Patented Feb. 9, 1954

2,668,522

UNITED STATES PATENT OFFICE

2,668,522

MOTOR GASOLINE ADDITIVE

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No Drawing. Application November 29, 1951, Serial No. 258,992

10 Claims. (Cl. 123—1)

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The present invention is concerned with improved gasoline fuel compositions adapted to provide markedly improved motor operation under cool, moist operating conditions. The fuel compositions of the present invention comprise hydrocarbons boiling in the motor fuel boiling range and from about 1.0% to 2.5% of an alcohol in conjunction with a critical, relatively small amount of an added branched ether. A preferred composition of the present invention comprises hydrocarbons boiling in the motor fuel boiling range to which are added about 1.0% to 2.5% of di-methyl carbinol and from .05% to 0.2% of a branched ether, as for example, diisopropyl ether. It is also desirable that about 0.5% of what is known as a solvent oil be present. In addition, these fuel compositions may contain the conventional gasoline additives such as lead alkyl anti-detonants, dyes, gum inhibitors, oxidation inhibitors and the like.

The novel fuel compositions of this invention are primarily intended to overcome certain operational difficulties in connection with automotive, marine, stationary, and airplane engines. The difficulties referred to result in frequent stalling of the engine under idling conditions. This stalling may be encountered whenever the weather conditions in which the engine is used are such as to provide a relatively high humidity, and a temperature below about 60° F.

While this problem has actually been existent for many years, attention has recently been focused on it due to numerous complaints of car owners in the northern portion of the United States. These owners report that during cool, wet weather their cars give poor idling performance characterized by a high number of engine stalls. The difficulty is encountered in all types of cars employing all types of carburetors and utilizing all commercial brands of gasoline.

In order to indicate the magnitude of this difficulty, reference may be made to a survey conducted in the New Jersey area based on the experiences of 300 car owners driving twenty different car models, during the fall and winter period. These cars employed the winter grade of regular and premium commercial gasolines. Table 1 gives a summary of the results obtained, showing the substantial number of stalls encountered in the operation of the cars under the indicated conditions.

TABLE 1

	Number of Complaints of Two Stalls or More (Per 100 Cars)				
Temperature, °F	32	35	37	52	56
Relative Humidity, per cent.	52	70	90	100	96
Weather	Clear	Overcast	Light Rain	Heavy Rain	Rain.
Winter Regular Users	5	15	20	21	7.
Winter Premium Users	6	38	40	42	2.

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The bare statistics of Table 1 coupled with the common experience of all automotive users serves to indicate the magnitude of the problem of engine stalling encountered under cool, humid temperature conditions. However, it is significant to note that this problem has of late become of increased importance due to certain specific factors. First, most post-war cars are now provided without a manual throttle so that car owners are no longer able to increase the idle speed during the warm-up period to prevent stalling. Second, the idle speed of cars with automatic transmissions is rather critical during a warm-up and the fastest idle which may be used must not be too fast, increasing the criticality of stalling conditions. Third, stalling of a car with automatic transmission frequently does not occur until the driver is ready to accelerate, so that just at this most inconvenient time it is necessary to shift the car to neutral, restart the engine, and shift back into gear—magnifying the inconvenience of frequent stalls. A fourth factor affecting the magnitude of stalling difficulties relates to the volatility of the fuels now provided for automotive use. The volatility of commercial fuels over a period of years has been increased sufficiently to increase stalling difficulties as will be brought out herein.

On investigating this problem, it has been determined that the cause of repeated engine stalling in cool, humid weather is the formation of ice in the carburetor of the engine. On a cool, moist day, gasoline evaporating in the carburetor exerts sufficient refrigerating effect to condense and freeze moisture present in the air entering the carburetor. Normal fuel vaporization within the carburetor can cause a temperature reduction of the metal parts of the carburetor up to 50° F. below that of the entering air. Consequently, prior to the time of complete engine and radiator warm-up, this drop in temperature may cause formation of ice in the carburetor. Ice formation probably occurs most readily under conditions of light load operation. The result is that after a period of light load operation, when the throttle is closed to the idle position, ice already formed on the throttle plate and adjacent walls, plus ice which then forms, restricts the narrow air openings to cause engine stalling.

