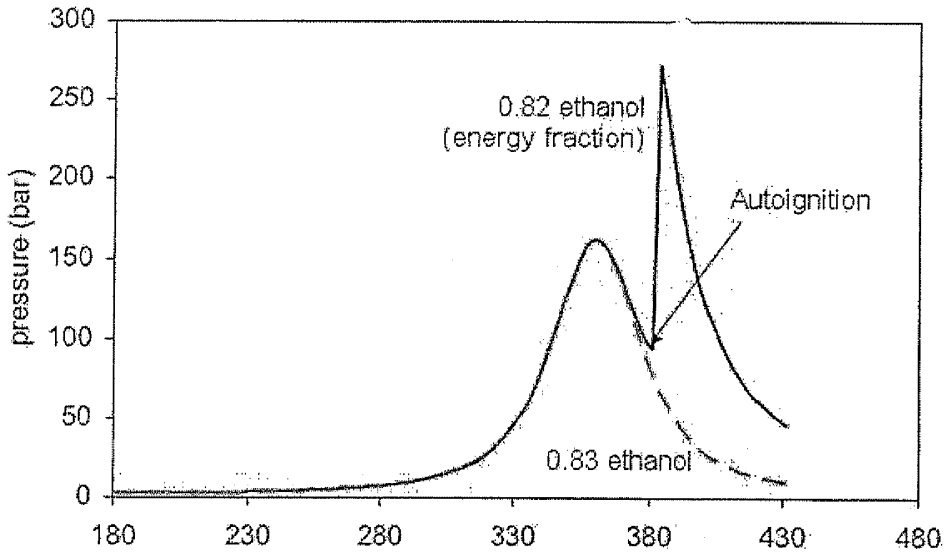


FIG. 2a Crank angle

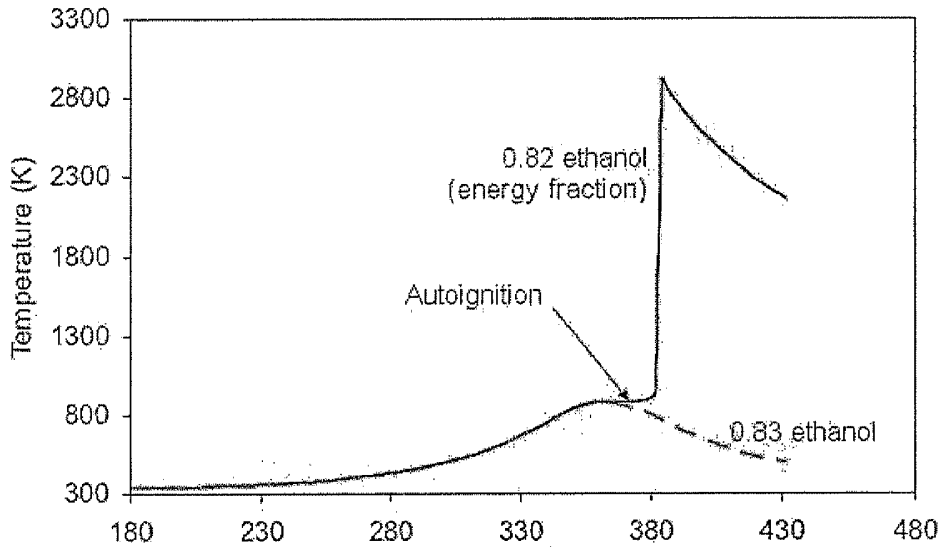


FIG. 2b Crank angle

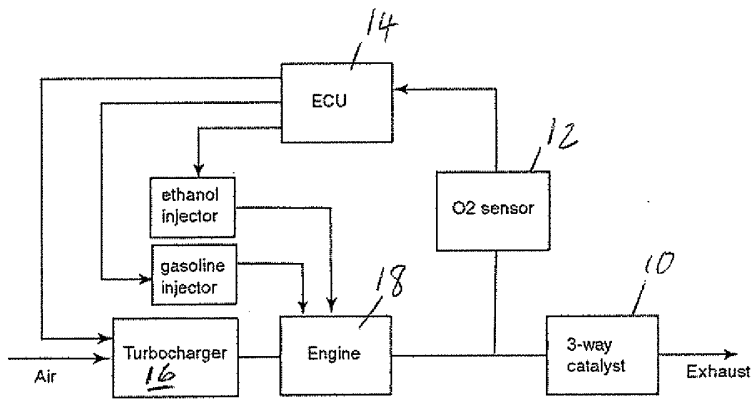
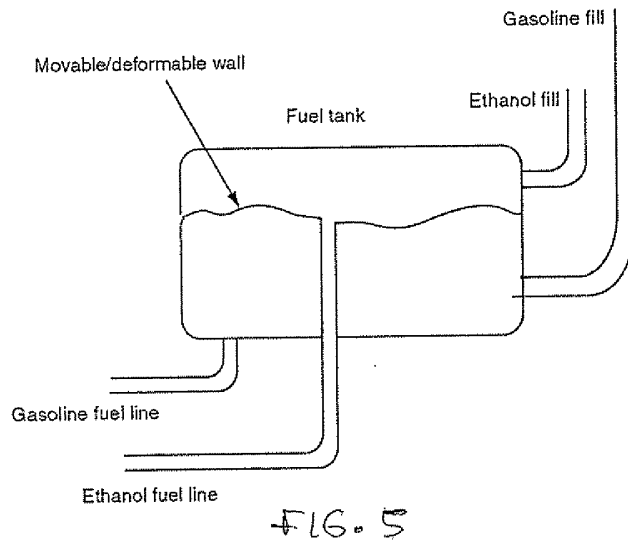
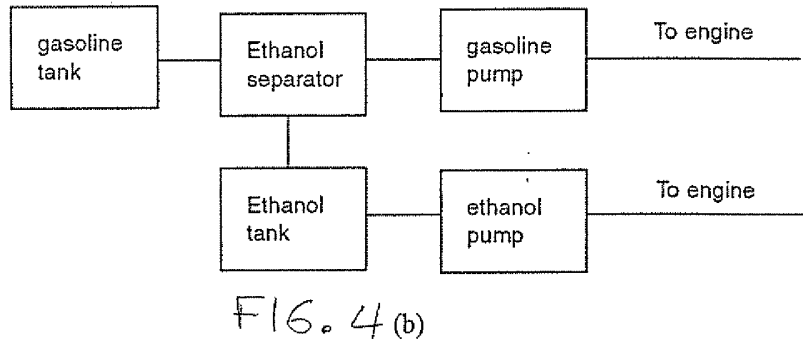
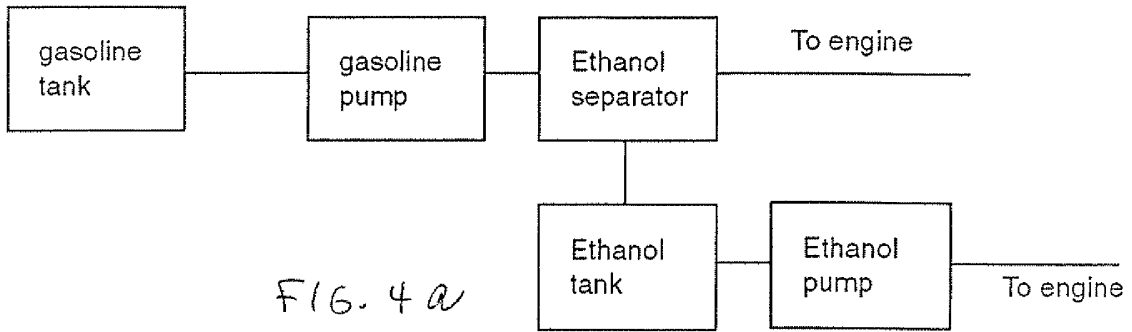


FIG. 3





## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	1839417
<b>Application Number:</b>	11758157
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	3972
<b>Title of Invention:</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
<b>First Named Inventor/Applicant Name:</b>	Leslie Bromberg
<b>Customer Number:</b>	24280
<b>Filer:</b>	Sam Pasternack/Elizabeth Burke
<b>Filer Authorized By:</b>	Sam Pasternack
<b>Attorney Docket Number:</b>	0492611-0762
<b>Receipt Date:</b>	05-JUN-2007
<b>Filing Date:</b>	
<b>Time Stamp:</b>	13:13:26
<b>Application Type:</b>	Utility

### Payment information:

Submitted with Payment	no
------------------------	----

### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part /.zip	Pages (if appl.)
1		MIT11381CONIApplication.pdf	208348	yes	30

Multipart Description/PDF files in .zip description					
Document Description		Start	End		
Specification		1	23		
Claims		24	29		
Abstract		30	30		
<b>Warnings:</b>					
<b>Information:</b>					
2	Application Data Sheet	MIT11381CIPII.pdf	1136735	no	5
<b>Warnings:</b>					
<b>Information:</b>					
3	Oath or Declaration filed	MIT11381CONIIDeclaration.pdf	369744	no	7
<b>Warnings:</b>					
<b>Information:</b>					
4	Drawings	MIT11381CONIIFigures.pdf	90785	no	3
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>			1805612		
<p>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.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b>  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.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b>  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.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b>  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.</p>					

6/5/07

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

<b>PATENT APPLICATION FEE DETERMINATION RECORD</b> Substitute for Form PTO-875	<b>11/758,157</b>
---	-------------------

APPLICATION AS FILED – PART I			SMALL ENTITY		OTHER THAN SMALL ENTITY	
	(Column 1)	(Column 2)		FEE (\$)		FEE (\$)
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)		RATE (\$)	
BASIC FEE (37 CFR 1.16(a), (b), or (c))				75		
SEARCH FEE (37 CFR 1.16(k), (l), or (m))				250		
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))				100		
TOTAL CLAIMS (37 CFR 1.16(i))	5	minus 20 =	X 25=		X 50=	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5	minus 3 =	X 100=	200	X 200=	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 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).					
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A		N/A	
			TOTAL	625	TOTAL	

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

APPLICATION AS AMENDED – PART II					SMALL ENTITY		OTHER THAN SMALL ENTITY	
	(Column 1)	(Column 2)	(Column 3)		ADDITIONAL FEE (\$)		ADDITIONAL FEE (\$)	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		RATE (\$)	
	Total (37 CFR 1.16(i))	*	Minus **	=	X =		X =	
	Independent (37 CFR 1.16(h))	*	Minus ***	=	X =		X =	
	Application Size Fee (37 CFR 1.16(s))							
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		N/A	
					TOTAL ADD'T FEE		TOTAL ADD'T FEE	

APPLICATION AS AMENDED – PART II					SMALL ENTITY		OTHER THAN SMALL ENTITY	
	(Column 1)	(Column 2)	(Column 3)		ADDITIONAL FEE (\$)		ADDITIONAL FEE (\$)	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		RATE (\$)	
	Total (37 CFR 1.16(i))	*	Minus **	=	X =		X =	
	Independent (37 CFR 1.16(h))	*	Minus ***	=	X =		X =	
	Application Size Fee (37 CFR 1.16(s))							
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		N/A	
					TOTAL ADD'T FEE		TOTAL ADD'T 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 number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. 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 12 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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Alexandria, Virginia 22313-1450
www.uspto.gov

Table with 7 columns: APPLICATION NUMBER, FILING or 371(c) DATE, GRP ART UNIT, FIL FEE REC'D, ATTY.DOCKET.NO, TOT CLAIMS, IND CLAIMS. Row 1: 11/758,157, 06/05/2007, 3747, 0.00, 0492611-0762, 5, 5

CONFIRMATION NO. 3972

24280
CHOATE, HALL & STEWART LLP
TWO INTERNATIONAL PLACE
BOSTON, MA02110

FILING RECEIPT

Date Mailed: 06/25/2007

Receipt is acknowledged of this regular Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. 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 mail to the Commissioner for Patents P.O. Box 1450 Alexandria Va 22313-1450. 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 (if appropriate).

Applicant(s)

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

Assignment For Published Patent Application

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, MA

Power of Attorney: The patent practitioners associated with Customer Number 24280

Domestic Priority data as claimed by applicant

This application is a CIP of 11/100,026 04/06/2005 PAT 7,225,787
and is a CIP of 10/991,774 11/18/2004

Foreign Applications

If Required, Foreign Filing License Granted: 06/22/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is US11/758,157

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

\*\* SMALL ENTITY \*\*

**Title**

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

**Preliminary Class**

123

**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 (1-866-999-4158).

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**LICENSE FOR FOREIGN FILING UNDER****Title 35, United States Code, Section 184****Title 37, Code of Federal Regulations, 5.11 & 5.15****GRANTED**

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**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).



## 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	ATTORNEY DOCKET NUMBER
11/758,157	06/05/2007	Leslie Bromberg	0492611-0762

24280  
 CHOATE, HALL & STEWART LLP  
 TWO INTERNATIONAL PLACE  
 BOSTON, MA 02110

**CONFIRMATION NO. 3972**  
**FORMALITIES**  
**LETTER**

Date Mailed: 06/25/2007

**NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION****FILED UNDER 37 CFR 1.53(b)***Filing Date Granted***Items Required To Avoid Abandonment:**

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.  
*Applicant must submit \$ 75 to complete the basic filing fee for a small entity.*

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 1,2a-b:
  - The drawings have a line quality that is too light to be reproduced (weight of all lines and letters must be heavy enough to permit adequate reproduction) or text that is illegible (reference characters, sheet numbers, and view numbers must be plain and legible) see 37 CFR 1.84(l) and (p)(1)); See Figure(s) 1.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:



- Additional claim fees of **\$200** as a small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of \$65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.

**SUMMARY OF FEES DUE:**

Total additional fee(s) required for this application is **\$690** for a small entity

- **\$75** Statutory basic filing fee.
- **\$65** Surcharge.
  
- The application search fee has not been paid. Applicant must submit **\$250** to complete the search fee.
- The application examination fee has not been paid. Applicant must submit **\$100** to complete the examination fee for a small entity in compliance with 37 CFR 1.27.
  
- Total additional claim fee(s) for this application is **\$200**
  - **\$200** for 2 independent claims over 3.

