This invention is directed to the treatment of hydrocarbons, such as the distillate fuels, which tend to accumulate potentially hazardous electrostatic charges in service. According to the present invention, the addition of a hydrocarbon-soluble betaine to a static-prone hydrocarbon substrate minimizes the accumulation of static electricity in such substrate.

The accumulation of electrical charges in the handling of hydrocarbons is widely recognized as a serious hazard. A number of explosions and fires that have occurred in recent years during the bulk handling of distillate fuels and solvents have been attributed to the accumulation (and subsequent discharge) of static electricity in the systems involved. Some handling conditions that contribute to the rapid generation of dangerous charge levels are rapid flow of fuel through pipelines and hoses, splash filling of receiving vessels (storage tanks and seagoing tankers), and mixing of the fuel with water.

The problem of static formation in the distillate fuels is of considerable concern to the military as well as to the petroleum industry, and much searching has been and is being done to find a solution thereto. The results of a number of investigations indicate that most distillate fuels would be expected to produce substantial amounts of static electricity under service conditions, and practically all produce sufficient static electricity to ignite vapor-air mixtures, providing there is present a mechanism for collecting and discharging the electricity. The production of static electricity in such fuels is associated with the presence of colloidal impurities which are ionic or which are capable of becoming ionized in the hydrocarbon environment. These impurities are believed to be either naturally occurring or represent fuel degradation and oxidation products or residues from treating operations. As a result of preferential adsorption of positively or negatively charged ions from the impurities on the container (e.g. wall or hose lining), the fuel will acquire a charge of the opposite sign. The rate of production of static electricity in liquid hydrocarbons increases with the flow rate and is accelerated by the presence of small amounts of water, air and dispersed solids. Since leakage of the charge from the body of the hydrocarbon is normally a very slow process, a potential may soon be established during the normal handling of the fuel to ignite fuel-air mixtures or to cause internal stress on jet submersibles or explosions within the fuel when the electricity finally discharges. The problem is particularly acute with jet fuels.

As discussed in "Electrostatics in the Petroleum Industry," edited by A. Klingenberg and J. L. van der Neen, Elsevier, 1958, expedients such as grounding the apparatus, blanketing of the fuel with inert gas, and mechanical modifications in the handling procedures are helpful but not entirely satisfactory safeguards. The most promising approach appears to be the use of additives. To be practical, particularly for use in jet fuels where volumes have been small, an antistatic additive should (1) be effective, in technically feasible small concentrations, in fuels of both charge types i.e. in positive prone and negative prone fuels; (2) have no adverse effect on water-tolerance characteristics of the fuel; (3) have no adverse effect on jet fuel thermal stability; (4) have no adverse effect on fuel storage stability; and, (5) be non-metallic since metals in general adversely affect fuel stability and contribute to the formation of combustion deposits, and, tend to embrittle alloys used for turbine engines.

Deficient in at least one of the above requirements are the polar compounds suggested heretofore; compounds such as metal or ammonium (including quaternary ammonium) salts of inorganic and organic acids (including acids of phosphorus, sulfur and carboxylic acids) are representative of such polar compounds. For example, Rogers, McDermott and Munday, "Static Electricity in Petroleum Products," Oil and Gas J. 55, 166-93 (1957), disclose that "all the additives studied so far are polar compounds which are surface active and promote the formation of emulsions when the blends are mixed with water. Thus, they fail to meet the water tolerance specifications of jet fuels and in addition are rather easily extracted on contact of the fuel with water."

It is an object of the present invention to provide novel antistatic agents which are significantly effective, in liquid hydrocarbons, in minimizing the accumulation of static electricity in both types of charge-prone liquid hydrocarbons. It is a further object of this invention to provide novel liquid hydrocarbon compositions containing antistatic agents which antistatic agents do not adversely affect other fuel properties such as water tolerance characteristics. It is still another object of the present invention to provide novel liquid hydrocarbon compositions containing antistatic agents, said liquid hydrocarbon being a jet fuel and said antistatic agent, in addition to minimizing the accumulation of static electricity, minimizing the adverse effects of thermal stress on jet fuels, which adverse effects are normally encountered.