To more clearly define the problem of engine

stalling due to carburetor icing, data were tabulated based on customer reaction surveys, carefully controlled road tests, and laboratory cold room engine performance tests. These tests show that carburetor icing depends primarily upon atmospheric temperature and humidity conditions. The tests show that stalling difficulties due to ice formation in the carburetor are not encountered below about 30° F., nor above about 60° F. when employing fuels having conventional volatility characteristics. Similarly, these tests demonstrate that stalling is only encountered when the humidity is in excess of about 65%.

Another factor having a bearing on the formation of ice in the carburetor, is the volatility of the fuel employed. To determine this effect, laboratory cold room tests were conducted to evaluate the stalling characteristics during warm-up of a number of fuels varying in volatility. In these tests a 1947 Chrysler car was installed in a room equipped with temperature and humidity controls. While the temperature and humidity were maintained at particular levels, the stalling characteristics of the car were determined during the warm-up period. The procedure employed was to start the car and then immediately to raise the engine speed to 1500 R. P. M. This speed was maintained for 30 seconds, after which the engine was allowed to idle for 15 seconds. If the engine stalled before 15 seconds had expired, the car was again started and raised to a speed of 1500 R. P. M. for 30 seconds, while if stalling did not occur, the speed was immediately increased to 1500 R. P. M. after the 15 second idling time. The alternate cycles of 30 seconds at 1500 R. P. M. followed by 15 seconds at idling were repeated until the engine was completely warmed up. The number of stalls encountered during this procedure, and up to the time of complete engine warm-up were then recorded. Tests were conducted at 40° F. and at a relative humidity of 100% employing three fuels of varying volatilities. The most volatile fuel was a premium grade of commercial gasoline having a 10% ASTM distillation point of 110° F., a 50% point of 190° F., and a 90% point of 294° F. It was found that this fuel resulted in about 14 or 15 stalls during warm-up. A medium volatility fuel was also tested, consisting of a regular grade commercial gasoline having ASTM distillation characteristics such that 10% distilled at 121° F., 50% distilled at 220° F., and 90% distilled at 342° F. The number of stalls encountered with this fuel were 11. Finally a low volatility gasoline was subjected to the same test procedure. The gasoline had ASTM distillation 10, 50, and 90% points, at 126° F., 270° F. and 387° F. It was found that 5 stalls were encountered with this fuel.

As indicated by these data, carburetor icing is related to the volatility of the fuel employed. Thus, the least volatile fuel tested above, having a 50% distillation point of 270°, only resulted in 5 stalls, while the highest volatility fuel, having a 50% distillation point of 190° F., resulted in 15 stalls. Extrapolating these data as to the volatility of the fuel, it appears that a fuel having a volatility such that the ASTM 50% distillation point is 310° F., or higher would not be subject to stalling difficulties during warm-up. It must be appreciated, however, that a fuel having ASTM distillation characteristics of this nature would not be desirable as regards warm-up time, cold engine acceleration, economy and crank case dilution. However, in appreciating the scope of the present invention, it is important to note that this invention is only of application to gasoline fuels having an ASTM 50% distillation point below about 310° F. At the same time, as will be brought out, it is possible to correlate the quantity of additives required to overcome icing problems with the volatility of the fuel to be improved. In other words, smaller proportions of additives may be employed with fuels of relatively low volatility, while higher proportions of additives may be required with fuels of higher volatility.

As will be brought out by the data which follow, it will be shown that stalling difficulties may be overcome by employing critical percentages of dimethyl carbinol together with diisopropyl ether and a conventional solvent oil. Each of these additives contributes to the solution of the icing problem. The solvent oil, being a low volatility heavy oil, serves to maintain an oil film over the carburetor parts so as to minimize the adherence of moisture and ice to the carburetor. The dimethyl carbinol is sufficiently volatile and water soluble to vaporize in the carburetor and to dissolve in moisture present so as to depress the freezing point of the moisture. Together then, the dimethyl carbinol sharply lowers the freezing point of moisture in the carburetor while the solvent oil decreases the adherence of moisture and ice to the carburetor. The ether reduces still further the accumulation of ice, apparently through synergistic association with dimethyl carbinol since the ether in the absence of dimethyl carbinol has no effect on ice accumulation. This synergism occurs in the presence or in the absence of solvent oil.

It is a particular feature that by jointly using solvent oil, dimethyl carbinol and the ether, each component contributing a different function in preventing carburetor icing problems, it is possible to achieve a very high degree of anti-icing with only about 0.5% of solvent oil, not more than 2.5% of dimethyl carbinol, and from 0.05 to 0.2% of the ether.