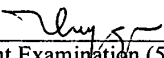
Replies should be mailed to: Mail Stop Missing Parts  
Commissioner for Patents  
P.O. Box 1450  
Alexandria VA 22313-1450

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<https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

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Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199  
PART 3 - OFFICE COPY

ATTORNEY'S DOCKET NUMBER: 04926111-0762

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant:	Bromberg et al.	Examiner:	Not Yet Assigned
Serial No.:	11/758,157	Art Unit:	3747
Filed:	June 5, 2007	Confirmation No.:	3972
For:	OPTIMIZED FUEL MANAGEMENT SYSTEMS FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES		

Mail Stop Missing Parts  
Commissioner for Patents  
P. O. Box 1450  
Alexandria, VA 22313-1450

Sir:

**RESPONSE TO NOTICE TO FILE MISSING PARTS**

In response to the Notice to File Missing Parts in the above-referenced application dated June 25, 2007, attached herewith is the following:

1. Payment in the amount of \$1,085.00 via electronic credit card authorization for payment of the late submission fee, extension of time, and claims;
2. Copy of Preliminary Amendment filed October 26, 2007;
3. Request for Extension of Time (Three Months); and
4. Replacement Figures (Figures 1-5).

Docket No. 0492611-0762

4274592v1

As this Response is electronically-filed, a copy of the Notice to File Missing Parts is not attached. Please charge any additional fees associated with this filing, or apply any credits, to our Deposit Account No. 03-1721.

Respectfully submitted,

/SamPasternack/

Sam Pasternack  
Registration Number 29,576

CHOATE, HALL & STEWART LLP  
Two International Place  
Boston, MA 02110  
(617) 248-5000  
Dated: November 26, 2007

Docket No. 0492611-0762

4274592v1

Under the paperwork Reduction Act of 1996, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

<b>PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)</b> <b>FY 2008</b> <i>(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)</i>		Docket Number (Optional) <b>0492611-0762</b>	
Application Number <b>11/758,157</b>		Filed <b>June 5, 2007</b>	
For <b>Optimized Fuel Management Systems for Direct Injection Ethanol Enhancement of Gasoline Engines</b>			
Art Unit <b>3747</b>		Examiner <b>Not Yet Assigned</b>	
This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application. The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):			
		<u>Fee</u>	<u>Small Entity Fee</u>
<input type="checkbox"/>	One month (37 CFR 1.17(a)(1))	\$120	\$60
<input type="checkbox"/>	Two months (37 CFR 1.17(a)(2))	\$460	\$230
<input checked="" type="checkbox"/>	Three months (37 CFR 1.17(a)(3))	\$1050	\$525
<input type="checkbox"/>	Four months (37 CFR 1.17(a)(4))	\$1640	\$820
<input type="checkbox"/>	Five months (37 CFR 1.17(a)(5))	\$2230	\$1115
<input checked="" type="checkbox"/>	Applicant claims small entity status. See 37 CFR 1.27.		
<input type="checkbox"/>	A check in the amount of the fee is enclosed.		
<input checked="" type="checkbox"/>	Payment by credit card. Form PTO-2038 is attached.		
<input type="checkbox"/>	The Director has already been authorized to charge fees in this application to a Deposit Account.		
<input checked="" type="checkbox"/>	The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number <u>03-1721</u> . I have enclosed a duplicate copy of this sheet.		
<b>WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.</b>			
I am the	<input type="checkbox"/>	applicant/inventor.	
	<input type="checkbox"/>	assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).	
	<input checked="" type="checkbox"/>	attorney or agent of record. Registration Number <u>29,576</u>	
	<input type="checkbox"/>	attorney or agent under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 _____	
	<u>/SamPasternack/</u>		<u>November 26, 2007</u>
	Signature		Date
	<u>Sam Pasternack</u>		<u>617-248-5000</u>
	Typed or printed name		Telephone Number
NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.			
<input checked="" type="checkbox"/>	Total of <u>1</u> forms are submitted.		

This collection of information is required by 37 CFR 1.136(a). 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 6 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.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

## Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ATTORNEY'S DOCKET NUMBER: 04926111-0762

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant:	Bromberg et al.	Examiner:	Not Yet Assigned
Serial No.:	11/758,157	Art Unit:	3747
Filed:	June 5, 2007	Confirmation No.:	3972
For:	OPTIMIZED FUEL MANAGEMENT SYSTEMS FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES		

Mail Stop: Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

**PRELIMINARY AMENDMENT**

Prior to examination of the above-referenced application, please preliminarily amend the application as follows.

**Amendments to the Claims** begin on page 2 of this paper.

**Remarks** begin on page 6 of this paper.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required for consideration of this paper (including fees for net addition of claims) are authorized to be charged to our **Deposit Account No. 03-1721**.

### Listing of Claims

Claims 1-5 (cancelled)

6. (New) A spark ignition engine which is turbocharged or supercharged and is fueled with gasoline from a first source and with direct injection of alcohol from a second source, comprising:

a spark ignition engine;

a turbocharger or supercharger;

means for fueling the engine with gasoline from the first source;

means for direct injection of the alcohol from the second source;

wherein during part of engine operating time, the engine is powered both by gasoline from the first source and the directly injected alcohol from the second source;

wherein under some operating conditions the instantaneous energy ratio of the alcohol to total fuel is at least 20%; and

wherein a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the turbocharger or supercharger increases the manifold pressure; and

wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the alcohol to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the second fuel is directly injected.

7. (New) The engine system of claim 6 where substantially stoichiometric operation with the changing alcohol/gasoline ratio that occurs as the manifold pressure is increased is achieved by use of a control system which employs information from a knock sensor, an oxygen sensor and a look up table and where the control system enables use of a three way catalyst.

8. (New) The engine system of claim 7 wherein the fuel management system minimizes the amount of the alcohol that is used to prevent knock and employs closed loop control using information from a knock sensor.

9. (New) The engine system of claim 8 wherein spark retard is changed as a function of the amount of alcohol that has been used.

10. (New) The engine system of claim 8 where the fuel in the second source is a mix of ethanol with another fuel and has variable characteristics and where during some of the operating time the ethanol energy fraction used in the engine is between 40 and 80 %.

11. (New) The engine system of claim 7 where the gasoline from the first source is directly injected using an independently controlled injector that is separate from an injector that directly injects the alcohol from the second source and the alcohol/gasoline ratio is controlled in a closed loop using information from a knock detector.

12. (New) The engine system of claim 7 where the gasoline from the first source is directly injected using an injector that contains two nozzles where one is used for direct injection of the alcohol from the second source and where the alcohol/gasoline ratio is controlled in a closed loop using information from a knock detector.

13. (New) The engine system of claim 7 where the gasoline from the first source and the alcohol from the second source are injected from the same injector and where their ratio is varied so as to prevent knock by use of a valving system which is upstream from the injector and the gasoline/alcohol ratio is controlled in a closed loop using information from a knock detector.

14. (New) The engine system of claim 6 where during some operating conditions the alcohol energy fraction used in the engine is between 40 and 80% and the manifold pressure is at least 2 bar.

15. (New) The engine system of claim 14 where the engine is downsized by at least a factor of two relative to an engine which uses port fuel injection of gasoline alone and operates with a drive cycle efficiency that is at least 20 % greater.



16. (New) The engine system of claim 14 where the fuel in the second source is an alcohol and the alcohol is mixed with water.
17. (New) The engine system of claim 14 where the fuel in the second source is a mixture of ethanol and gasoline.
18. (New) The engine system of claim 7 where the compression ratio is 11 or greater.
19. (New) The engine system of claim 7 where the engine is started using only fuel from the first source.
20. (New) A spark ignition engine which is turbocharged or supercharged and is port fueled with gasoline from a first source and with direct injection of a liquid alcohol fuel from a second source comprising:
  - a spark ignition engine;
  - a turbocharger or supercharger;
  - means for port fueling the engine with gasoline from the first source;
  - means for direct injection of the alcohol from the second source;
  - wherein during part of engine operating time, the engine is powered both by gasoline from the first source and the directly injected alcohol from the second source;
  - wherein under some operating conditions the instantaneous energy ratio of the alcohol to total fuel is at least 20%; and
  - where a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the turbocharger or supercharger increases the manifold pressure; and
  - where the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the second fuel to obtain a

substantially stoichiometric air/fuel ratio during some or all of the time that the second fuel is directly injected and

where the substantially stoichiometric operation with the changing alcohol/gasoline ratio that occurs as the manifold pressure is increased is achieved by use of a control system which employs information from a knock sensor and an oxygen sensor and where the control system enables use of a three way catalyst.

21. (New) The engine system of claim 20 where the control system also includes a look up table and where the fuel management system minimizes the amount of alcohol that is employed to prevent knock by means of closed loop control using information from a knock detector.

22. New) The engine system of claim 21 where the engine operates with a compression ratio of 11 or greater and

where the fuel in the second source is a mix of ethanol and another fuel and has variable characteristics and

where during some of the operating time the ethanol energy fraction used in the engine is between 40 and 80 %.

23. (New) The engine system of claim 20 where the alcohol is ethanol and where during some of the operating time the ethanol energy fraction in the engine is between 40 and 80 %.

24. (New) The engine system of claim 23 where the manifold pressure is at least 2 bar.

25. (New) A turbocharged or supercharged spark ignition engine where alcohol and gasoline are directly injected at the same time into the engine cylinders and

where the fuel is directly injected in such a way as to provide a non uniform distribution with a greater concentration in the end gas region of the cylinder; and

where alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution.

26. (New) The turbocharged or supercharged engine of claim 25 where alcohol energy fraction in the engine varies and  
where the alcohol energy fraction is less than 80 % and the manifold pressure is greater than 2 bar.
27. (New) The turbocharged or supercharged spark ignition engine of claim 24 further including a means for port fuel injection of the fuel.
28. (New) The turbocharged or supercharged engine of claim 24 where the nonuniform distribution is used only part of the time and when it is employed the directly injected fuel is concentrated in the outside region of the engine cylinders.
- 29 (New) The turbocharged or supercharged spark ignition engine of claim 28 where swirl is used.
30. (New) The turbocharged or supercharged engine of claim 25 where fuel is directly injected after the inlet valve has closed.

**REMARKS**

Claims 1-5 are pending in this application and have been cancelled herein in favor of new claims 6-30. No new matter is being introduced by these claims in that they are generally supported throughout the specification.

Please charge any fees that may be required for the processing of this Response, or credit any overpayments; to our Deposit Account Number 03-1721. Applicant would like to thank the Examiner in advance for review of this request.

Respectfully submitted,  
CHOATE, HALL & STEWART LLP

/Sam Pasternack/  
Sam Pasternack  
Registration No. 29,576

Patent Department  
CHOATE, HALL & STEWART, LLP  
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Boston, MA 02110  
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Dated: October 26, 2007

## Electronic Patent Application Fee Transmittal

<b>Application Number:</b>	11758157			
<b>Filing Date:</b>	05-Jun-2007			
<b>Title of Invention:</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES			
First Named Inventor/Applicant Name:	Leslie Bromberg			
<b>Filer:</b>	Sam Pasternack/Elisabeth Dunkle			
<b>Attorney Docket Number:</b>	0492611-0762			
Filed as Small Entity				
<b>Utility Filing Fees</b>				
<b>Description</b>	<b>Fee Code</b>	<b>Quantity</b>	<b>Amount</b>	<b>Sub-Total in USD(\$)</b>
<b>Basic Filing:</b>				
Utility filing Fee (Electronic filing)	4011	1	75	75
Utility Search Fee	2111	1	255	255
Utility Examination Fee	2311	1	105	105
<b>Pages:</b>				
<b>Claims:</b>				
Claims in excess of 20	2202	5	25	125
<b>Miscellaneous-Filing:</b>				
<b>Petition:</b>				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
<b>Patent-Appeals-and-Interference:</b>				
Post-Allowance-and-Post-Issuance:				
<b>Extension-of-Time:</b>				
Extension - 3 months with \$0 paid	2253	1	525	525
<b>Miscellaneous:</b>				
<b>Total in USD (\$)</b>				<b>1085</b>

## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	2504988
<b>Application Number:</b>	11758157
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	3972
<b>Title of Invention:</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
<b>First Named Inventor/Applicant Name:</b>	Leslie Bromberg
<b>Customer Number:</b>	24280
<b>Filer:</b>	Sam Pasternack/Elisabeth Dunkle
<b>Filer Authorized By:</b>	Sam Pasternack
<b>Attorney Docket Number:</b>	0492611-0762
<b>Receipt Date:</b>	26-NOV-2007
<b>Filing Date:</b>	05-JUN-2007
<b>Time Stamp:</b>	16:03:49
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
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Deposit Account	
Authorized User	

### File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
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1	Drawings-only black and white line drawings	Figs.pdf	93118 aabdc39646c49bd485702eede2ce12725303bfed1	no	3
<b>Warnings:</b>					
<b>Information:</b>					
2	Applicant Response to Pre-Exam Formalities Notice	RespMP.pdf	57591 8e3c4bee9bf85f6c8718f04bece0152f68d8b76	no	2
<b>Warnings:</b>					
<b>Information:</b>					
3	Extension of Time	Exttime.pdf	186536 22ac1eb1261bbf916b345a0f9f58487cca0255b	no	2
<b>Warnings:</b>					
<b>Information:</b>					
4	Amendment - After Non-Final Rejection	Amend.pdf	300405 bc53969471d4aa1a1cb1a962bb32a4b5d4b30a4	no	7
<b>Warnings:</b>					
<b>Information:</b>					
5	Fee Worksheet (PTO-06)	fee-info.pdf	8731 c22bc6b149b9f047dceae24b86dc696a0c742558	no	2
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>				646381	
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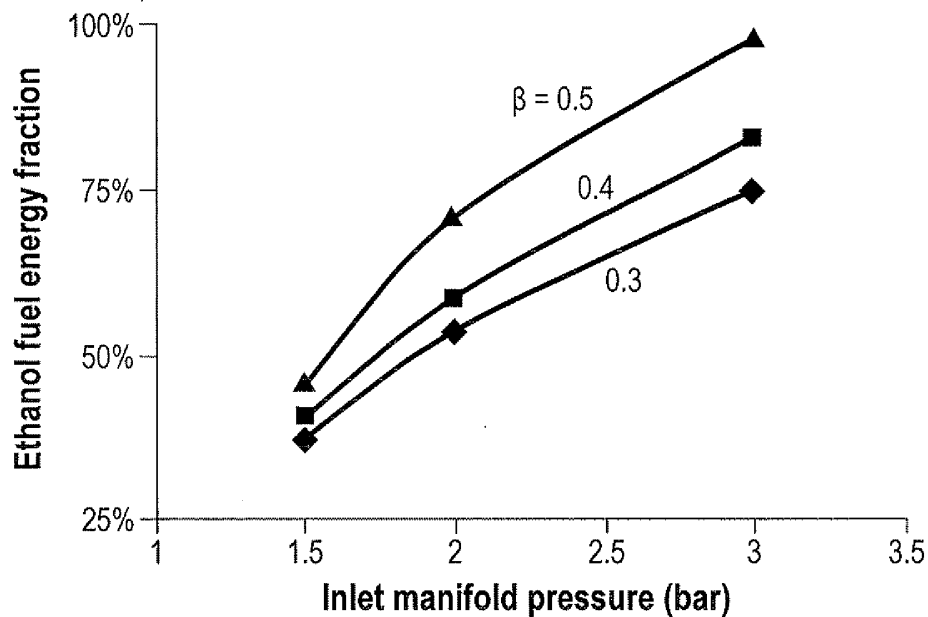


