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GASOLINE FUEL CONTAINING DIMETHYL CARBINOL AND SOLVENT OIL

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This invention relates to gasoline fuel compositions adapted to provide markedly improved motor operation under cool moist operating conditions. The fuel compositions of this invention consist of hydrocarbons boiling in the gasoline boiling range to which are added about 1.0% to 2.5% of dimethyl carbinol and about 0.5% of what is known as a solvent oil. More narrowly, the preferred fuel composition of this invention, consists of a mixture of a gasoline fuel base containing 0.5% of solvent oil and 2% of dimethyl carbinol. In addition these fuel compositions may contain the conventional gasoline additives such as lead alkyl antidetonants, dyes, gum inhibitors, oxidation inhibitors, etc.

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 I 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)				
	32	35	37	52	56
Temperature....° F.	52	70	96	100	96
Relative Humidity %..	Clear	Overcast	Light Rain	Heavy Rain	Rain
Weather.....					
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 I 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

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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 to then immediately 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

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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 has been found in accordance with this invention, that stalling difficulties may be overcome by employing critical percentages of dimethyl carbinol together with a conventional solvent oil. Each of these additives contributes to the solution of the icing problem so as to effectively solve the 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.

It is a particular feature of this invention that by jointly using solvent oil and dimethyl carbinol, each component contributing a different function in preventing carburetor icing problems, it is possible to use only about 0.5% of solvent oil and not more than 2.5% of dimethyl carbinol.

With regard to the solvent oil to be used in compositions of this invention, reference may be made to U. S. Patent 2,066,234, issued to Sloane and Wasson on December 29, 1936. This patent fully discloses the nature of the additive known as solvent oil which is contemplated for use in the compositions of this invention. Essentially, as there brought out, a solvent oil consists of a liquid hydrocarbon mixture having a kauributanol 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 and as fully described in the cited patent.

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 cannot be tolerated, in part since a phase separation would occur on adding the crude product to gasoline. The consequent phase separation 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 invention, it is of interest to note that

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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. It is apparent, therefore, that dimethyl carbinol is uniquely qualified, and in effect is the only compound of its class which can be considered as a possible agent for solving the present problem.

The compositions embraced within this invention, the nature, and objects of this invention may be more fully understood by reference to the following examples.

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.....	413 @ 10 M. M. Hg
Saybolt viscosity at 100° F..	75.3
API gravity.....	26.6

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 another agent, dimethyl carbinol, to coact with the solvent oil to completely eliminate icing difficulties.

Data of the nature indicated in this example therefor 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 ccs. 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. Per Cent (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
Per Cent D+L (a) 158° F.	34.5	35.0	37.5
R 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., Per Cent for Icing	Number of Engine Stalls at 40° F. and indicated Relative Humidity, Per Cent			
		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 affected 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.

Example 5

In a typical test case involving an automobile susceptible to stalling difficulties, in addition to 0.5% of solvent oil, 2.5% of 99% pure dimethyl carbinol was added to the premium grade gasoline normally used by the owner. It was found that this composition eliminated any operating difficulties due to ice formation, even though as many as 7 or more stalls had previously occurred on cool, humid days when the car was driven over the same route.

As brought out by the preceding description and by the examples given, the present invention embraces gasoline compositions to which are added from 1 to 2.5% of dimethyl carbinol together with about 0.5% of solvent oil. In appreciating this invention it is important to realize that additions of these additives should not exceed the indicated proportions. Economical and practical reasons limiting the quantity of solvent oil have already been indicated. As regards dimethyl carbinol, even more stringent requirements limit the quantity which can be used to a maximum of about 2.5%.

A practical consideration limiting the maximum amount of dimethyl carbinol which can be used resides in the relative cost of this additive and the gasoline to which it is added. Thus, since dimethyl carbinol is more expensive than gasoline, it would not be commercially attractive to add any substantial portions of dimethyl carbinol to the gasoline.