With regard to the solvent oil to be used, this consists essentially of a liquid hydrocarbon mixture having a kauri-butanol solvent power above about 20, having a 50% distillation point above 350° F., at 10 mm. mercury pressure, having a Saybolt viscosity at 100° F., not above 450 seconds, and having an API gravity of about 18 to 28°. It is to be understood, therefore, that in referring to a solvent oil throughout this specification, reference is made to an additive of this nature, as defined above.

The dimethyl carbinol, or isopropanol, to be employed must be of 98% purity, or greater, although it is preferred that 98% pure dimethyl carbinol be employed. This chemical is ordinarily produced as crude dimethyl carbinol having a purity of 65%. The 35% of impurities consist chiefly of water together with small quantities of di-isopropyl ether, higher carbinols and ketones. Use of the crude product of this nature can not be tolerated, in part since a phase separation would occur on adding the crude product to gasoline. The consequent phase operation would result in an aqueous phase and a gasoline phase containing about 98% pure dimethyl carbinol. It is presently contemplated that, if desired, crude dimethyl carbinol may be added to gasoline in the indicated manner in order to obtain the final product consisting of gasoline containing dimethyl carbinol of 98% purity. It

is preferred, however, to purify the dimethyl carbinol in the conventional manner to obtain substantially pure dimethyl carbinol having less than 2% of water. The purified dimethyl carbinol of greater than 98% purity may then be blended directly into the gasoline.

As an aid in understanding the principles of this mixture, it is of interest to note that homologues of dimethyl carbinol cannot satisfactorily be employed. In the case of higher molecular weight homologues, it has been found that normal propyl carbinol, iso-propyl carbinol and ethyl methyl carbinol, together with all other higher homologues are not sufficiently water soluble to be effective for suppressing the formation of carburetor ice. In the case of dimethyl carbinol, apparently sufficient quantities of this compound dissolve in any water condensed in the carburetor so as to sufficiently lower the freezing point of this water to prevent ice formation. However, in the case of the higher carbinols, solubility is not sufficient in the water to permit this effect. A further consideration in this connection is that it is desirable to employ a compound having as low a molecular weight as possible, to depress the freezing point of water to the maximum extent according to Raoult's law. However, it has also been found impossible to use carbinols of lower molecular weight than dimethyl carbinol. Thus in the case of carbinol, or methanol, the volatility is such that the compound would not condense on the throttle plate of the carburetor, and apparently for this reason has little effect in suppressing icing. As a further consideration, gasoline compositions containing carbinol are extremely water sensitive so that the unavoidable contact of gasoline with water during marketing, or in a car, would result in the loss of most, or all of the compound. Methyl carbinol, or ethanol, is similarly objectionable particularly on the basis of water sensitivity. Thus on contact of any gasoline composition containing these compounds with, for example, the water which may be present in storage tanks, most of the compounds would be leached out by the water. To clearly show this effect, reference may be made to data obtained by contacting gasoline compositions containing, respectively, 2% of carbinol, methyl carbinol, and dimethyl carbinol, with two volume percent of water. It was found that 81% of the carbinol was removed by the water, while 65% of the methyl carbinol was removed, while only 10% of the dimethyl carbinol was lost.

The compositions embraced within this invention may be more fully understood by reference to the following examples, which show the effect of solvent oil alone; dimethyl carbinol alone; solvent oil and dimethyl carbinol; and solvent oil, dimethyl carbinol and diisopropyl ether in synergistic association.

Example 1

A commercial automotive gasoline was subjected to the cold starting tests formerly described. This gasoline had the following inspections:

10% D+L	°F.	134
50% D+L	°F.	209
90% D+L	°F.	305
Reid vapor pressure		9.2
Gravity	°API	61.7

It was found that this gasoline stock resulted in 11 stalls during the test procedure, or during the warm-up time of the engine at 40° F., and 100% relative humidity. 0.5 volume percent of solvent oil was then added to the gasoline. This solvent oil had the following characteristics:

Kauri-butanol value	25.2
50% distillation point	[1]413
Saybolt viscosity at 100° F.	75.3
A. P. I. gravity	26.6

[1] At 10 mm. Hg press.

It was determined that the icing characteristics of the carburetor were improved since warm-up was accomplished with only 8 or 9 stalls.