Fig. 1

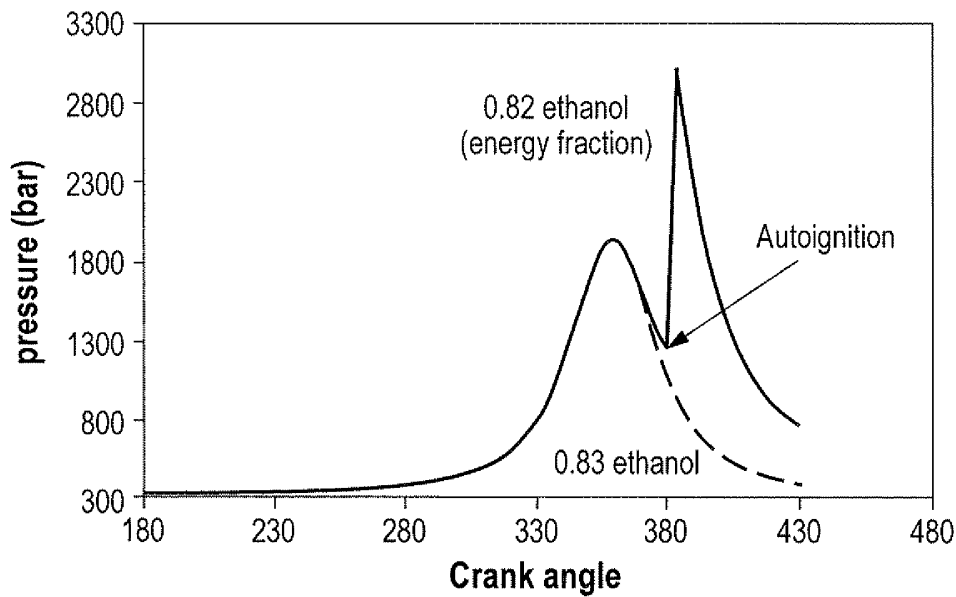


Fig. 2a

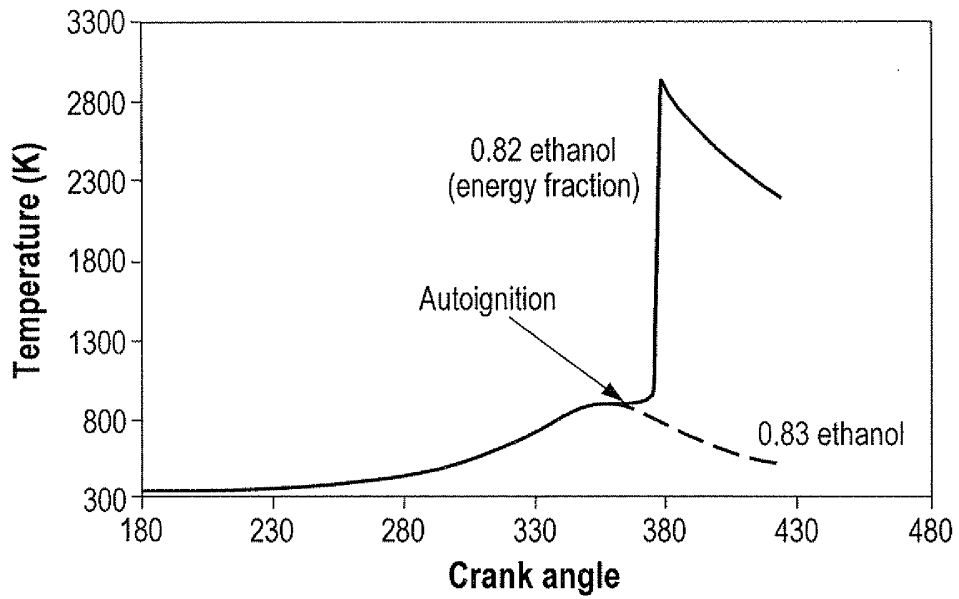


Fig. 2b

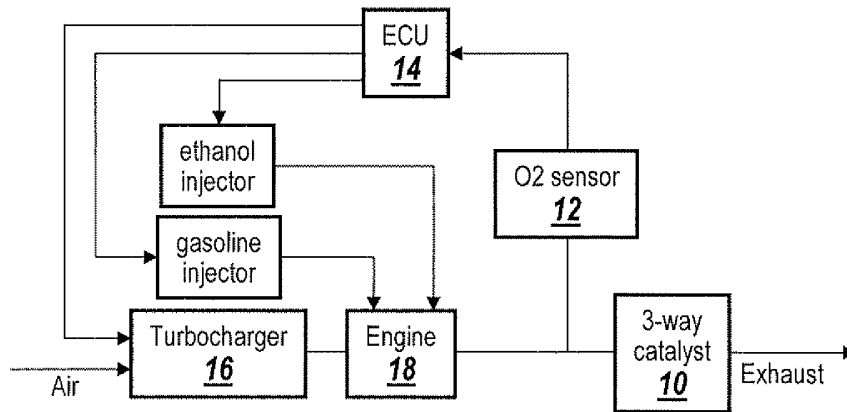


Fig. 3

Replacement Sheet

3/3

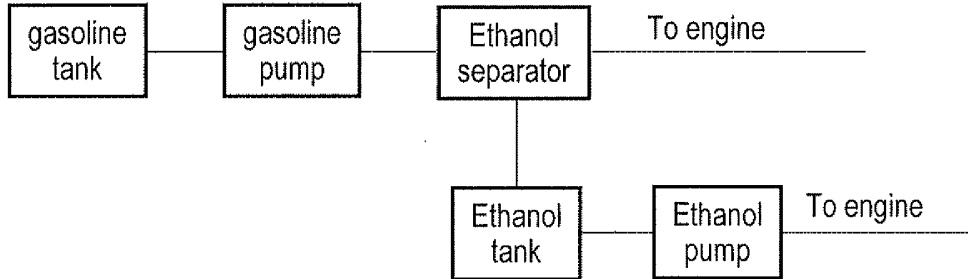


Fig. 4a

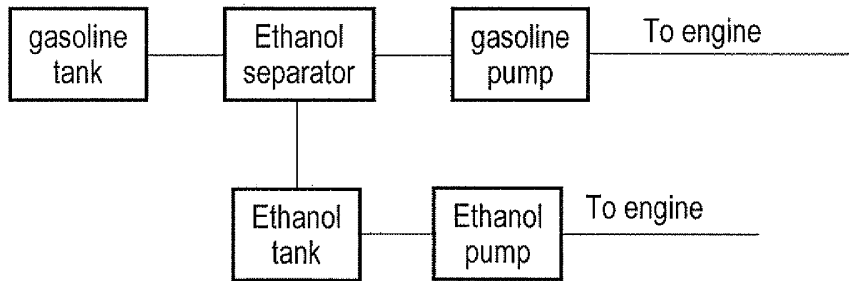


Fig. 4b

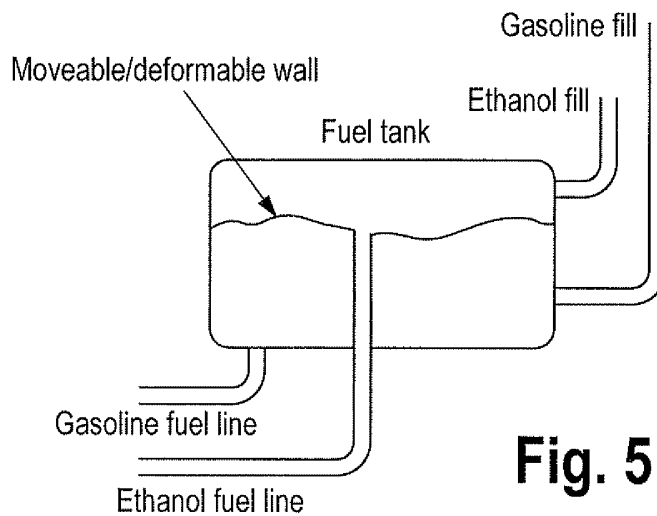


Fig. 5

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<b>PATENT APPLICATION FEE DETERMINATION RECORD</b> Substitute for Form PTO-875					Application or Docket Number <b>11758,157</b>	Filing Date <b>06/05/2007</b>	<input type="checkbox"/> To be Mailed				
<b>APPLICATION AS FILED – PART I</b>					<b>OTHER THAN SMALL ENTITY</b>						
(Column 1)		(Column 2)		SMALL ENTITY <input checked="" type="checkbox"/>		OR					
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR	RATE (\$)	FEE (\$)				
<input type="checkbox"/> BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A			N/A					
<input type="checkbox"/> SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A			N/A					
<input type="checkbox"/> EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A			N/A					
TOTAL CLAIMS <small>(37 CFR 1.16(j))</small>	minus 20 =	*	X \$ =			X \$ =					
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	minus 3 =	*	X \$ =			X \$ =					
<input type="checkbox"/> APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 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).										
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT <small>(37 CFR 1.16(j))</small>											
* If the difference in column 1 is less than zero, enter "0" in column 2.											
<b>APPLICATION AS AMENDED – PART II</b>				<b>OTHER THAN SMALL ENTITY</b>							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		SMALL ENTITY	
AMENDMENT	<b>11/26/2007</b>	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)	
	Total <small>(37 CFR 1.16(j))</small>	* 25	Minus	** 20	= 5	X \$25 =	125		X \$ =		
	Independent <small>(37 CFR 1.16(h))</small>	* 3	Minus	***5	= 0	X \$105 =	0		X \$ =		
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>										
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>										
						TOTAL ADD'L FEE	<b>125</b>	OR	TOTAL ADD'L FEE		
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		SMALL ENTITY	
AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)		
	Total <small>(37 CFR 1.16(j))</small>	*	Minus	**	=	X \$ =		X \$ =			
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=	X \$ =		X \$ =			
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>										
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>										
						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 number found in the appropriate box in column 1.											
						Legal Instrument Examiner: /SUSAN K. FORD/					

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*If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

ATTORNEY'S DOCKET NUMBER: 04926111-0762

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Bromberg et al. Examiner: Not Yet Assigned  
Serial No.: 11/758,157 Art Unit: 3747  
Filed: June 5, 2007 Confirmation No.: 3972  
For: OPTIMIZED FUEL MANAGEMENT SYSTEMS FOR DIRECT  
INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

Mail Stop Missing Parts  
Commissioner for Patents  
P. O. Box 1450  
Alexandria, VA 22313-1450

Sir:

**RESPONSE TO NOTICE TO FILE MISSING PARTS**

In response to the Notice to File Missing Parts in the above-referenced application dated June 25, 2007, attached herewith is the following:

1. Payment in the amount of \$1,085.00 via electronic credit card authorization for payment of the late submission fee, extension of time, and claims;
2. Copy of Preliminary Amendment filed October 26, 2007;
3. Request for Extension of Time (Three Months); and
4. Replacement Figures (Figures 1-5).

11/29/2007 VVAN11 00000010 031721 11758157  
01 FC:2051 65.00 DA

Docket No. 04926111-0762  
4274592v1

As this Response is electronically-filed, a copy of the Notice to File Missing Parts is not attached. Please charge any additional fees associated with this filing, or apply any credits, to our Deposit Account No. 03-1721.

Respectfully submitted,

/SamPasternack/  
Sam Pasternack  
Registration Number 29,576

CHOATE, HALL & STEWART LLP  
Two International Place  
Boston, MA 02110  
(617) 248-5000  
Dated: November 26, 2007

Docket No. 0492611-0762  
4274592v1



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Table with 7 columns: APPLICATION NUMBER, FILING or 371(c) DATE, GRP ART UNIT, FIL FEE REC'D, ATTY.DOCKET.NO, TOT CLAIMS, IND CLAIMS. Values: 11/758,157, 06/05/2007, 3747, 625, 04926111-0762, 25, 3

CONFIRMATION NO. 3972

UPDATED FILING RECEIPT



24280
CHOATE, HALL & STEWART LLP
TWO INTERNATIONAL PLACE
BOSTON, MA 02110

Date Mailed: 12/03/2007

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 write to the Office of Initial Patent Examination's Filing Receipt Corrections. 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

Applicant(s)

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

Assignment For Published Patent Application

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, MA

Power of Attorney: The patent practitioners associated with Customer Number 24280

Domestic Priority data as claimed by applicant

This application is a CIP of 11/100,026 04/06/2005 PAT 7,225,787
and is a CIP of 10/991,774 11/18/2004

Foreign Applications

If Required, Foreign Filing License Granted: 06/22/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is US 11/758,157

Projected Publication Date: 03/13/2008

Non-Publication Request: No

Early Publication Request: No

\*\* SMALL ENTITY \*\*

**Title**

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

**Preliminary Class**

123

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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>.

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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/758,157	06/05/2007	Leslie Bromberg	04926111-0762

**CONFIRMATION NO. 3972**

24280  
CHOATE, HALL & STEWART LLP  
TWO INTERNATIONAL PLACE  
BOSTON, MA02110

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

**Publication No.** US-2008-0060627-A1

**Publication Date:** 03/13/2008

**NOTICE OF PUBLICATION OF APPLICATION**

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 publicly available Searchable Databases via the Internet at [www.uspto.gov](http://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 Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

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Pre-Grant Publication Division, 703-605-4283

**ATTORNEY'S DOCKET NUMBER: 04926111-0762**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Bromberg et al. Examiner: Not Yet Assigned  
Serial No.: 11/758,157 Art Unit: 3747  
Filed: June 5, 2007  
For: OPTIMIZED FUEL MANAGEMENT SYSTEMS FOR DIRECT  
INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

**SECOND PRELIMINARY AMENDMENT**

Prior to examination of the above-referenced application, please preliminarily amend the application as follows.