These and other objects will be apparent in the following specification and claims.

More specifically, the objects of the present invention are achieved by employing a hydrocarbon-soluble betaine, as hereinafter described and claimed, as the antistatic agent in small quantity sufficient to minimize the tendency of the hydrocarbon to accumulate electrostatic charge. Such quantity will usually be in the range of from about 0.1 to 30 lbs. per 1000 barrels (0.000053 to 0.01% by weight) of the stationary liquid hydrocarbon. It is preferred to use an antistatic quantity of at least 0.5 lb. and not more than 15 lbs. per 1000 barrels.

Betaines which may be used according to this invention are hydrocarbon-soluble members of the class of dipolar ions represented by Formula I which follows:

$$\text{R}_1\text{R}_2\text{N}^+\text{H}^+\text{R}_3\text{R}_4\text{C}^\text{O}^-$$

where \( \text{R}_1\) is a divalent hydrocarbon radical, such as an alkylene or alkylidene radical, \( \text{R}_2\) and \( \text{R}_3\) are aliphatic hydrocarbyl radicals, such as the lower-alkyl radicals, and \( \text{R}_4\) is an uncharged alkylidene radical such as hydrocarbyl and hydrocarbyl substituted by ether (−O−), hydroxyl (−OH) and carbonyl (−C=O−) groups. \( \text{R}_4\) is primarily a solubilizing group and should be free of substituents that promote the emulsification of the fuel with water. To have sufficient hydrocarbon-solubility the betaine should contain at least about 11 carbon atoms and preferably at least about 16 carbon atoms in the molecule. Ordinarily the betaine will contain no more than about 35 carbon atoms, and usually up to about 30 carbon atoms.

Preferably, \( \text{R}_1\) will be an alkylene radical, particularly methylene, or an alkylidene radical having up to 17 carbon atoms, such as ethyldiene, propyldiene, undecyldiene, tridecyldiene and heptadecyldiene. \( \text{R}_2\) and \( \text{R}_3\) may be the same or different C-(C \( \text{R}_4\)) alkyl.
radicals, e.g. methyl, ethyl propyl, butyl and amyl, preferably C₃-C₆. Preferably, R₄ is an aliphatic hydrocarbyl radical containing up to 20 carbon atoms and may be saturated or unsaturated, straight chain or branched chain. Representative examples of R₄ are methyl, butyl, hexyl, decyl, tridecyl, octadecyl, etc.; octadecyl, octadecenyl and 3,7-dimethyl-2,6-octadienyl. Also, R₄ may be an hydroxy-alkoxy-alkyl radical, such as a 2-hydroxy-3-alkoxypropyl radical.

\[
\begin{align*}
\text{R} & \text{O-C-H-CH-OH} \\
& \text{R} \quad \text{R} \\
\text{O} \quad \text{O} \\
\text{R} & \text{R}
\end{align*}
\]

where R is an aliphatic hydrocarbyl radical as defined for R₄ above, that is, it may be for example an alkyl, alkenyl, or alkadienyl radical having up to 20 carbon atoms, preferably one having 10 or more carbons. Also, R₄ may be a hydrocarbon radical containing a carbonyl group, as in

\[
\begin{align*}
\text{R} & \text{O-C-H-CH-OH} \\
& \text{R} \quad \text{R} \\
\text{O} \quad \text{O} \\
\text{R} & \text{R}
\end{align*}
\]

where R is as defined above. The preferred betaines may be represented generically by Formula II which follows:

\[
\begin{align*}
\text{R} & \text{R}_2 \\
& \text{R} \quad \text{R} \\
\text{O} \quad \text{O} \\
\text{R} & \text{R}
\end{align*}
\]