A more important factor limiting the quantity of dimethyl carbinol which can be used concerns the relative heat value of dimethyl carbinol as opposed to that of gasoline. A gallon of commercial grade automotive gasoline has a heat content of about 116,000 B. t. u.'s per gallon, while a gallon of dimethyl carbinol has a heat content of only 84,100 B. t. u.'s per gallon. Addition of dimethyl carbinol to a gas-

oline can, therefore, only be made at a substantial sacrifice in the heat value of the gasoline which would be manifested in lower mileage. While additions of as much as 2.5% of dimethyl carbinol can be tolerated without making any appreciable change in gasoline mileage, it is apparent that quantities above this proportion would be undesirable.

A still further factor in regard to the dimethyl carbinol content concerns the effect of this compound on the volatility characteristics of the gasoline. A relatively small amount of dimethyl carbinol sharply increases the vapor to liquid ratio of a gasoline composition. This has the effect of causing vapor lock problems and, as the dimethyl carbinol content is increased, would actually result in complete failure of engine starting when restarting the engine after a period of engine operation. Again, therefore, this factor necessitates use of dimethyl carbinol in the smallest possible quantities so that proportions above 2.5% are not desirable.

A still further factor concerns the possibility of loss of dimethyl carbinol due to accidental contact of water with gasoline containing dimethyl carbinol. If any substantial quantities of dimethyl carbinol are blended in a gasoline, light ends must be eliminated from the gasoline to adjust the volatility of the gasoline. If then dimethyl carbinol is lost by accidental water contact, the remaining fuel composition would be unsuitable. Again, this is an effect which would not be particularly harmful with gasolines containing no more than 2.5% dimethyl carbinol, but would be very bad in the case of gasolines containing more than this amount.

Therefore, as formerly indicated, it is a particular feature of this invention that a combination of solvent oil and dimethyl carbinol be used to overcome stalling and carburetor icing difficulties. In addition to enhancing the effect of the dimethyl carbinol, the solvent oil permits use of a minimum and tolerable quantity of dimethyl carbinol. Furthermore, the solvent oil has the advantage of minimizing the possibility of losing alcohol from the composition in marketing.

With reference to the possibility of loss of dimethyl carbinol due to contact of the fuel composition with water, particular notice may be taken of a characteristic of the fuel compositions of this invention. As indicated, this composition consists of a gasoline fuel base containing about 0.5% of a solvent oil and about 2% of dimethyl carbinol. It is well established that a heavy oil will dissolve water more readily than a light oil. Insofar as the solvent oil added to the gasoline is a relatively heavy oil as compared to the gasoline, it is apparent that this effect will aid the retention of dimethyl carbinol in the composition on contact with water.

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 monooleate, penta erythri-

tol monooleate 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 essentially of a mixture of hydrocarbons boiling in the gasoline boiling range, about 0.5 volume percent of solvent oil, and from 1.0 to 2.5% of dimethyl carbinol 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°.

2. The composition of claim 1 in which the concentration of the said dimethyl carbinol is 2.0%.

3. The composition of claim 1 in which the said dimethyl carbinol consists of at least 98% pure dimethyl carbinol.

4. A gasoline composition including 0.5% of solvent oil and 2.0% of 98% pure dimethyl carbinol.

5. The composition defined by claim 4 in which the mid boiling point of the said mixture of hydrocarbons boiling in the gasoline boiling range is below about 310° F.

6. The composition defined by claim 4 in which the said mixture of hydrocarbons boiling in the gasoline boiling range has a mid boiling point of about 190° F.

7. The method of operating an internal combustion engine in moist, cool temperature conditions which comprises burning a gasoline fuel in the said engine including 0.5% of solvent oil and 2.0% of dimethyl carbinol of at least 98% purity 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°.

8. 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 presence of about 0.5 volume percent of solvent oil and 2.0% of dimethyl carbinol based on the quantity of gasoline 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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