**Amendments to the Claims** begin on page 2 of this paper.

**Remarks** begin on page 7 of this paper.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required for consideration of this paper (including fees for net addition of claims) are authorized to be charged to our **Deposit Account No. 03-1721**.

4391135v1

**Listing of Claims**

Claims 1- 30 ( cancelled)

31. (New) A spark ignition engine which is turbocharged or supercharged and is port fueled with gasoline from a first source and with direct injection of alcohol from a second source comprising:

a spark ignition engine;

a turbocharger or supercharger;

means for port fueling the engine with gasoline from the first source;

means for direct injection of alcohol from the second source;

wherein during part of engine operating time, the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source and;

wherein a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the manifold pressure is increased ; and

wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the alcohol so as to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the alcohol from the second source is directly injected.

32. (New) The engine system of claim 31 wherein the substantially stoichiometric operation with the changing of the alcohol /gasoline ratio that occurs as the manifold pressure is increased is achieved by use of a control system which employs information from a knock sensor and an oxygen sensor and wherein the control system enables use of a three way catalyst.

33. (New) The engine system of claim 32 wherein the control system controls the amount of alcohol that is employed to prevent knock by means of closed loop control using information from a knock detector.
34. (New) The engine system of claim 33 wherein the control system uses a microprocessor and minimizes the amount of alcohol that is used to prevent knock.
35. (New) The engine system of claim 34 further including the use of open loop control with a look up table.
36. (New) The engine system of claim 32 wherein spark retard is changed so as to reduce alcohol consumption.
37. (New) The engine system of claim 32 wherein spark retard is changed as a function of the amount of alcohol that has been consumed.
38. (New) The engine system of claim 32 wherein the alcohol is directly injected so as to provide a non-uniform distribution of alcohol in the cylinder with a greater concentration near the walls of the cylinder.
39. (New) The engine system of claim 38 wherein alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution.
40. (New) The engine system of claim 32 wherein the engine operates with a compression ratio of 11 or greater.
41. (New) The engine system of claim 32 wherein a liquid which is a mixture of alcohol and another liquid is directly injected into the engine from the second source and wherein this mixture has variable characteristics.
42. (New) The engine system of claim 32 wherein an alcohol–water mixture is directly injected into the engine from the second source.
43. (New) The engine system of claim 32 wherein the alcohol is methanol.

44. (New) The engine system of claim 32 wherein the alcohol that is directly injected into the engine is mixed with a lubricant.
45. (New) The engine system of claim 32 wherein an alcohol–gasoline mixture is directly injected into the engine from the second source.
46. (New) The engine system of claim 32 wherein the alcohol is ethanol.
47. (New) The engine system of claim 32 wherein the manifold pressure is at least 2 bar.
48. (New) A spark ignition engine which is turbocharged or supercharged and is fueled with gasoline from a first source and with direct injection of alcohol from a second source, comprising:
- a spark ignition engine;
  - a turbocharger or supercharger;
  - means for fueling the engine with gasoline from the first source;
  - means for direct injection of alcohol from the second source;
  - wherein during part of engine operating time, the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source; and
  - wherein a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the manifold pressure is increased; and
  - wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the alcohol to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the second fuel is directly injected.
49. (New) The engine system of claim 48 wherein substantially stoichiometric operation with the changing alcohol/gasoline ratio that occurs as the manifold pressure is increased is

achieved by use of a control system which employs information from a knock sensor, an oxygen sensor and a look up table and wherein the control system enables use of a three way catalyst.

50. (New) The engine system of claim 49 wherein the fuel management system minimizes the amount of the alcohol that is used to prevent knock and employs closed loop control using information from a knock sensor.

51. (New) The engine system of claim 49 wherein spark retard is changed so as to vary alcohol consumption.

52. (New) The engine system of claim 49 wherein spark retard is changed as a function of the amount of alcohol that has been consumed.

53. (New) The engine system of claim 49 wherein the gasoline from the first source is directly injected using an independently controlled injector that is separate from an injector that directly injects the alcohol from the second source and the alcohol/gasoline ratio is controlled in a closed loop using information from a knock detector.

54. (New) The engine system of claim 49 wherein the gasoline from the first source is directly injected using an injector that contains two nozzles wherein one is used for direct injection of the alcohol from the second source and where the alcohol/gasoline ratio is controlled in a closed loop using information from a knock detector.

55. (New) The engine system of claim 49 where the gasoline from the first source and the alcohol from the second source are injected from the same injector and where their ratio is varied so as to prevent knock by use of a valving system which is upstream from the injector and the gasoline/alcohol ratio is controlled in a closed loop using information from a knock detector.

56. (New) The engine system of claim 49 wherein the a mixture of alcohol and water is directly injected into the engine.

57. (New) The engine system of claim 49 wherein the alcohol is methanol.

58. (New) The engine system of claim 49 wherein the alcohol is ethanol.

59. (New) The engine system of claim 49 wherein the engine is downsized by at least a factor of two relative to an engine which uses port fuel injection of gasoline alone and operates with a drive cycle efficiency that is at least 20 % greater.
60. (New) The engine system of claim 49 wherein a mixture of alcohol and gasoline is directly injected into the engine.
61. (New) The engine system of claim 49 wherein the compression ratio is 11 or greater.
62. (New) The engine system of claim 49 wherein the a mixture of alcohol and a lubricant is directly injected into the engine.
63. (New) The engine system of claim 49 wherein an ethanol- gasoline mixture including but not limited to E 85 is directly injected into the engine.
64. (New) A turbocharged or supercharged spark ignition engine wherein alcohol is directly injected into the engine cylinders and
- wherein gasoline is also introduced into the engine;
- wherein the alcohol is directly injected in such a way as to provide a non-uniform distribution with a greater concentration in the end gas region of the cylinder; and
- wherein the alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution.
65. (New) The turbocharged or supercharged spark ignition engine of claim 64 further including a means for port fuel injection of the fuel.
66. (New) The turbocharged or supercharged engine of claim 64 wherein the non-uniform distribution is used only part of the time and when it is employed the directly injected fuel is concentrated in the outside region of the engine cylinders.
67. (New) The turbocharged or supercharged spark ignition engine of claim 64 wherein swirl is used.



**REMARKS**

Claims 6-30 are pending in this application and have been cancelled herein in favor of new claims 31-67. No new matter is being introduced by these claims in that they are generally supported throughout the specification.

Respectfully submitted,  
CHOATE, HALL & STEWART LLP

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Dated: November 25, 2008

## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	4349407
<b>Application Number:</b>	11758157
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	3972
<b>Title of Invention:</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
<b>First Named Inventor/Applicant Name:</b>	Leslie Bromberg
<b>Customer Number:</b>	24280
<b>Filer:</b>	Sam Pasternack/Christina Andrews
<b>Filer Authorized By:</b>	Sam Pasternack
<b>Attorney Docket Number:</b>	04926111-0762
<b>Receipt Date:</b>	25-NOV-2008
<b>Filing Date:</b>	05-JUN-2007
<b>Time Stamp:</b>	11:07:17
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	no
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### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	PreliminaryAmendment.pdf	89611 21639c922367a49ec5a825157a03cb6be4d de9b3	no	7

### Warnings:

### Information:

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.



Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

<b>PATENT APPLICATION FEE DETERMINATION RECORD</b> Substitute for Form PTO-875					Application or Docket Number <b>11758,157</b>	Filing Date <b>06/05/2007</b>	<input type="checkbox"/> To be Mailed				
<b>APPLICATION AS FILED – PART I</b>					<b>OTHER THAN SMALL ENTITY</b>						
(Column 1)		(Column 2)		SMALL ENTITY <input checked="" type="checkbox"/>		OR					
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR	RATE (\$)	FEE (\$)				
<input type="checkbox"/> BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A			N/A					
<input type="checkbox"/> SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A			N/A					
<input type="checkbox"/> EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A			N/A					
TOTAL CLAIMS <small>(37 CFR 1.16(j))</small>	minus 20 =	*	X \$ =			X \$ =					
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	minus 3 =	*	X \$ =			X \$ =					
<input type="checkbox"/> APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 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).										
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT <small>(37 CFR 1.16(j))</small>											
* If the difference in column 1 is less than zero, enter "0" in column 2.											
<b>APPLICATION AS AMENDED – PART II</b>				<b>OTHER THAN SMALL ENTITY</b>							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		OTHER THAN SMALL ENTITY	
<b>AMENDMENT</b>	<b>11/25/2008</b>	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)		
	Total <small>(37 CFR 1.16(j))</small>	* 37	Minus	** 25	=	12		X \$ =			
	Independent <small>(37 CFR 1.16(h))</small>	* 3	Minus	***3	=	0		X \$ =			
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>										
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>										
					TOTAL ADD'L FEE	<b>312</b>	OR	TOTAL ADD'L FEE			
<b>AMENDMENT</b>	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)			
	Total <small>(37 CFR 1.16(j))</small>	*	Minus	**	=		X \$ =				
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=		X \$ =				
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>										
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>										
					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 number found in the appropriate box in column 1.											
Legal Instrument Examiner: /DORIS M. KING/											

This collection of information is required by 37 CFR 1.16. 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 12 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.**

*If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

App. No.: 11/758,157

**ATTORNEY'S DOCKET NUMBER: 0492611-0762**  
**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

1<sup>st</sup> Inventor: Leslie Bromberg  
U.S. App. No.: 11/758,157  
Filing Date: June 5, 2007

Confirmation No.: 3972  
Art Unit: 3741  
Examiner: Ali, Hyder

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

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**INFORMATION DISCLOSURE STATEMENT (IDS)**

Dear Madam:

Pursuant to 37 CFR § 1.56, § 1.97 and § 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08 form. It is respectfully requested that the information be expressly considered during the prosecution of the above-identified application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

CERTIFICATION STATEMENT

This Information Disclosure Statement (IDS) is filed in compliance with the following Rule(s), as far as is known to the undersigned:

37 CFR § 1.97 (b)(3) , i.e. before the mailing of a first Office action on the merits.

Copies of any cited foreign patent or non-patent literature documents not previously provided to the USPTO are enclosed herewith. Copies of non-patent literature documents numbered 1-5 were previously submitted to the USPTO in an IDS for application number 10/991,774, which is relied on for an earlier effective filing date under 35 U.S.C. § 120.

4393364v1

1 of 2

Attorney Docket No.: 0492611-0762

App. No.: 11/758,157

Additionally, the Applicant brings to the attention of the Examiner co-pending U.S. patent applications: App. No. 10/991,774 now issued as patent No. 7,314,033; App. No. 11/100,026 now issued as patent No. 7,225,787; App. No. 11/229,755 now issued as patent No. 7,444,987; App. No. 11/840,719; App. No. 11/871,384; and App. No. 12/020,285. Applicant also brings to the attention of the Examiner co-pending U.S. patent applications: App. No. 11/682,372; App. No. 11/782,050; App. No. 11/683,564; App. No. 11/684,100; and App. No. 12/167,534. Prosecution of these applications may have bearing on the above-identified application.

In accordance with 37 CFR § 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR § 1.56(a) exists. In accordance with 37 CFR § 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is “prior art” for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR § 1.98, and the Examiner is respectfully requested to consider the listed references. The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith to our Deposit Account No. 03-1721.

Respectfully submitted,  
CHOATE, HALL & STEWART LLP

Date: December 9, 2008

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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
	First Named Inventor	Leslie Bromberg
	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code <sup>1</sup>	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, Blake	
	2	3106194		1963-10-08	Cantwell, et al.	
	3	3557763		1971-01-26	Probst, Stephen C.	
	4	4031864		1977-06-28	Crothers, William T.	
	5	4056087		1977-11-01	Boyce, Leonard D.	
	6	4230072		1980-10-28	Noguchi et al.	
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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		11758157	
	Filing Date		2007-06-05	
	First Named Inventor	Leslie Bromberg		
	Art Unit		3741	
	Examiner Name	Ali, Hyder		
	Attorney Docket Number		0492611-0762	

	9	4480616		1984-11-06	Takeda, Keiso	
	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	Fosseen, Dwayne	
	14	4967714		1990-11-06	Inoue, Ryuzaburo	
	15	4974416		1990-12-04	Taylor, Jack R.	
	16	5179923		1993-01-19	Tsurutani 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.	

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		11758157	
	Filing Date		2007-06-05	
	First Named Inventor	Leslie Bromberg		
	Art Unit		3741	
	Examiner Name	Ali, Hyder		
	Attorney Docket Number		0492611-0762	

	20	5937799		1999-08-17	Binion, W. 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.	
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	26	6358180		2002-03-19	Kuroda et al.	
	27	6508233		2003-01-21	Suhre et al.	
	28	6513505		2003-02-04	Watanabe et al.	
	29	6543423		2003-04-08	Dobryden, et al.	
	30	6561157		2003-05-13	zur Loye et al.	