where x=0 or 1 and R₁, R₂, R₃ and R are as preferentially defined above. The “R” groups and x may be varied in accordance with the above definition so that the hydrocarbon content of the dipolar ion is sufficient for solubilization of a substantial quantity of the compound in the hydrocarbon to be treated; that is, the compound should contain from about 11 to about 35 carbon atoms. The following are representative betaines of the present invention in which R₀ of Formula I is an aliphatic hydrocarbyl radical attached to nitrogen of a dialkyl glycinic radical: N-lauryl betaine (i.e. N-lauryl-N,N-di-methyl glycine), N-hexadecyl betaine, N-octadecyl betaine, N-octadecenyl betaine, N-lauryl-N,N-dipropyl glycine, C-decyl betaine (i.e., 2-trimethylammonio-do-decanate), C-dodecyl betaine, C-tetradecyl betaine; and, N-lauryl-C-methyl betaine. The above betaines are described and may be prepared by methods disclosed by Downing and Johnson in U.S. Patent 2,129,264.

Other betaines which may be used according to this invention are those in which R₀ is an aliphatic substituted hydrocarbyl radical, e.g. ROCH₂CHOHCH₂ of Formula II, attached to nitrogen of an N,N-dialkyl glycinic radical. Representative examples are N-(2-hydroxy-3-butyl-oxopropyl)betaine, N-(2-hydroxy-3-decyl oxopropyl)betaine, N-(2-hydroxy-3-lauryl oxopropyl)betaine, N-[2-hydroxy-3-(3,7-dimethyl-2,6-octadienyl)oxopropyl]betaine, N-(2-hydroxy-3-tridecyl oxygenpropyl)betaine, N-(2-hydroxy-3-octadeclencil oxygenpropyl) - N,N-diethyl glycine and the corresponding substituted -N,N-dipropyl glycine.

The above N-(2-hydroxy-3-alkoxypropyl) - N,N-dialkyl glycinic may be prepared by known methods, for example by condensing an alcohol with epichlorhydrin and reacting the intermediate condensation product thus obtained with an alkali metal salt of an N,N-dialkyl glycine. Preferably, the alcohol will contain from 10 to 20 carbon atoms. Available alcohols of this type are the "Lorol" fatty alcohols mixed with lauryl alcohol; "Ocenol" fatty acids, e.g. "Ocenol" P which is principally oleyl alcohol; geraniol (3,7-dimethyl-2,6-octadienol); oxo-alcohols, which are mixtures of branched chain primary alkanols, e.g. oxo-tridecane.

As illustrated above, R, R₂, R₃, R₄ and x will be chosen so that the dipolar ion is soluble in hydrocarbons to the extent of at least about 0.1 lb., preferably at least 0.5 lb., per 1000 barrels (bbls.) of the hydrocarbon. The quantity of the antistatic agent needed to minimize the accumulation of static electricity in the hydrocarbon substrate will vary with the particular betaine and the particular liquid hydrocarbon product, and, will depend, in general, on how prone such hydrocarbons are to accumulate static electricity. Normally, from about 0.5 to 15 lbs. of additive, and preferably 1 to 5 per 1000 bbl. of substrate will be employed. Larger quantities, e.g. 30 lbs./1000 bbl. are operable for antistatic effects, but are usually unnecessary, also such unusually large quantities tend to promote the water emulsification of distillate fuels. While smaller quantities, e.g. 0.1 lb./1000 bbls., may also be operable, they do not always provide the desired degree of protection.