Since the solvent oil is sufficiently non-volatile to form a liquid film on the carburetor parts, it appears that this film is effective to decrease the condensation or adherence of water and ice in the carburetor. However, this effect of solvent oil is apparently not suitable to eliminate icing problems completely. Thus when the percentage of solvent oil in the gasoline of this example was doubled, no appreciable improvement in engine operation was obtained. So while the liquid film forming effect of solvent oil may be relied on to decrease icing problems, resort must be had to other agents to coact with the solvent oil to completely eliminate icing difficulties.

Data of the nature indicated in this example therefore shows that about 0.5% of solvent oil is sufficient to materially improve unsatisfactory engine operation due to carburetor icing; and that use of greater proportions provides little if any incremental improvement. It is preferred that the quantity of solvent oil should not exceed about 0.5% by volume since it materially changes distillation or volatility characteristics of gasoline when present in any substantial portions, and since it also adversely changes the octane number of the fuel and the copper dish gum test inspections.

Example 2

To the base gasoline employed in Example 1, 1% of 99% dimethyl carbinol was added. It was found that the number of stalls encountered during warm-up with this fuel composition had been reduced from a control value of about 11 to about 6. These data, therefore, indicate that 1% of dimethyl carbinol is sufficient to effect an appreciable improvement in the carburetor icing characteristics of a base gasoline.

Example 3

To the base gasoline fuel of Example 1, 0.5 volume percent of solvent oil, and 1% of 99% pure dimethyl carbinol were added. It was found that the number of engine stalls according to the cold room engine test procedure was about 3 for this composition. These data show that the indicated reduction in stalling contributed by solvent oil and contributed by dimethyl carbinol separately, can also be appreciated when these additives are both employed. While the tests used to evaluate carburetor icing and stalling frequency were necessarily of a somewhat qualitative nature, the data does show a definite coaction of the dimethyl carbinol and solvent oil. In understanding this coaction, it is helpful to realize that at least a portion of the dimethyl carbinol will be maintained in solution in the film of solvent oil. The solvent oil thus has the

effect of holding dimethyl carbinol at the exact point where it is needed.

Example 4

To determine the effect of employing small quantities of solvent oil and dimethyl carbinol in gasoline, experiments were conducted with a gasoline containing 0.5 volume percent of solvent oil and 0, 1, and 2% of dimethyl carbinol. The base fuel employed, consisting of a premium brand commercial gasoline containing 0.5% solvent oil and 1.38 cc. per gallon of lead tetraethyl which will be identified as Fuel Base A, had the characteristics indicated in the following Table 2. Also indicated in the table are the characteristics of this fuel base plus 1 and 2 volume percent of 99% pure dimethyl carbinol.

TABLE 2

	Fuel A Containing 0.5% Solvent Oil		
Vol. Percent (99% Dimethyl Carbinol)	0	1	2
ASTM Distillation, I. B. P., ° F.	84	86	87
° F. for 10% D+L	110	106	105
° F. for 50% D+L	190	190	187
° F. for 90% D+L	294	293	292
Percent D+L (a) 158° F.	34.5	35.0	37.5
Reid Vapor Pressure, p. s. i.	13.2	12.8	12.3
Gravity, ° API	66.3	66.0	65.7
General Motors Gum, mg./100 ml.	0.8	0.8	2.2
Copper Dish Gum, mg./100 ml.	276	251	238
ASTM Breakdown, Minutes	454	300	338
Motor Octane Number	82.2	82.0	82.2
Research Octane Number	91.4	91.6	91.7
Lead Content, cc./gal.	1.38	1.37	1.35

It will be noted from this table that addition of 1 and 2% of dimethyl carbinol to the base fuel stock containing the solvent oil does not adversely affect the inspections of the fuel. It is significant that even at 2% concentration, sufficient dimethyl carbinol was not present to affect the octane rating of the fuel outside of the experimental error involved in octane determinations.

Laboratory cold room tests were then conducted according to the afore-described procedure to determine the carburetor icing characteristics of a car containing the fuel compositions of Table 2. Results of these tests are given in Table 3. By way of explanation, it may be noted that the temperature and humidity conditions of the test were chosen as being the most severe which could be encountered as regards stalling tendency. Thus, by the nature of tests formerly indicated involving consumer reaction, laboratory tests, and road tests, it was determined that engine stalling occurs most frequently at a temperature of about 40° F., when the humidity is relatively high.