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		11758157	
	Filing Date		2007-06-05	
	First Named Inventor	Leslie Bromberg		
	Art Unit		3741	
	Examiner Name	Ali, Hyder		
	Attorney Docket Number		0492611-0762	

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	37	6951202		2005-10-04	Oda, Tomihisa	
	38	6990956		2006-01-31	Niimi, Kuniaki	
	39	7021277		2006-04-04	Kuo et al.	
	40	7107942		2006-09-19	Weissman et al.	
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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
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	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

	42	7188607		2007-03-13	Kobayashi, Tatsuo	
	43	7320302		2008-01-22	Kobayashi, Tatsuo	
	44	3089470		1963-05-14	Payne, W.H.	
	45	4182278		1980-01-08	Coakwell, Charles A.	
	46	4993386		1991-02-19	Ozasa et al.	
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	48	5715788		1998-02-10	Tarr et al.	
	49	5983855		1999-11-16	Benedikt et al.	
	50	6073607		2000-06-13	Liber, Bruno	

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 <sup>1</sup>	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
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	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

1							
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**FOREIGN PATENT DOCUMENTS**

Examiner Initial*	Cite No	Foreign Document Number <sup>3</sup>	Country Code <sup>2</sup> i	Kind Code <sup>4</sup>	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T <sup>5</sup>
	1							<input type="checkbox"/>

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**NON-PATENT LITERATURE DOCUMENTS**

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 <sup>5</sup>
	1	A. MODAK and L.S. CARLETTO, "Engine Cooling by Direct Injection of Cooling Water," Society of Automotive Engineers, Inc., 700887.	<input type="checkbox"/>
	2	JULIAN A. LoRUSSO and HARRY A. CIKANEK, "Direct Injection Ignition Assisted Alcohol Engine," Society of Automotive Engineers, Inc., 880495, International Congress and Exposition in Detroit, Michigan (February 29-March 5, 1998).	<input type="checkbox"/>
	3	BORJE GRANDIN, et al., "Knock Suppression in a Turbocharged SI Engine by Using Cooled EGR," Society of Automotive Engineers, Inc., 982476, International Fall Fuels and Lubricants Meeting and Exposition in San Francisco, California (October 19-22, 1998).	<input type="checkbox"/>
	4	BORJE GRANDIN and HANS-ERIK ANGSTROM, "Replacing Fuel Enrichment in a Turbo Charged SI Engine: Lean Burn or Cooled EGR," Society of Automotive Engineers, Inc., 1999-01-3505.	<input type="checkbox"/>
	5	C. STAN, et al., "Internal Mixture Formation and Combustion - from Gasoline to Ethanol," Society of Automotive Engineers, Inc., 2001-01-1207.	<input type="checkbox"/>

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
	First Named Inventor	Leslie Bromberg
	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

6	USPTO Non-Final Office Action, Application No. 10/991,774, April 25, 2006.	<input type="checkbox"/>
7	USPTO Final Office Action, Application No. 10/991,774, September 27, 2006.	<input type="checkbox"/>
8	USPTO Non-Final Office Action, Application No. 10/991,774, May 25, 2007.	<input type="checkbox"/>
9	USPTO Non-Final Office Action, Application No. 11/100,026, August 3, 2006.	<input type="checkbox"/>
10	FIKRET YUKSEL and BEDRI YUKSEL, "The Use of Ethanol-Gasoline Blend as a Fuel in an SI Engine," Renewable Energy, Vol. 29 (2004) pp. 1181-1191.	<input type="checkbox"/>
11	USPTO Non-Final Office Action, Application No. 11/229,755, March 22, 2007.	<input type="checkbox"/>
12	USPTO Non-Final Office Action, Application No. 11/229,755, October 4, 2007.	<input type="checkbox"/>
13	USPTO Non-Final Office Action, Application No. 11/682,372, January 2, 2008.	<input type="checkbox"/>
14	USPTO Final Office Action, Application No. 11/682,372, October 17, 2008.	<input type="checkbox"/>
15	USPTO Non-Final Office Action, Application No. 11/684100, June 3, 2008.	<input type="checkbox"/>
16	PCT International Search Report and Written Opinion, Application No. PCT/IB07/03004, July 9, 2008.	<input type="checkbox"/>

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
	First Named Inventor	Leslie Bromberg
	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

17	PCT International Search Report and Written Opinion, Application No. PCT/US07/05777, March 24, 2008.	<input type="checkbox"/>
18	PCT International Search Report and Written Opinion, Application No. PCT/US07/74227, February 25, 2008.	<input type="checkbox"/>
19	PCT International Search Report and Written Opinion, Application No. PCT/US08/69171, October 3, 2008.	<input type="checkbox"/>
20	USPTO Non-Final Office Action, Application No. 11/840719, July 11, 2008.	<input type="checkbox"/>
21	J.B. Heywood, "Internal Combustion Engine Fundamentals," McGraw Hill, 1988, page 477.	<input type="checkbox"/>
22	J. Stokes et al., "A gasoline engine concept for improved fuel economy - the lean-boost system," SAE paper 2001-01-2902, pp. 1-12.	<input type="checkbox"/>
23	H. J. Curran et al., "A comprehensive modeling study of iso-octane oxidation," Combustion and Flame 129:263-280 (2002) pp. 253-280.	<input type="checkbox"/>
24	B. Lecointe and G. Monnier, "Downsizing a gasoline engine using turbocharging with direct injection" SAE paper 2003-01-0542.	<input type="checkbox"/>

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.

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

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
	First Named Inventor	Leslie Bromberg
	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

**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)	2008-12-09
Name/Print	Sam Pasternack	Registration Number	29,576

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.**



## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		11758157
	Filing Date		2007-06-05
	First Named Inventor	Leslie Bromberg	
	Art Unit		3741
	Examiner Name	Ali, Hyder	
	Attorney Docket Number		0492611-0762

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code <sup>1</sup>	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	6340015		2002-01-22	Benedikt et al.	
	2	6536405		2003-03-25	Rieger et al.	
	3	6745744		2004-06-08	Suckewer et al.	
	4	6748918		2004-06-15	Rieger et al.	
	5	6755175		2004-06-29	McKay et al.	
	6	6955154		2005-10-18	Douglas, Denis	
	7	7013847		2006-03-21	Auer, Gerhard	
	8	7077100		2006-06-18	Vogel et al.	

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
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	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

	9	7086376		2006-08-08	McKay, Michael	
	10	7201136		2007-04-10	McKay 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 <sup>1</sup>	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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**FOREIGN PATENT DOCUMENTS**

Examiner Initial*	Cite No	Foreign Document Number <sup>3</sup>	Country Code <sup>2</sup> j	Kind Code <sup>4</sup>	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T <sup>5</sup>
	1							<input type="checkbox"/>

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

**NON-PATENT LITERATURE DOCUMENTS**

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 <sup>5</sup>
	1		<input type="checkbox"/>

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

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
	First Named Inventor	Leslie Bromberg
	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

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

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	11758157
	Filing Date	2007-06-05
	First Named Inventor	Leslie Bromberg
	Art Unit	3741
	Examiner Name	Ali, Hyder
	Attorney Docket Number	0492611-0762

**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)	2008-12-09
Name/Print	Sam Pasternack	Registration Number	29,576

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	4414734
<b>Application Number:</b>	11758157
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	3972
<b>Title of Invention:</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
<b>First Named Inventor/Applicant Name:</b>	Leslie Bromberg
<b>Customer Number:</b>	24280
<b>Filer:</b>	Sam Pasternack/Elyse Pino
<b>Filer Authorized By:</b>	Sam Pasternack
<b>Attorney Docket Number:</b>	04926111-0762
<b>Receipt Date:</b>	09-DEC-2008
<b>Filing Date:</b>	05-JUN-2007
<b>Time Stamp:</b>	17:00:50
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	no
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### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement Letter	IDS_ltr_0492611_0762.pdf	21992 f5fb2c7c0f2c0bbe698fca8269372d3410b09cd45	no	2

### Warnings:

### Information:

2	Information Disclosure Statement (IDS) Filed (SB/08)	US_IDS_Form__SB_08a_1.pdf	1364042 c98bb8f09adff936038784048747604b7b38a16	no	10
<b>Warnings:</b>					
<b>Information:</b>					
3	NPL Documents	OA_10991774_060425.pdf	367712 51e0a8dc46d919b7c3b420c17a76c9ef173ca8fc	no	10
<b>Warnings:</b>					
<b>Information:</b>					
4	NPL Documents	OA_10991774_060927.pdf	473418 bd9e9295b2cd925a9406d5615bf395539a6ba033	no	13
<b>Warnings:</b>					
<b>Information:</b>					
5	NPL Documents	OA_10991774_070525.pdf	200037 7a2a799afed5b316178446ba1bc30c6bd15ca5c6	no	5
<b>Warnings:</b>					
<b>Information:</b>					
6	NPL Documents	OA_11100026_060803.pdf	255018 377cc950f21e2da320406c81bd008e69e2dca25e	no	7
<b>Warnings:</b>					
<b>Information:</b>					
7	NPL Documents	Yuksel_Renewable_Energy_2004.pdf	611425 571f176c622655fa28370c3f542143cce34d634d	no	9
<b>Warnings:</b>					
<b>Information:</b>					
8	NPL Documents	OA_11229755_070322.pdf	195371 42f650eaf513de40593d559c035aa5c7134ff2bc	no	5
<b>Warnings:</b>					
<b>Information:</b>					
9	NPL Documents	OA_11229755_071004.pdf	160109 e524417f7cb4ef20dd17a5e255a4606125dc2b54	no	4
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<b>Information:</b>					
10	NPL Documents	OA_11682372_080102.pdf	224282 22b91e17f637a0852a3c71d6f58fc11d3d681d15	no	6
<b>Warnings:</b>					
<b>Information:</b>					



11	NPL Documents	OA_11682372_081017.pdf	224290	no	7
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13	NPL Documents	ISR_WO_PCTIB0703004.pdf	679100	no	10
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<b>Information:</b>					
14	NPL Documents	ISR_WO_PCTUS0705777.pdf	919580	no	9
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<b>Warnings:</b>					
<b>Information:</b>					
18	NPL Documents	Heywood_1988.pdf	137182	no	3
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<b>Warnings:</b>					
<b>Information:</b>					

20	NPL Documents	Curran_2002.pdf	2621607 6e41ccaa2fd792b4f828f4fa309c3b432d3fbd	no	28
<b>Warnings:</b>					
<b>Information:</b>					
21	NPL Documents	Lecointe_2003.pdf	1359043 e1584f91a0b4705bc3004cfc061a426a6d46ee	no	12
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<b>Information:</b>					
22	Information Disclosure Statement (IDS) Filed (SB/08)	US_IDS_Form__SB_08a_2.pdf	857616 7a0b99de7f2ce0a1429022e25a4b7e143850c02d	no	5
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>				13821313	
<p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b>  <b>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.</b></p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b>  <b>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.</b></p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b>  <b>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.</b></p>					

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PTO/SB/61 (01-09)

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<b>POWER OF ATTORNEY OR REVOCAION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS</b>	<b>Application Number</b>	11/758157
	<b>Filing Date</b>	08/05/2007
	<b>First Named Inventor</b>	Leslie Bromberg et al.
	<b>Title</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT
	<b>Art Unit</b>	3741
	<b>Examiner Name</b>	HUNG Q NGUYEN
	<b>Attorney Docket Number</b>	11381.105735

I hereby revoke all previous powers of attorney given in the above-identified application.

A Power of Attorney is submitted herewith.

**OR**

I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

91197

**OR**

I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified application to:

The address associated with the above-mentioned Customer Number.

**OR**

The address associated with Customer Number.

Firm or Individual Name

Address

City State Zip

Country

Telephone Email

I am the:

Applicant/Inventor.

**OR**

Assignee of record of the entire interest. See 37 CFR 3.71.  
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on 07/08/2005

**SIGNATURE of Applicant or Assignee of Record**

Signature	<i>Daniel O'Brien</i>	Date	12/30/2009
Name	Daniel O'Brien	Telephone	617.258.7148
Title and Company	IP Manager Massachusetts Institute of Technology		

**NOTE:** Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

\*Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 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.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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**STATEMENT UNDER 37 CFR 3.73(b)**

Applicant/Patent Owner: Leslie Bromberg et al.

Application No./Patent No.: 11/758157 Filed/Issue Date: 06/05/2007

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

Massachusetts Institute of Technology, a Non-profit  
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

- 1.  the assignee of the entire right, title, and interest in;
- 2.  an assignee of less than the entire right, title, and interest in (The extent (by percentage) of its ownership interest is \_\_\_\_\_ %); or
- 3.  the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A.  An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 016751, Frame 0156, or for which a copy therefore is attached.

OR

B.  A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

2. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

3. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

Additional documents in the chain of title are listed on a supplemental sheet(s).

As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Daniel O'Brien  
Signature

12/30/2009  
Date

Daniel O'Brien  
Printed or Typed Name

IP Manager  
Title

This collection of information is required by 37 CFR 3.73(b). 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 12 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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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/758,157	06/05/2007	Leslie Bromberg	11381.105735

**CONFIRMATION NO. 3972**

**POA ACCEPTANCE LETTER**



91197  
Technology Licensing Office  
Masachusetts Institute of Technology  
Five Cambridge Center  
Kendall Square  
Cambridge, MA 02142-1493

Date Mailed: 01/14/2010

**NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 12/30/2009.

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.

/hgray/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/758,157	06/05/2007	Leslie Bromberg	0492611-0762

24280  
CHOATE, HALL & STEWART LLP  
TWO INTERNATIONAL PLACE  
BOSTON, MA 02110

**CONFIRMATION NO. 3972**  
**POWER OF ATTORNEY NOTICE**



Date Mailed: 01/14/2010

**NOTICE REGARDING CHANGE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 12/30/2009.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/hgray/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PLUS Search Results for S/N 11758157, Searched Wed May 05 08:27:08 EDT 2010  
The Patent Linguistics Utility System (PLUS) is a USPTO automated search system for U.S. Patents from 1971 to the present PLUS is a query-by-example search system which produces a list of patents that are most closely related linguistically to the application searched. This search was prepared by the staff of the Scientific and Technical Information Center, SIRA.

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Table with 5 columns: APPLICATION NO., FILING DATE, FIRST NAMED INVENTOR, ATTORNEY DOCKET NO., CONFIRMATION NO. Includes sub-tables for EXAMINER (NGUYEN, HUNG Q), ART UNIT (3741), PAPER NUMBER, and NOTIFICATION DATE (05/13/2010) DELIVERY MODE (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
mjoyce@mit.edu





## DETAILED ACTION

### *Priority*

1. 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, or 365(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. 120 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 the first paragraph of 35 U.S.C. 112. 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. 10/991,774, fails to provide adequate support or enablement in the manner provided by the first paragraph of 35 U.S.C. 112 for one or more claims of this application. The disclosure of the prior-filed application ('774) fails to provide support for the recitations "wherein the fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as *the manifold pressure is increased*", as claimed in claims 31 and 48. **Accordingly, claims 31-63 are not entitled to the benefit of the prior application.**

***Claim Objections***

2. Claims 31, 48, 56, 61-62, 64 and 66 are objected to because of the following informalities:

**Re claims 31, 48**, the recitation "wherein a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the manifold pressure is increased" should be corrected to "wherein a fuel management system increases **an** alcohol/gasoline ratio to an amount that is sufficient to suppress knock as **a** manifold pressure is increased".

**Re claim 56**, the recitation "wherein the a mixture" should be corrected to "wherein a mixture".

**Re claims 61-62**, the recitations "wherein the compression ratio" and "wherein the a mixture of alcohol" should be corrected "wherein compression ratio" and "wherein a mixture of alcohol", respectively.