It should be understood that the presence of the antistatic agent in the hydrocarbon substrate does not do away with the need for adequate grounding of the equipment for containing and handling the hydrocarbon product. The antistat apparently functions to minimize the accumulation of static electricity in the hydrocarbon product by conducting the charge (as it tends to build up in the hydrocarbon) from the hydrocarbon to the groundings making it harmless. The use of the betaine antistatic agents of the present invention is applicable to any liquid hydrocarbon that boils in the distillate fuel range and is prone to accumulate static electricity in service. These include hydrocarbon solvents and distillate fuels, representative examples of which are the solvent naphtha, Varsols and Stoddard solvent, isocyanate, both raw and refined kerosenes, gasoline (both automotive and aviation), jet fuels (JP-4, JP-5 and JP-6), diesel fuel and heating oil. The problem appears to be particularly acute with the jet fuels; accordingly, the preferred embodiment of the invention is the use of the instantly described and claimed antistatic additives in jet fuels. For convenience in handling, the betaine antistatic agents may be added to the hydrocarbon substrate as a concentrate in a suitable carrier, which is preferably a liquid hydrocarbon. For example, a 20 to 60%, usually about 50%, by weight of N-lauryl betaine in xylene or kerosene is a preferred form of the antistatic additive. The antistatic additives may be used in the presence of other additives that the hydrocarbon product may normally contain, such as the approved oxidation and rust inhibitors for jet fuels.

The betaines of this invention are effective antistatic agents in practical use concentrations. They are ashless (i.e. being non-metallic they leave no harmful residues in the combustion of fuels containing them) and in general do not promote the tendency of the fuel blends containing them to emulsify when mixed with water. This is particularly surprising and important since betaines in general are regarded as surface active agents and it is known that polar additives that are surface active, when used in concentrations required for antistatic activity, have the major disadvantage of failing to meet the water tolerance specifications of fuels such as the jet fuels.

As shown in the examples, jet fuel containing N-lauryl betaine as an antistat not only passes the standard water tolerance test, but shows no tendency to accumulate electrostatic charge even after the blended fuel has been shaken with as much as 5 vol. percent of water. Further, as shown in the examples, antistat concentration is very effective to minimize the deterioration of jet fuel when the blended jet fuel is subjected to the thermal stresses of the CFR Coker Test. The following representative examples illustrate the present invention.

**EXAMPLES**

Testing of the betaine antistatic agents was conducted by the procedure described by Rogers et al., Oil and Gas Journal, 55, 166-95 (1957). The equipment employed
was essentially a duplicate of that described in the above reference and was enclosed in a constant humidity chamber.

The tests involve recirculating a sample of the liquid hydrocarbon (with or without additive) at a flow rate of 1450 ml/minute through a column packed with Pyrex glass wool (Filtering Fiber Cat. No. 800). The glass wool acts as a charge separator. A tungsten wire electrode inserted into the packed column leads to an external spark gap, which provides the means for discharging the accumulated static electricity. The humidity of the atmosphere contained in the Lucite enclosure for the whole apparatus was maintained at 15% or less, to minimize the effect of humidity on the conductivity of the air through which the spark gap fires. In the present runs the fuel was circulated (and recirculated) through the glass wool packed column for a 10 minute warm-up period, and then a 20 minute run was made during which time the number of discharges were counted across the spark gap which had been calibrated to fire at 2000 volts (2 kv.). The number of 2 kv. discharges in 20 minutes is a measure of the tendency of the fuel to accumulate static electricity and thus is a measure of the effectiveness of the antistatic additive.

In addition, each fuel (with and without additives) was subjected to the water tolerance test in accord with Method 3251 of Federal Specification VV-L-791c. The test consists of shaking 80 ml of the fuel and 20 ml of water (containing a pH 7 phosphate buffer) in a 100 ml stopped graduate cylinder for 2 minutes, and allowing it to stand for 5 minutes. To pass the test, the water and oil phases must break cleanly within the 5 minute standing period. Any emulsion or lacing in the oil, or precipitate at the interface leads to a "fail" rating.