TABLE 3

Laboratory tests—1947 Chrysler

	Minimum Rel. Hum., Percent for Icing	Number of Engine Stalls at 40° F. and Indicated Relative Humidity, Percent			
		70	80	90	100
Fuel A	72	0	10	12.5	14.5
+1.0% dimethyl carbinol	95	0	0	0	2.0
+2.0% dimethyl carbinol	99	0	0	0	1.0
+2.5% dimethyl carbinol	100	0	0	0	0.5

Referring to Table 3, it will be noted that the base fuel identified as Fuel A and containing 0.5% of solvent oil was subject to an average of about 14.5 stalls during the warm-up time, at a humidity of 100%. The frequency of stalls was somewhat less at the lower humidity levels of 90 and 80%. When 1% of dimethyl carbinol was added to Fuel A, it was found that no stalling occurred at relative humidities below about 95%, and that even at 100% relative humidity, only about 2 stalls occurred during warm-up. Finally, it will be noted that addition of 2% and 2.5% of dimethyl carbinol effected a greater improvement in stalling causing the frequency of stalls to be respectively about 1 and about 0.5 during warm-up, and further limiting the humidities at which stalling could occur to relative humidities of about 99%, or greater. The data of Table 3, therefore, fully demonstrates the advantageous characteristics of the compositions of this invention. That is, the data show that a gasoline fuel containing 0.5 volume percent of solvent oil, and from about 1.0% to 2.5% of dimethyl carbinol is substantially free of stalling tendencies.

The indicated compositions are completely free of adverse carburetor icing below relative humidities of 95%, and at 2% concentrations of dimethyl carbinol do not permit stalling at relative humidities below 99%. In addition, these fuel compositions under the most adverse conditions would not be subject to stalling except in an extremely narrow temperature region. Thus with the 1% dimethyl carbinol blend, carburetor icing would ordinarily not occur except at relative humidities above 95%, and then only when ambient temperatures are in the range of about 38° F. to 42° F. It should further be noted in connection with the data of Table 3, that Fuel A employed in this table is a relatively high volatility fuel having a 50% distillation point of 190° F. This volatility is such that the commercial gasoline having this volatility is ordinarily described as approaching the volatility characteristics of aviation fuels. Consequently, in extrapolating the data of Table 3, to regular brand gasolines having lower volatility it is apparent that addition of 0.5% solvent oil and from 1 to 2% of dimethyl carbinol is effective in substantially eliminating carburetor icing difficulties.

From the foregoing it is apparent that improved fuel compositions are secured when utilizing an alcohol, particularly dimethyl carbinol in conjunction with a solvent oil. It has now been discovered that a further improvement is secured provided a relatively small amount of diisopropyl ether be utilized in conjunction with the hydrocarbon-alcohol mixture. In accordance with the present invention, it is preferred to use from 0.5 to 2.5% by volume (based upon the motor fuel) of a low molecular weight alcohol, particularly dimethyl carbinol in a motor gasoline and to use in conjunction with the low molecular weight alcohol from .05 to 0.2% by volume (based upon the motor fuel) of an ether, particularly diisopropyl ether.

The present invention may be more fully appreciated by the following example illustrating the same.

Example 5

In a series of carburetor icing tests, blends containing dimethyl carbinol and diisopropyl ether in a motor fuel of the type of premium

grade motor gasoline and containing about 0.5% solvent oil were used. Such gasoline normally contains "ethyl fluid" corresponding to between 1 and 3 cc. of tetraethyl-lead per gallon of gasoline and normally has at least 80 octane number. A gasoline having an initial boiling point of about 100° F., a final boiling point of about 350° F., about 20% distilled at 158° F., about 60% distilled at 212° F., and about 90% distilled at 302° F. by ASTM Method D-86, was mixed with various percentages of dimethyl carbinol and diisopropyl ether and the icing characteristics of the fuels were determined. The fuel was carbureted by air saturated with water at about 40° F., employing an air-fuel ratio of about 12/1 by weight. The minutes of elapsed time prior to the first indication of ice formation on the carburetor throttle plate are shown in Table 4.

TABLE 4

Carburetor icing tests

Volume Percent		Time to Initial Ice Formation, Mins.
Dimethyl Carbinol	Diisopropyl Ether	
0	0	0.6
0	2.0	0.6
1.0	1.0	2.8
1.5	0.5	5.0
1.8	0.2	6.1
1.9	0.1	7.6
2.0	0	6.3

From the above it is apparent that when utilizing a relatively small amount of diisopropyl ether in conjunction with dimethyl carbinol and solvent oil, unexpected desirable results are secured when the volume percent of ether is in the range from .05 to 0.2%. A very desirable mixture comprises 1.9% by volume of dimethyl carbinol and about 0.1% by volume of diisopropyl ether.