**Re claim 64**, the recitation in line 2, "injected into the engine cylinders" should be corrected to "injected into engine cylinders". Line 5, "in the end gas" should be corrected to "in an end gas". Line 6, "wherein the alcohol/gasoline ratio" should be corrected to "wherein an alcohol/gasoline ratio".

**Re claim 66**, line 3, "the outside region" should be corrected to "an outside region".

Appropriate correction is required.

***Claim Rejections - 35 USC § 112***

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

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.

4. Claims 33-35, 50, 53-55, 59 and 65-66 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

5. Claim 33 sets forth a "knock detector" in non-antecedent basis form, but claim 32 already sets forth a "knock sensor". Are these not one and the same? If so, correction is required. Note, many of the claims, such as claims 50, 53-55, also set forth structure in a non-antecedent basis manner where in fact the elements have already been introduced in a preceding claim 49. Appropriate correction is required.

6. Re claim 59, it is indefinite since the recitation can be interpreted in two different ways. First, the engine (i.e., as claimed) is downsized by at least a factor of two relative to an engine which "uses port fuel injection of gasoline alone **and** operates with a drive cycle efficiency that is at least 20 % or greater". Alternatively, the second interpretation could be wherein the engine (i.e., as claimed) is downsized by at least a factor of two relative to an engine which uses port fuel injection **and** wherein the engine (i.e., as claimed) operates with a drive cycle efficiency that is at least 20 % or greater. Appropriate correction is required.

7. Re claims 65-66, it is unclear whether the recitation "fuel" in each of the claims refers back to either the gasoline or alcohol or both. Appropriate correction is required.

***Claim Rejections - 35 USC § 102***

8. The following is a quotation of the appropriate paragraphs of 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.

9. **Claims 31-67 are rejected under 35 U.S.C. 102(b) as being anticipated by Gray, Jr. (US 6,651,432 B1).**

10. **Re claims 31 and 48,** Gray discloses a spark ignition engine which is turbocharged or supercharged and is port fueled with gasoline from a first source (53) and with direct injection of alcohol from a second source (23) comprising a spark ignition engine 22 (fig. 2; col. 6, lines 35-37; col. 10, lines 34-39), a turbocharger 27 or supercharger 27 (fig. 2), a means for port fueling the engine with gasoline from the first source (53) and a means for direct injection of alcohol from the second source (23).

Please note that the claims are directed to an apparatus which must be distinguished from the prior art in term of structure rather function [MPEP 2114]. Hence, the functional limitations:

“wherein during part of engine operating time, the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source and;

wherein a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the manifold pressure is increased ; and

wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the alcohol so as to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the alcohol from the second source is directly injected”,

which are narrative in form, have been given very little patentable weight. In order to be given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language. *In re Schreiber, 128 F.3d 1473, 1477-78, 44 USPQ2d 1429, 1431-32 (Fed. Cir. 1997)*.

11. **Re claims 64-65**, Gray discloses a turbocharged or supercharged spark ignition engine wherein alcohol is directed injected into engine cylinders and wherein gasoline is also introduced into the engine and further includes a means for port fuel injection (53) of the fuel.

**Re claims 64-67**, please note that the claims are directed to an apparatus which must be distinguished from the prior art in term of structure rather function [MPEP 2114]. Hence, the functional limitations:

“wherein the alcohol is directly injected in such a way as to provide a non-uniform distribution with a greater concentration in the end gas region of the cylinder; and

wherein the alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution,

wherein the non-uniform distribution is used only part of the time and when it is employed the directly injected fuel is concentrated in the outside region of the engine cylinders, and

wherein swirl is used”,

which are narrative in form, have been given very little patentable weight. In order to be given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language. *In re Schreiber, 128 F.3d 1473, 1477-78, 44 USPQ2d 1429, 1431-32 (Fed. Cir. 1997).*

12. **Re claims 32-47 and 49-63**, please note that the claims are directed to an apparatus which must be distinguished from the prior art in term of structure rather function [MPEP 2114]. Hence, the functional limitations as claimed in claims 32-47 and 49-63, which are narrative in form, have been given very little patentable weight. In order to be given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language. *In re Schreiber, 128 F.3d 1473, 1477-78, 44 USPQ2d 1429, 1431-32 (Fed. Cir. 1997).*

#### **Conclusion**

Applicant is duly reminded that a complete response must satisfy the requirements of 37 C.F. R. 1.111, including: “The reply must present arguments pointing out the specific distinctions believed to render the claims, including any newly presented claims, patentable over any applied references. A general allegation that the claims “define a patentable invention” without specifically pointing out how the language of the claims patentably distinguishes them from the references does not comply with the requirements of this section. Moreover, “The prompt development of a clear Issue requires that the replies of the applicant meet the objections to and rejections of the

claims.” Applicant should also specifically point out the support for any amendments made to the disclosure. See MPEP 2163.06 II(A), MPEP 2163.06 and MPEP 714.02. The "disclosure" includes the claims, the specification and the drawings.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HUNG Q. NGUYEN whose telephone number is (571) 270-5424. The examiner can normally be reached on Mon-Fri 8am - 6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, MICHAEL CUFF can be reached on (571) 272-6778. 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.

/HUNG Q. NGUYEN/  
Examiner, Art Unit 3741



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Page 9

Art Unit: 3741

/Michael Cuff/

Supervisory Patent Examiner, Art Unit 3741

<b>Notice of References Cited</b>	Application/Control No. 11/758,157	Applicant(s)/Patent Under Reexamination BROMBERG ET AL.	
	Examiner HUNG Q. NGUYEN	Art Unit 3741	Page 1 of 1

**U.S. PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A US-6,651,432	11-2003	Gray, Jr., Charles L.	60/605.2
*	B US-5,131,228	07-1992	Mochizuki et al.	60/602
*	C US-4,216,744	08-1980	Oswald et al.	123/1A
*	D US-7,410,514	08-2008	Binions, Greg	44/301
*	E US-4,993,386	02-1991	Ozasa et al.	123/25J
*	F US-			
*	G US-			
*	H US-			
*	I US-			
*	J US-			
*	K US-			
*	L US-			
*	M US-			


**FOREIGN PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
*	N				
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**NON-PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
*	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.


<b>Search Notes</b>  	<b>Application/Control No.</b>  11758157	<b>Applicant(s)/Patent Under Reexamination</b>  BROMBERG ET AL.
	<b>Examiner</b>  HUNG Q. NGUYEN	<b>Art Unit</b>  3741

SEARCHED			
Class	Subclass	Date	Examiner
123	299,300,304,406.45,406.47,559.2,564,575,576,577, 25a-25f, 1a, dig.2, 27ge, 431, 304, 198a	5/3/2010	hn
60	597,598,600,601-603,605.1,614,615,619	5/4/2010	hn

SEARCH NOTES		
Search Notes	Date	Examiner
EAST and PLUS	5/3/2010	hn
consulted Noah for search	5/3/2010	hn
inventor names searched in EAST	5/3/2010	hn
consulted with Primary Wolfe Willis for search	5/3/2010	hn

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner


/HUNG Q NGUYEN/ Examiner.Art Unit 3741	
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<b>Index of Claims</b> 	<b>Application/Control No.</b> 11758157	<b>Applicant(s)/Patent Under Reexamination</b> BROMBERG ET AL.
	<b>Examiner</b> HUNG Q. NGUYEN	<b>Art Unit</b> 3741

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

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

CLAIM		DATE							
Final	Original	05/03/2010							
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<b><i>Index of Claims</i></b> 	<b>Application/Control No.</b> 11758157	<b>Applicant(s)/Patent Under Reexamination</b> BROMBERG ET AL.
	<b>Examiner</b> HUNG Q. NGUYEN	<b>Art Unit</b> 3741

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

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<b>CLAIM</b>			<b>DATE</b>						
Final	Original	05/03/2010							
	67	✓							


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**BIB DATA SHEET**
**CONFIRMATION NO. 3972**

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.		
11/758,157	06/05/2007	123	3741	11381.105735		
<b>APPLICANTS</b> Leslie Bromberg, Sharon, MA; Daniel R. Cohn, Cambridge, MA; John B. Heywood, Newton, MA;						
<b>** CONTINUING DATA *****</b> This application is a CIP of 11/100,026 04/06/2005 PAT 7,225,787 and is a CIP of 10/991,774 11/18/2004 PAT 7,314,033						
<b>** FOREIGN APPLICATIONS *****</b>						
<b>** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** ** SMALL ENTITY **</b> 06/22/2007						
Foreign Priority claimed	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="checkbox"/> Met after Allowance	<b>STATE OR COUNTRY</b>	<b>SHEETS DRAWINGS</b>	<b>TOTAL CLAIMS</b>	<b>INDEPENDENT CLAIMS</b>
35 USC 119(a-d) conditions met	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Initials	MA	3	25	3
Verified and Acknowledged	/HUNG Q NGUYEN/ Examiner's Signature					
<b>ADDRESS</b> Technology Licensing Office Massachusetts Institute of Technology Five Cambridge Center Kendall Square Cambridge, MA 02142-1493 UNITED STATES						
<b>TITLE</b> OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES						
<b>FILING FEE RECEIVED</b> 937	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:			<input type="checkbox"/> All Fees		
				<input type="checkbox"/> 1.16 Fees (Filing)		
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				<input type="checkbox"/> Credit		

## EAST Search History

## EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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S6	475	(123/27ge).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/03 11:27
S7	2500	(123/525,575,527).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/03 11:27
S8	560	(123/431,304).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/03 11:27



S9	724	(123/198a).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/03 11:27
S10	51	("4031864"   "4402296"   "4884530"   "4909225"   "4913099"   "4945882").PN. OR ("4993386").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/03 11:35
S11	282	(turbocharg\$3 supercharg\$3) and knock\$3 and ((port and direct) with inject\$3) and (oxygen) and (manifold) and (sens\$3 detect\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/05/03 11:41
S12	1702	(123/1a).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/03 13:46
S13	35	S12 and ((turbocharg\$3 supercharg\$3) and knock\$3 and ((port and direct) with inject\$3) and (oxygen) and (sens\$3 detect\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/05/03 13:46
S14	2	"US 20080060627"	US-PGPUB; USPAT; USOCR; DERWENT	OR	ON	2010/05/03 15:04
S15	2	("4664091").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/03 15:10

S16	2	("4993388").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	OFF	2010/05/03 15:11
S17	13	("4450810"   "4561401"   "4619236"   "4679536"   "4727841"   "4905648"   "4905649"   "4920494").PN. OR ("4993388").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/03 15:11
S18	16	("3822583"   "4328779").PN. OR ("4619236").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/03 15:51
S19	13	("4450810"   "4561401"   "4619236"   "4679536"   "4727841"   "4905648"   "4905649"   "4920494").PN. OR ("4993388").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/03 16:01
S20	437	(123/25r).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	OFF	2010/05/03 16:03
S21	1997	(123/25a-25f).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	OFF	2010/05/03 16:03
S22	227	(turbocharg\$3 supercharg\$3) and knock\$3 and ((port and direct) with inject\$3) and (oxygen) and (manifold with pressure) and (sens\$3 detect\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	ON	2010/05/03 16:09
S23	49	(turbocharg\$3 supercharg\$3) and knock\$3 and ((port and direct) with inject\$3) and (oxygen) and (manifold with pressure) and (sens\$3 detect\$3) and (alcohol methanol ethanol butanol propanol) and (close\$1loop open\$1loop)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	ON	2010/05/03 16:12

S24	4565	((123/299,300,304,406.45,406.47,559.2,564,575,576,577)).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	ON	2010/05/03 16:24
S25	3706	(60/597,598,600,601-603,605.1,614,615,619).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	OFF	2010/05/03 16:25
S26	67	((S24 S25) and spark and ((direct\$2 "in-cylinder" cylinder) near2 inject\$3) and ((intake manifold boost) near pressure) and (turbo supercharg\$3 turbocharg\$3) and ((ethanol methanol alcohol) with ratio)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	ON	2010/05/03 16:27
S27	85	((LESLIE) near2 (BROMBERG)).INV.	US-PGPUB; USPAT	OR	ON	2010/05/03 16:33
S28	121	((DANIEL) near2 (COHN)).INV.	US-PGPUB; USPAT	OR	ON	2010/05/03 16:33
S29	56	((JOHN) near2 (HEYWOOD)).INV.	US-PGPUB; USPAT	OR	ON	2010/05/03 16:33
S30	4	(("6651432") or ("5131228")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; BM_TDB	OR	OFF	2010/05/03 16:34
S31	32	("4424676"   "4539948"   "4703732").PN. OR ("5131228").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/03 16:47
S32	32	("4424676"   "4539948"   "4703732").PN. OR ("5131228").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 10:15
S33	48	("2022094"   "2067757"   "2330866"   "2891524"   "3125086"   "3161182"   "3187728"   "3202141"   "3400695"   "3450109"   "3526214"   "3996912"   "4028892"   "4075990"   "4096697"   "4123997"   "4216744"   "4383507"   "4387676"   "4399786").PN. OR ("4539948").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 10:42

S34	46	123/dig.2.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/05/04 11:15
S35	10	("2024419"   "3628516"   "3709202"   "4039637"   "4085721"   "4136652").PN. OR ("4216744").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 11:16
S36	54	("1338982"   "1338983"   "1377992"   "1384946"   "1398947"   "1420622"   "1469053"   "1471566"   "1495094"   "1496260"   "1527144"   "1572750"   "1684685"   "1775461"   "1960633"   "3650255"   "3960131"   "4123997"   "4216744").PN. OR ("4603662").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 11:17
S37	25	("1907309"   "20030207783"   "20040093789"   "4207077"   "4266947"   "4341038"   "4378973"   "4541836"   "4603662"   "4749382"   "4929252"   "5256167"   "5324865"   "5682842"   "5688295"   "5693106"   "5826369"   "6017371"   "6039772"   "6302929"   "6458173"   "6533829"   "6652608"   "6835217").PN. OR ("7410514").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 11:19
S38	39	("3216407"   "3439655"   "3641986"   "3722490"   "3908624"   "3999532"   "4022165"   "4117810"   "4123997"   "4216744").PN. OR ("4446830").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 11:35
S39	3	("4117810").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/05/04 12:01
S40	10	("2495237"   "2556985"   "3845745").PN. OR ("4424676").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/04 12:10

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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		11758157	
	Filing Date		2007-06-05	
	First Named Inventor	Leslie Bromberg		
	Art Unit		3741	
	Examiner Name	Ali, Hyder		
	Attorney Docket Number		0492611-0762	

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			Art Unit	3741		
			Examiner Name	Ali, Hyder		
			Attorney Docket Number	0492611-0762		

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	10	4541383		1985-09-17	Jessel, Alfred J.	
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			Attorney Docket Number	0492611-0762		

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			Attorney Docket Number	0492611-0762		

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			Examiner Name	Ali, Hyder		
			Attorney Docket Number	0492611-0762		

6	USPTO Non-Final Office Action, Application No. 10/991,774, April 25, 2006.	<input type="checkbox"/>
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	Examiner Name	Ali, Hyder		
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	Examiner Name	Ali, Hyder		
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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 <sup>5</sup>
	1		<input type="checkbox"/>

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

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		11758157	11758157 - GAU: 3741
	Filing Date		2007-06-05	
	First Named Inventor	Leslie Bromberg		
	Art Unit	3741		
	Examiner Name	Ali, Hyder		
	Attorney Docket Number	0492611-0762		

EXAMINER SIGNATURE			
Examiner Signature	/Hung Nguyen/		Date Considered
05/03/2010			
*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.			
<small> <sup>1</sup> See Kind Codes of USPTO Patent Documents at <a href="http://www.USPTO.GOV">www.USPTO.GOV</a> or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.           </small>			

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /H.N./

**ATTORNEY DOCKET NO.: 11381.105735**  
**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Daniel R. Cohn et al. Examiner: Hung Q. Nguyen  
Serial No.: 11/758157 Art Unit: 3741  
Filing Date: June 5, 2007 Confirmation No.: 3972  
Title: OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION  
ETHANOL ENHANCEMENT OF GASOLINE ENGINES

**AMENDMENT**

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

Dear Sir:

In response to the office action mailed May 13, 2010 please amend the application as follows.