### Example 1

A 50 weight percent xylene solution of N-(2-hydroxy-3-octadecenoyl)-oxypropyl) betaine was blended by stirring into a liquid hydrocarbon product as designated below, to provide the concentration of the active ingredient also given below. The results obtained in the circulating static electricity test on the treated and untreated hydrocarbons follow:

<table>
<thead>
<tr>
<th>Hydrocarbon</th>
<th>Type</th>
<th>Charge Prono</th>
<th>No. of 2 kv, Discharges in 20 Minutes</th>
<th>Additive, lbs./1,000 bbl.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>7.5</td>
</tr>
<tr>
<td>(A) JP-5 jet fuel</td>
<td>negative</td>
<td>325</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>(B) JP-5 jet fuel</td>
<td>positive</td>
<td>720</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>(C) JP-4 jet fuel</td>
<td>positive</td>
<td>120</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(D) Refined kerosene</td>
<td>negative</td>
<td>429</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(E) Heavy fuel solvent</td>
<td>positive</td>
<td>208</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(F) Gasoline</td>
<td>negative</td>
<td>488</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

* A labeled automotive-type gasoline containing 3 ml of tetraethyl lead per gallon.

All the above compositions passed the water tolerance test.

The results of the electrostatic test show that the betaine effectively minimizes the accumulation of static electricity (being completely effective at the 15 lb./1000 bbl. level) in liquid hydrocarbon products, irrespective of the charge sign. Further research may be required to acquire the maximum effectiveness of the betaine.

The N-(2-hydroxy-3-octadecenoyl)-oxypropyl) betaine of Example 1 was prepared by reacting "Ocenol" P fatty alcohol with epichlorhydrin in the presence of sulfuric acid catalyst, followed by reacting the thus-produced octadecenoyl glyceryl ether chloride with sodium N,N-dimethylglycinate in the presence of KI catalyst.

Employing the corresponding N-(2-hydroxy-3-octadecenoyl)-oxypropyl) glycine, at a concentration of 15 lbs./1000 bbl. in Fuels A and B above, gave identical results in the electrostatic and water tolerance tests.

Substantially similar results are obtained on employing other betaines of this type, as indicated in the following example.

### Example 2

By the procedure of Example 1, Fuels A and B described above were treated to contain N-(2-hydroxy-3-octadecenoyl)-oxypropyl) betaine in the concentrations given below, and the resulting blends tested to yield the following results:

<table>
<thead>
<tr>
<th>Additive Conc., lbs./1,000 bbl.</th>
<th>2-kv. Discharges in 20 Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fuel A</td>
</tr>
<tr>
<td>None (Control) 15</td>
<td>125</td>
</tr>
<tr>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>30</td>
<td>0</td>
</tr>
</tbody>
</table>

All the fuel blends passed the water tolerance test.

### Exemple 3

A 50 weight percent solution in xylene of a betaine of the formula:

\[
\text{R} = \text{N(CH}_2\text{)}_2 - \text{R}_1 - \text{CO}^+ \\
\]

was blended by stirring into liquid hydrocarbon products B and C described in Example 1. R and R1 of the betaine, the concentrations of betaine employed, and the results of the electrostatic test are as described below:

<table>
<thead>
<tr>
<th>Additive</th>
<th>Conc., lbs./1,000 bbl.</th>
<th>No. of 2-kv. Discharges in 20 Minutes, ia—</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (Control) 15</td>
<td>720</td>
<td>450</td>
</tr>
<tr>
<td>lauryl</td>
<td>CH\text{—}</td>
<td>0.5</td>
</tr>
<tr>
<td>octadecyl</td>
<td>CH\text{—}</td>
<td>10</td>
</tr>
<tr>
<td>methyl</td>
<td>doc(CE)\text{—}</td>
<td>15</td>
</tr>
<tr>
<td>methyl</td>
<td>etyl(CE)\text{—}</td>
<td>15</td>
</tr>
</tbody>
</table>

All the hydrocarbon blends passed the water tolerance test.