Example 6

In another series of tests, a mixture containing about 92% dimethyl carbinol, 6% diisopropyl ether and 2% water by volume was added in various proportions to a gasoline similar to that employed in Example 5 and containing about 0.5% of solvent oil. The icing characteristics of the resulting blends, as determined in the carburetor icing apparatus, are shown in Table 5.

TABLE 5

Carburetor icing tests

Volume Percent: Dimethyl Carbinol, Diisopropyl Ether Mixture	Time to Initial Ice Formation, Minutes
None	0.7
0.5	0.6
1.0	0.8
1.5	5.1
2.0	10+

The data show that decidedly superior results are obtained by employing dimethyl carbinol, diisopropyl ether and solvent oil in particular proportions and in particular concentrations.

It is apparent that the fuel compositions falling within the scope of this invention may include any of the commonly used gasoline additives, such as lead alkyl anti-detonants, lead scavenging agents, dyes, gum inhibitors, oxidation inhibitors, etc. It is particularly contemplated that metal deactivators and rust preventives may be included in the fuel. N,N'-disalicylal-1, 2-diamino propane, and N,N'-disalicylal-1,2-diamino ethane are examples of suitable metal deactivators. Sorbitan monoleate, pentaerythritol monoleate and phosphates, nitrates, and nitrites such as the amine phosphates, nitrates, and nitrites are examples of suitable rust preventives which may be used. It is apparent that this invention is of application to any gasoline fuel base having a volatility such that the 50% distillation point falls below about 310° F. The gasolines thus include automotive type gasolines, marine type gasolines, and aviation gasolines.

What is claimed is:

1. A composition consisting of a mixture of hydrocarbons boiling in the gasoline boiling range and containing from about 1.0 to 2.5% by volume of dimethyl carbinol and from about .05 to 0.2% by volume of diisopropyl ether.

2. Composition as defined by claim 1 wherein said composition contains about 0.5% by volume of a solvent oil.

3. A composition consisting essentially of a mixture of hydrocarbons boiling in the gasoline boiling range and containing about 0.5 volume percent of solvent oil, from about 1.0 to 2.5% by volume of dimethyl carbinol and from about .05 to 0.2% by volume of diisopropyl ether, said solvent oil consisting of a liquid hydrocarbon mixture having a kauri-butanol solvent power above about 20, a distillation point above about 50° F. at 10 mm. mercury pressure, a Saybolt viscosity at 100° F., not above 450 seconds, and an API gravity of about 18 to 28°.

4. The composition of claim 3 in which the concentration of the said dimethyl carbinol is 2.0%.

5. The composition of claim 3 in which the said dimethyl carbinol consists of at least 98% pure dimethyl carbinol.

6. A gasoline composition including 0.5% by volume of solvent oil and 1.9% by volume of 98% pure dimethyl carbinol and 0.1% by volume of diisopropyl ether.

7. The composition defined by claim 6 in which the mid-boiling point of the said mixture of hydrocarbons boiling in the gasoline boiling range is below about 310° F.

8. The composition defined by claim 6 in which the said mixture of hydrocarbons boiling in the gasoline boiling range has a mid-boiling point of about 190° F.

9. The method of operating an internal combustion engine in moist, cool temperature conditions which comprises burning a gasoline fuel in the said engine containing about 0.5% of solvent oil, 1.9% of dimethyl carbinol of at least 98% purity and about 0.1% of diisopropyl ether, said solvent oil consisting of a liquid hydrocarbon mixture having a kauri-butanol solvent power above about 20, a 50% distillation point above 350° F., at 10 mm. mercury pressure, a Saybolt viscosity at 100° F., not above 450 seconds, and an API gravity of about 18 to 28°.

10. The method of improving the combustion of a gasoline fuel at ambient temperatures between 30 and 60° F., and employing air having relative humidities greater than about 65%, which comprises burning said gasoline fuel and said air in the pressure of about 0.5 volume percent of solvent oil and 1.9% of dimethyl carbinol based on the quantity of gasoline, and about

0.1% of diisopropyl ether said solvent oil consisting of a liquid hydrocarbon mixture having a kauri-butanol solvent power above about 20, a 50% distillation point above 350° F., at 10 mm. mercury pressure, a Saybolt viscosity at 100° F., not above 450 seconds, and an API gravity of about 18 to 28°.

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