Listing of Claims

31. (Currently amended) A spark ignition engine which is turbocharged or supercharged and is port fueled with gasoline from a first source and with direct injection of alcohol from a second source comprising:

a spark ignition engine;

a turbocharger or supercharger;

means for port fueling the engine with gasoline from the first source;

means for direct injection of alcohol from the second source;

a fuel management system to control the amount of air, gasoline and alcohol introduced into the engine;

wherein during part of engine operating time, the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source and;

wherein a the fuel management system increases ~~the~~ an alcohol/gasoline ratio to an amount that is sufficient to suppress knock as ~~the~~ a manifold pressure is increased; and

wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the alcohol so as to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the alcohol from the second source is directly injected.

32. (Currently amended) The engine system of claim 31 wherein the substantially stoichiometric operation with the changing of the alcohol/gasoline ratio that occurs as the manifold pressure is increased is achieved by the use of ~~a control~~ the fuel management system which employs information from a knock sensor and an oxygen sensor and wherein the ~~control~~ fuel management system enables the use of a three-way catalyst.

33. (Currently amended) The engine system of claim 32 wherein the ~~control~~ fuel management system controls the amount of alcohol that is employed to prevent knock by means of closed loop control using information from a the knock detector sensor.

34. (Currently amended) The engine system of claim 33 wherein the ~~control~~ fuel management system uses a microprocessor and minimizes the amount of alcohol that is used to prevent knock.

35. (Previously presented) The engine system of claim 34 further including the use of open loop control with a lookup table.

36. (Previously presented) The engine system of claim 32 wherein spark retard is changed so as to reduce alcohol consumption.

37. (Previously presented) The engine system of claim 32 wherein spark retard is changed as a function of the amount of alcohol that has been consumed.

38. (Previously presented) The engine system of claim 32 wherein the alcohol is directly injected so as to provide a non-uniform distribution of alcohol in the cylinder with a greater concentration near the walls of the cylinder.

39. (Previously presented) The engine system of claim 38 wherein alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution.

40. (Previously presented) The engine system of claim 32 wherein the engine operates with a compression ratio of 11 or greater.

41. (Previously presented) The engine system of claim 32 wherein a liquid which is a mixture of alcohol and another liquid is directly injected into the engine from the second source and wherein this mixture has variable characteristics.

42. (Previously presented) The engine system of claim 32 wherein an alcohol-water mixture is directly injected into the engine from the second source.

43. (Previously presented) The engine system of claim 32 wherein the alcohol is methanol.

44. (Previously presented) The engine system of claim 32 wherein the alcohol that is directly injected into the engine is mixed with a lubricant.

45. (Previously presented) The engine system of claim 32 wherein an alcohol/gasoline mixture is directly injected into the engine from the second source.

46. (Previously presented) The engine system of claim 32 wherein the alcohol is ethanol.

47. (Previously presented) The engine system of claim 32 wherein the manifold pressure is at least 2 bar.

48. (Currently amended) A spark ignition engine which is turbocharged or supercharged and is fueled with gasoline from a first source and with direct injection of alcohol from a second source, comprising:

a spark ignition engine;

a turbocharger or supercharger;

means for fueling the engine with gasoline from the first source;

means for direction injection of alcohol from the second source;

a fuel management system to control the amount of air, gasoline and alcohol introduced into the engine;

wherein during part of engine operating time, the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source; and

wherein a the fuel management system increases the an alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the a manifold pressure is increased/and

wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of alcohol to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the second fuel is directly injected.

49. (Currently amended) The engine system of claim 48 wherein substantially stoichiometric operation with the changing alcohol/gasoline ratio that occurs as the manifold pressure is increased is achieved by use of ~~a control~~ the fuel management system which employs information from a knock sensor, an oxygen sensor and a lookup table and wherein ~~the control~~ fuel management system enables use of a three-way catalyst.

50. (Currently amended) The engine system of claim 49 wherein the fuel management system minimizes the amount of alcohol that is used to prevent knock and employs closed loop control using information from a the knock sensor.

51. (Previously presented) The engine system of claim 49 wherein spark retard is changed so as to vary alcohol consumption.

52. (Previously presented) The engine system of claim 49 wherein spark retard is changed as a function of the amount of alcohol that has been consumed.

53. (Currently amended) The engine system of claim 49 wherein the gasoline from the first source is directly injected using an independently controlled injector that is separate from an injector that directly injects the alcohol from the second source and the alcohol/gasoline ratio is controlled in a closed loop using information from a the knock detector sensor.

54. (Currently amended) The engine system of claim 49 wherein the gasoline from the first source is directly injected using an injector that contains two nozzles wherein one is used for direct injection of the alcohol from the second source and where the alcohol/gasoline ratio is controlled in a closed loop using information from a the knock detector sensor.

55. (Currently amended) The engine system of claim 49 where the gasoline from the first source and the alcohol from the second source are injected from the same injector, and where their ratio is varied so as to prevent knock by use of a valving system which is upstream from the injector and the gasoline/alcohol ratio is controlled in a closed loop using information from a the knock detector sensor.

56. (Currently amended) The engine system of claim 49 wherein ~~the~~ a mixture of alcohol and water is directly injected into the engine.

57. (Previously presented) The engine system of claim 49 wherein the alcohol is methanol.

58. (Previously presented) The engine system of claim 49 wherein the alcohol is ethanol.

59. (Currently amended) The engine system of claim 49 wherein the engine is downsized by at least a factor of two relative to an engine which uses port fuel injection of gasoline alone and wherein the engine operates with a drive cycle efficiency that is at least 20% greater.

60. (Previously presented) The engine system of claim 49 wherein a mixture of alcohol and gasoline is directly injected into the engine.

61. (Currently amended) The engine system of claim 49 wherein the compression ratio is 11 or greater.

62. (Currently amended) The engine system of claim 49 wherein the a mixture of alcohol and a lubricant is directly injected into the engine.

63. (Previously presented) The engine system of claim 49 wherein an ethanol-gasoline mixture including but not limited to E85 is directly injected into the engine.

64. (Currently amended) A turbocharged or supercharged spark ignition engine including an injector through which ~~wherein~~ alcohol is directed into the engine cylinders and

wherein gasoline is also introduced into the engine;

wherein the alcohol is directly injected through the injector in such a way as to provide a non-uniform distribution with a greater concentration in ~~the~~ an end gas region of the cylinder; and

wherein ~~the~~ an alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution.

65. (Currently amended) The turbocharged or supercharged spark ignition engine of claim 64 further including a means for port fuel injection of the ~~fuel~~ gasoline.

66. (Currently amended) The turbocharged or supercharged engine of claim 64 wherein the non-uniform distribution is used only part of the time and when it is employed the directly injected ~~fuel~~alcohol is concentrated in the an outside region of the engine cylinders.

67. (Previously presented) The turbocharged or supercharged spark ignition engine of claim 64 wherein swirl is used.

**Remarks**

Reexamination and reconsideration of the rejections are hereby requested. The examiner has indicated that the pending claims are not entitled to the benefit of prior application serial number 10/991,774 filed November 18, 2004. However, the present application is a continuation of, and is entitled to priority of, U.S. Patent Application Serial Number 11/100,026 filed April 6, 2005. This intermediate priority application was set forth in the specification as originally filed.

Many of the claims have been amended herein in view of the claim objections made by the examiner. In addition, claims have been amended to overcome the 35 USC Section 112 rejections, particularly relating to antecedent basis issues. It is submitted that the amendments herein, made in accordance with the examiner's request, overcomes these objections and rejections.

Claims 31-67 stand rejected under 35 USC Section 102 (b) as being anticipated by Gray, Jr. (U.S. Patent Number 6,651,432). In conjunction with this rejection, the examiner indicated that certain limitations were in narrative form and were given little patentable weight. In response, independent claims 31 and 48 have been amended to recite a fuel management system to control the amount of air, gasoline and alcohol introduced into the engine. No new matter is being added as the specification supports this language.

As set out in the claims, the present invention is a spark ignition engine that utilizes gasoline from a first source that may be either directly or port fuel injected, and direct injection of alcohol from a second source. The claim requires that during part of engine operating time the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source. The engine is controlled by a fuel management system that controls the amount of air, gasoline and alcohol introduced into the engine. The alcohol/gasoline ratio is controlled by the fuel management system to a value sufficient to suppress knock as manifold pressure is increased.

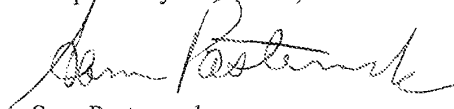
Gray is directed to a controlled temperature combustion engine that controls temperature to reduce the amount of oxides of nitrogen and particulate matter. In all of his embodiments, only a single fuel is used rather than varying mixtures of a primary fuel and a directly injected antiknock agent as disclosed and claimed in the present application. In a first embodiment a low



octane and high cetane fuel such as conventional diesel fuel is used. In a second embodiment, high octane and low cetane fuel such as a conventional gasoline is used in an autoignition mode. In these two embodiments the fuel is port or directly injected. A third embodiment uses very high octane fuel such as methanol or ethanol or certain gasolines. As with the other two embodiments, the engine uses only a single fuel. Further, Gray teaches replacing the direct injectors 23 with ignition sources such as a spark plug or glow plug and thus the alcohol is introduced through the port injectors 53. Again, this third embodiment does not use gasoline along with alcohol for its operation. Thus, Gray lacks several limitations rendering it ineffective as an anticipatory reference. Gray does not teach fueling an engine with gasoline from a first source while directly injecting alcohol from a second source. Gray further lacks a fuel management system to control the relative amount of air, gasoline and alcohol introduced into the engine so as to prevent knock and provide operation at a substantially stoichiometric air/fuel ratio as manifold pressure is increased. The engine control in Gray controls boost pressure and oxygen concentration so as to result in lower temperature operation that suppresses the formation of oxides of nitrogen. Thus, Gray is clearly not an appropriate anticipatory reference.

For the forgoing reasons, it is submitted that the pending claims, as amended herein, are patentable over Gray and early favorable action is requested.

Respectfully Submitted,



Sam Pasternack  
Registration No.: 29576  
**Massachusetts Institute of Technology**  
Five Cambridge Center  
Room NE25-230  
Cambridge, MA 02412-1493  
617.258.7171

## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	7842205
<b>Application Number:</b>	11758157
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	3972
<b>Title of Invention:</b>	OPTIMIZED FUEL MANAGEMENT SYSTEM FOR DIRECT INJECTION ETHANOL ENHANCEMENT OF GASOLINE ENGINES
<b>First Named Inventor/Applicant Name:</b>	Leslie Bromberg
<b>Customer Number:</b>	91197
<b>Filer:</b>	Sam Pasternack/Anna Yem
<b>Filer Authorized By:</b>	Sam Pasternack
<b>Attorney Docket Number:</b>	11381.105735
<b>Receipt Date:</b>	18-JUN-2010
<b>Filing Date:</b>	05-JUN-2007
<b>Time Stamp:</b>	10:45:09
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	no
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### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	11381105735oarsp.pdf	342431 6827decc2af2eae8b78bbae34bbae633e7010795f	no	10

### Warnings:

### Information:

Total Files Size (in bytes):

342431

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.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

<b>PATENT APPLICATION FEE DETERMINATION RECORD</b> Substitute for Form PTO-875					Application or Docket Number <b>11758,157</b>	Filing Date <b>06/05/2007</b>	<input type="checkbox"/> To be Mailed				
<b>APPLICATION AS FILED – PART I</b>					<b>OTHER THAN SMALL ENTITY</b>						
(Column 1)		(Column 2)		SMALL ENTITY <input checked="" type="checkbox"/>		OR					
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR	RATE (\$)	FEE (\$)				
<input type="checkbox"/> BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A			N/A					
<input type="checkbox"/> SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A			N/A					
<input type="checkbox"/> EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A			N/A					
TOTAL CLAIMS <small>(37 CFR 1.16(j))</small>	minus 20 =	*	X \$ =			X \$ =					
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	minus 3 =	*	X \$ =			X \$ =					
<input type="checkbox"/> APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 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).										
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT <small>(37 CFR 1.16(j))</small>											
* If the difference in column 1 is less than zero, enter "0" in column 2.											
<b>APPLICATION AS AMENDED – PART II</b>					<b>OTHER THAN SMALL ENTITY</b>						
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		OTHER THAN SMALL ENTITY	
AMENDMENT	<b>06/18/2010</b>	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)		
	Total <small>(37 CFR 1.16(j))</small>	* 37	Minus	** 37	=	0		X \$ =			
	Independent <small>(37 CFR 1.16(h))</small>	* 3	Minus	***3	=	0		X \$ =			
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>										
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>										
					TOTAL ADD'L FEE	<b>0</b>	OR	TOTAL ADD'L FEE			
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		OTHER THAN SMALL ENTITY	
AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)			
	Total <small>(37 CFR 1.16(j))</small>	*	Minus	**	=		X \$ =				
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=		X \$ =				
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>										
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>										
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE			
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.</p>											
<p>Legal Instrument Examiner: /ANGELA WHITE/</p>											