### Example 4

The procedure of Example 3 was repeated, employing:

\[
\text{n-dodecyl-O-CH}_2\text{—N(CH}_2\text{)}_2 - \text{CH}_3\text{—CO}^+ \\
\]

at a concentration corresponding to 15 lbs./1000 bbl. (This betaine was prepared by reacting n-dodecyl alphachloroacetate with the sodium salt of N,N-dimethyl glycine.) The results of the antistatic test in hydrocarbons B and D were as follows:

The number of 2-kv. discharges in 20 minutes was reduced from 720 to 140 in positive-prone Fuel B, and from 459 to 19 in negative-prone Fuel D. Both compositions (containing the betaine) passed the water tolerance test.

### Example 5

A refined kerosine, with and without N-lauryl betaine at a concentration corresponding to 1 lb./1000 bbl., was vigorously shaken with 0.1 and 5 volume percent of water for about 5 minutes and the mixtures allowed to
settle for 16 hours. The electrostatic test results on the thus-treated products follow:

<table>
<thead>
<tr>
<th>N-Lauryl Betaine Present</th>
<th>Water, Volume Percent</th>
<th>2-Min. Discharges in 29 Minutes</th>
<th>Interfacial Tension, dynes/cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>None</td>
<td>458</td>
<td>B (JP-5)</td>
</tr>
<tr>
<td>No.</td>
<td>5</td>
<td>291</td>
<td>None</td>
</tr>
<tr>
<td>Yes</td>
<td>0.1</td>
<td>638</td>
<td>B (JP-5)</td>
</tr>
<tr>
<td>No.</td>
<td>0.1</td>
<td>638</td>
<td>B (JP-5)</td>
</tr>
</tbody>
</table>

The results show that fuel containing N-lauryl betaine (1 lb./1000 bbl.) resists accumulating static electricity even after being contacted with water.

**Example 6**

This example shows the beneficial effect of N-lauryl betaine on jet fuel filterability and pre-heater tube deposits as determined in the CFR Coker Test, in accordance with CRC Manual No. 3, Instructions for Operation and Maintenance of CFR Fuel Coker, March 1957, of the Coordinating Research Council, Inc. (The fuel coker is a laboratory apparatus designed to measure the fuel's high temperature stability. In principle, it subjects the test fuel to the same level of temperature stress and in a manner similar to that occurring in jet engines.)

The results obtained with two JP-5 jet fuels—one relatively stable (Fuel F) the other relatively unstable (Fuel G)—are tabulated below. The following code was used to rate each inch of the preheater tube's 13 inches of length:

0—No visible deposits
1—Visible haze or dulling, but no color
2—Barley visible discoloration
3—Light tan to peacock stain
4—Heavier than 3

**CFR FUEL COKER DATA FOR N-LAURYL BETAINES**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Preheater °F</th>
<th>Filter °F</th>
<th>Flow rate, lbs./hr.</th>
<th>Pressure, lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fuel**

<table>
<thead>
<tr>
<th>Additive Conc. lbs./1000 bbl.</th>
<th>Tube Deposits</th>
<th>Minutes to a Press Drop, in Inches of Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>None</td>
<td>122222341333</td>
</tr>
<tr>
<td>G</td>
<td>7.5</td>
<td>222222222222</td>
</tr>
<tr>
<td></td>
<td>7.5</td>
<td>222222222222</td>
</tr>
</tbody>
</table>

1 The additive passed the water tolerance test in both fuels.
2 Total time for the test was 300 minutes; where a pressure drop of 25 inches of mercury occurred before 300 minutes had elapsed, the run was stopped to remove the filter and then continued to 300 minutes.

The pressure drop across the filter and the condition of the preheater tube after 30 minutes with respect to tube deposits are a measure of the fuels high temperature stability. The betaine reduced the preheater tube deposits formed with both fuels. It improved the filterability of the less stable fuel (G) and did not significantly deprecate the filterability of the more stable fuel (F).

As stated, none of the betaine additives, in any of the hydrocarbon compositions described above, promoted the emulsification of hydrocarbon with water, as determined by the water tolerance test.

The non-emulsifying effect of the subject betaines is also shown in the following example.

**Example 7**

The data below show the effect of N-lauryl betaine on the interfacial tension between jet fuels B and G (JP-5 and JP-4) and water. The measurements were obtained at room temperature using a platinum ring coated with polyethylene.

It is currently believed that an additive cannot reduce the interfacial tension between fuel and water below 15 dynes/cm. without interfering with the operation of fuel-water separators. Thus, the above results indicate N-lauryl betaine, at concentrations that are effective for antistatic use, should not cause difficulty in the separation of fuel from water.

It will be apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. A liquid hydrocarbon boiling in the distillate fuel range containing an antistatic quantity, of from 0.1 to 30 pounds per 1000 barrels of said hydrocarbon, of a hydrocarbon-soluble betaine of the formula

\[
R_1 - N - R_2 - CO^+ \\
R_3 \quad \text{wherein } R_1 \text{ is a saturated divalent hydrocarbon radical, } R_2 \text{ and } R_3 \text{ are saturated aliphatic hydrocarbon radicals, and } R_4 \text{ is an uncharged aliphatic radical taken from the group consisting of hydrocarbon radicals and ether oxygen-, hydroxyl-, and carbonyl-substituted hydrocarbon radicals, } R_4 \text{ being free of substituents that promote the emulsification of said liquid hydrocarbon with water, } \text{ said betaine containing from about 11 to about 35 carbon atoms.}
\]

2. The composition of claim 1 containing an antistatic quantity of from 0.5 to 15.0 lbs. of said betaine per 1000 barrels of said liquid hydrocarbon.

3. A liquid hydrocarbon boiling in the distillate fuel range containing an antistatic quantity of from 0.1 to 30.0 pounds per 1000 barrels of said liquid hydrocarbon of a hydrocarbon-soluble betaine of the formula

\[
R_3 \quad \text{wherein } x \text{ is an integer within the range of } 0 \text{ to } 1, R \text{ is an aliphatic hydrocarbon radical, } R_3 \text{ is a saturated divalent hydrocarbon radical, and } R_3 \text{ and } R_4 \text{ are saturated aliphatic hydrocarbon radicals, said betaine containing from about } 11 \text{ to about } 35 \text{ carbon atoms.}
\]

4. The composition of claim 3 wherein the liquid hydrocarbon contains from 0.5 to 15.0 lbs. of said betaine per 1000 barrels of said liquid hydrocarbon.

5. A jet fuel liquid hydrocarbon boiling in the distillate fuel range containing from 0.1 to 30.0 lbs. per 1000 barrels of said jet fuel of N-lauryl-N,N-dimethyl glycine.

6. The composition of claim 5 containing an antistatic quantity of from 0.5 to 15.0 lbs. of said betaine per 1000 barrels of said liquid hydrocarbon.

7. An antistatic additive for liquid hydrocarbons boiling in the distillate fuel range, (1) a liquid hydro-
carbon carrier and (2) from 20-60% by weight of said carrier of a hydrocarbon-soluble betaine of the formula

\[ R_1^{\text{+}} - R_4 - R_3 - \text{CO}^- \]

wherein \( R_4 \) is a saturated divalent hydrocarbon radical, \( R_2 \) and \( R_3 \) are saturated aliphatic hydrocarbon radicals, and \( R_4 \) is an uncharged aliphatic radical taken from the group consisting of hydrocarbon radicals and ether oxygen-, hydroxyl-, and carbonyl-substituted hydrocarbon radicals, \( R_4 \) being free of substituents that promote the emulsification of said liquid hydrocarbon with water, said betaine containing from about 11 to about 35 carbon atoms.

8. The additive of claim 7 wherein the liquid hydrocarbon carrier is xylene.

9. The additive of claim 7 wherein the liquid hydrocarbon carrier is kerosene.

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2,886,423 Vitalis May 12, 1959
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