This collection of information is required by 37 CFR 1.16. 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 12 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.**

*If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*



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Table with 5 columns: APPLICATION NO., FILING DATE, FIRST NAMED INVENTOR, ATTORNEY DOCKET NO., CONFIRMATION NO.
11/758,157 06/05/2007 Leslie Bromberg 11381.105735 3972

91197 7590 09/02/2010
Technology Licensing Office
Massachusetts Institute of Technology
Five Cambridge Center
Kendall Square
Cambridge, MA 02142-1493

EXAMINER

NGUYEN, HUNG Q

ART UNIT PAPER NUMBER

3741

NOTIFICATION DATE DELIVERY MODE

09/02/2010

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
mjjoyce@mit.edu

<b>Office Action Summary</b>	<b>Application No.</b> 11/758,157	<b>Applicant(s)</b> BROMBERG ET AL.	
	<b>Examiner</b> HUNG Q. NGUYEN	<b>Art Unit</b> 3741	

-- 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 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 18 June 2010.
- 2a)  This action is **FINAL**.                      2b)  This action is non-final.
- 3)  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**

- 4)  Claim(s) 31-67 is/are pending in the application.
  - 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5)  Claim(s) \_\_\_\_\_ is/are allowed.
- 6)  Claim(s) 31-67 is/are rejected.
- 7)  Claim(s) \_\_\_\_\_ is/are objected to.
- 8)  Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9)  The specification is objected to by the Examiner.
- 10)  The drawing(s) filed on \_\_\_\_\_ 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).
- 11)  The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**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).
    - a)  All    b)  Some \*    c)  None of:
      - 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)  Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3)  Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 4)  Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 5)  Notice of Informal Patent Application
- 6)  Other: \_\_\_\_\_.

## DETAILED ACTION

### *Double Patenting*

1. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

2. Claims 31-63 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-9 of U.S. Patent No. 7,225,787. Although the conflicting claims are not identical, they are not patentably distinct from each other because they have the same scope.

***Claim Rejections - 35 USC § 102***

3. The following is a quotation of the appropriate paragraphs of 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.

4. **Claims 31-67 are rejected under 35 U.S.C. 102(b) as being anticipated by Stokes (US 5,526,797).**

5. **Re claims 31 and 48**, Stokes ('797) discloses a spark ignition engine (see fig. 3A) which is supercharged and is port fueled with gasoline from a first source (not depicted; see col. 2, lines 39-44) and with direct injection of alcohol from a second source (not depicted; see col. 2, lines 39-44) comprising:

a spark ignition engine (fig. 3A);

a supercharger (i.e., air compressor depicted in figure 8);

a means (fig. 3A: i.e., fuel injector 2) for port fueling the engine with gasoline from the first source (see col. 6, lines 59-67);



a means (fig. 3A; i.e., vapor chamber valve 4) for direct injection of alcohol from the second source; and

a fuel management system to control the amount of air, gasoline and alcohol introduced into the engine.

Note in column 6, line 59 through column 7, line 41, Stokes clearly teaches an electronic management unit 3 (not shown) controlling the ratio of the air/alcohol/gasoline mixture injected into the engine wherein a natural gas or a high-octane fuel (e.g., this fuel could be an alcohol such as methanol and ethanol; see column 1, lines 15-21).

Please note that the claims are directed to an apparatus which must be distinguished from the prior art in term of structure rather function [MPEP 2114]. Hence, the functional limitations:

“wherein during part of engine operating time, the engine is operated with both gasoline from the first source and the directly injected alcohol from the second source and;

wherein a fuel management system increases the alcohol/gasoline ratio to an amount that is sufficient to suppress knock as the manifold pressure is increased ; and

wherein the fuel management system controls the amount of air to the turbocharger or supercharger, the amount of gasoline and the amount of the alcohol so as to obtain a substantially stoichiometric air/fuel ratio during some or all of the time that the alcohol from the second source is directly injected”,

which are narrative in form, have been given very little patentable weight. In order to be given patentable weight, a functional recitation must be supported by

recitation in the claim of sufficient structure to warrant the presence of the functional language. *In re Schreiber*, 128 F.3d 1473, 1477-78, 44 USPQ2d 1429, 1431-32 (Fed. Cir. 1997).

Additionally, language, such as “wherein”, that suggests or makes optional but does not require steps to be performed or does not limit a claim to a particular structure does not limit the scope of a claim or claim limitation. See MPEP 2111.04.

6. **Re claims 64-65**, Stokes ('797) discloses a supercharged spark ignition engine including an injector 4 (fig. 3A) through which alcohol is directed directly into engine cylinders, and a means (fig. 3A: i.e., fuel injector 2) for port fuel injection of the gasoline wherein gasoline is also introduced into the engine cylinders.

7. **Re claims 64-67**, please note that the claims are directed to an apparatus which must be distinguished from the prior art in term of structure rather function [MPEP 2114]. Hence, the functional limitations:

“wherein the alcohol is directly injected in such a way as to provide a non-uniform distribution with a greater concentration in the end gas region of the cylinder; and

wherein the alcohol/gasoline ratio is sufficiently high so as to prevent knock and resulting in the alcohol/gasoline ratio being reduced as compared to a situation using a uniform distribution,

wherein the non-uniform distribution is used only part of the time and when it is employed the directly injected fuel is concentrated in the outside region of the engine cylinders, and

wherein swirl is used”,

which are narrative in form, have been given very little patentable weight. In order to be given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language. *In re Schreiber, 128 F.3d 1473, 1477-78, 44 USPQ2d 1429, 1431-32 (Fed. Cir. 1997)*.

Additionally, language, such as “wherein”, that suggests or makes optional but does not require steps to be performed or does not limit a claim to a particular structure does not limit the scope of a claim or claim limitation. See MPEP 2111.04.

8. **Re claims 32-47 and 49-63**, please note that the claims are directed to an apparatus which must be distinguished from the prior art in term of structure rather function [MPEP 2114]. Hence, the functional limitations as claimed in claims 32-47 and 49-63, which are narrative in form, have been given very little patentable weight. In order to be given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language. *In re Schreiber, 128 F.3d 1473, 1477-78, 44 USPQ2d 1429, 1431-32 (Fed. Cir. 1997)*.

Additionally, language, such as “wherein”, that suggests or makes optional but does not require steps to be performed or does not limit a claim to a particular structure does not limit the scope of a claim or claim limitation. See MPEP 2111.04.

#### ***Response to Arguments***

9. Applicant's arguments with respect to the claims have been considered but are moot in view of the new ground(s) of rejection.

**Conclusion**

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

**Mochizuki et al. (US 5,131,228)** teaches in column 4, lines 41-50 that the fuel management system will increase an alcohol/gasoline ratio to an amount that is sufficient to suppress knock as a manifold pressure is increased by the supercharger.

Applicant is duly reminded that a complete response must satisfy the requirements of 37 C.F. R. 1.111, including: "The reply must present arguments pointing out the specific distinctions believed to render the claims, including any newly presented claims, patentable over any applied references. A general allegation that the claims "define a patentable invention" without specifically pointing out how the language of the claims patentably distinguishes them from the references does not comply with the requirements of this section. Moreover, "The prompt development of a clear Issue requires that the replies of the applicant meet the objections to and rejections of the claims." Applicant should also specifically point out the support for any amendments made to the disclosure. See MPEP 2163.06 II(A), MPEP 2163.06 and MPEP 714.02. The "disclosure" includes the claims, the specification and the drawings.

11. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

***Contact Information***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HUNG Q. NGUYEN whose telephone number is (571) 270-5424. The examiner can normally be reached on Mon-Fri 8am - 6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, MICHAEL CUFF can be reached on (571) 272-6778. 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.

/HUNG Q. NGUYEN/  
Examiner, Art Unit 3741

/Michael Cuff/  
Supervisory Patent Examiner, Art Unit 3741

<b>Notice of References Cited</b>	Application/Control No. 11/758,157	Applicant(s)/Patent Under Reexamination BROMBERG ET AL.	
	Examiner HUNG Q. NGUYEN	Art Unit 3741	Page 1 of 1

**U.S. PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A US-5,526,797	06-1996	Stokes, Richard A.	123/575
*	B US-7,225,787	06-2007	Bromberg et al.	123/198A
	C US-			
	D US-			
	E US-			
	F US-			
	G US-			
	H US-			
	I US-			
	J US-			
	K US-			
	L US-			
	M US-			


**FOREIGN PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	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.

<b>Search Notes</b>  	<b>Application/Control No.</b>  11758157	<b>Applicant(s)/Patent Under Reexamination</b>  BROMBERG ET AL.
	<b>Examiner</b>  HUNG Q. NGUYEN	<b>Art Unit</b>  3741


SEARCHED			
Class	Subclass	Date	Examiner
123	299,300,304,406.45,406.47,559.2,564,575,576,577, 25a-25f, 1a, dig.2, 27ge, 431, 304, 198a	5/3/2010	hn
60	597,598,600,601-603,605.1,614,615,619	5/4/2010	hn
	Updated search	8/25/2010	hn
123	576, 575, 431,	8/25/2010	hn

SEARCH NOTES		
Search Notes	Date	Examiner
EAST and PLUS	5/3/2010	hn
consulted Noah for search	5/3/2010	hn
inventor names searched in EAST	5/3/2010	hn
consulted with Primary Wolfe Willis for search	5/3/2010	hn
Consulted with SPE (Devon Kramer) AU-3746 regarding the functional language	8/25/2010	hn
Consulted with SPE (Mike Cuff) regarding the functional language and finality	8/26/2010	hn

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/HUNG Q NGUYEN/ Examiner.Art Unit 3741	
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<b>Index of Claims</b> 	<b>Application/Control No.</b> 11758157	<b>Applicant(s)/Patent Under Reexamination</b> BROMBERG ET AL.
	<b>Examiner</b> HUNG Q. NGUYEN	<b>Art Unit</b> 3741

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

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

CLAIM		DATE							
Final	Original	05/03/2010	08/26/2010						
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<b>Index of Claims</b> 	<b>Application/Control No.</b> 11758157	<b>Applicant(s)/Patent Under Reexamination</b> BROMBERG ET AL.
	<b>Examiner</b> HUNG Q. NGUYEN	<b>Art Unit</b> 3741

✓	<b>Rejected</b>	-	<b>Cancelled</b>	N	<b>Non-Elected</b>	A	<b>Appeal</b>
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Final	Original	05/03/2010	08/26/2010																		
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## EAST Search History

## EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S63	21	("4391244").PN. OR ("4546732").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/08/26 11:39
S62	2	("4546732").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/26 11:38
S61	41	("3868936"   "4242992"   "4418672"   "4495930"   "4546732"   "4612904"   "4883039").PN. OR ("5018483").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/08/26 10:59
S60	66	S58 and @pd<="20050406"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/26 10:00
S56	1829	S55 and (methanol alcohol ethanol E85 (flexible near2 fuel\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/26 09:59
S57	1792	S55 and (methanol alcohol ethanol E85)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/26 09:59
S58	244	S57 and (123/575.ccls. 123/576.ccls. "60"/.clas.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/26 09:59
S55	14551	(port and (in-cylinder direct cylinder)) near5 (inject\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/26 09:58

S54	14	((("20030127072") or ("4031864") or ("4136652") or ("7082926")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/26 09:52
S53	3	("3741171").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/25 19:39
S51	98	S50 and (alcohol methanol ethanol)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/25 19:31
S52	94	S51 not (S47 S48)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/25 19:31
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S48	36	("4424676"   "4539948"   "4703732").PN. OR ("5131228").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/08/25 19:00

S47	48	("2022094"   "2067757"   "2330866"   "2891524"   "3125086"   "3161182"   "3187728"   "3202141"   "3400695"   "3450109"   "3526214"   "3996912"   "4028892"   "4075990"   "4096697"   "4123997"   "4216744"   "4383507"   "4387676"   "4399786").PN. OR ("4539948").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/08/25 18:38
S45	199	((port and direct) with inject \$3) near50 (alcohol methanol ethanol))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/25 18:23
S46	54	S45 and (123/575.ccls.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/25 18:23
S44	36	S43 and (123/575.ccls.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/25 17:28
S43	108	(turbocharg\$3 supercharg \$3) same ((port and direct) with inject\$3) near50 (alcohol methanol ethanol))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/25 17:26
S42	2	("4993386").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/14 17:15

**EAST Search History (Interference)**

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\ 11758157\_ Alcohol\_ Gasoline Injection and Turbocharger.wsp**



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Table with 5 columns: APPLICATION NO., FILING DATE, FIRST NAMED INVENTOR, ATTORNEY DOCKET NO., CONFIRMATION NO.
Row 1: 11/758,157, 06/05/2007, Leslie Bromberg, 11381.105735, 3972
Row 2: 91197, 7590, 06/09/2011, MIT's Technology Licensing Office, One Cambridge Center, Kendall Square, NE 18-501, Cambridge, MA 02142-1493, EXAMINER NGUYEN, HUNG Q, ART UNIT 3783, PAPER NUMBER, NOTIFICATION DATE 06/09/2011, DELIVERY MODE 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
mjoyce@mit.edu



<b>Notice of Abandonment</b>	<b>Application No.</b>	<b>Applicant(s)</b>	
	11/758,157	BROMBERG ET AL.	
	<b>Examiner</b>	<b>Art Unit</b>	
	HUNG Q. NGUYEN	3783	

**-- 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 02 September 2010.
  - (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 (a) 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) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114).
  - (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, the assignee of the entire interest, or all of the applicants.
5.  The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34(a)) 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:

/Michael Cuff/  
Supervisory Patent Examiner, Art Unit 3783

/HUNG Q NGUYEN/  
Examiner, Art Unit 3783

Petitions to revive under 37 CFR 1.137(a) or (b), 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.