As indicated above it appears that substantially any organic amine or mixtures of such amines are suitable for the practice of the invention, provided
(a) That the amine or amine mixture is miscible with the balance of the explosive so that it does not segregate substantially therein;
and
(b) That the amine or amine mixture is sufficiently basic to form salts with weak acids (either organic or inorganic), for example such acids as phosphoric, acetic, carbonic, sulphurous and nitrous, these being "weak acids" within the meaning of this specification and claims.

The amines having the above qualifications may be selected from either the aliphatic or aromatic groups. Examples of suitable organic amines found particularly satisfactory are:

In the aromatic group, aniline, diphenylethylenediamine and phenylbetalaminomethylamine;
In the aliphatic group, diethylamine, tetraethylpentamine, and morpholine.

The aliphatic amines, particularly diethylamine, have been found to be especially effective. Its amine-nitromethane has a phenomenal effect of increasing enormously the explosive power of nitromethane. Small percentages of any of these amines, around 2% by volume, when added to the nitromethane produce an explosive which is sensitive enough to be detonated by a standard No. 8 blasting cap even though the material is placed in an open thin-walled container. Such a mixture of amine-nitromethane will propagate the explosion through the liquid even when placed in thin-walled containers such as light metal tubing or pipe.

When nitromethane is detonated it appears to possess explosive properties which are comparable to trinitrotoluene, nitromethane having a higher velocity of detonation and higher brilliance than has been observed when an equivalent charge of trinitrotoluene is exploded. The effectiveness of the amine-nitromethane mixtures is clearly demonstrated by comparative tests in which trinitrotoluene is employed as a standard. All of these tests demonstrate that there is a great increase in the explosive power of these mixtures over that of trinitrotoluene.

The addition of approximately 2% by volume of any of the above amines to nitromethane appears sufficient to release a large proportion of the total energy of the nitromethane when the mixture is detonated. The percentages of amine which will produce this desired result vary from a trace to about 40% by volume of the amine.

A comparison of the explosive strengths of these nitromethane-amine mixtures has been made and compared with the explosive strength of an equivalent amount of trinitrotoluene. Tests were conducted employing a modified version of the Trauzl lead block expansion test.

The test is conducted briefly as follows: A solid lead cylinder 200 mm. in height and 200 mm. in diameter is bored with an axial hole in one end which is 25 mm. diameter and 125 mm. deep. When the routine manner of conducting the test is followed, 10 grams of the explosive to be tested are placed in the axial hole and a detonating cap is immersed in the explosive. It is customary to pack sand into the open end of the axial hole after the explosive and the cap have been introduced into the hole. The lead blocks are then allowed to reach room temperature (15° to 20° C.) before the charge is fired.

In conducting my investigation the Trauzl test was modified so that 15 grams of the explosive mixture were employed in place of the customary 10 gram charge. The use of 15 gram charges is desirable to insure a sufficient depth of liquid or explosive so as to enable the explosive to cover a No. 8 blasting cap. The following results demonstrate the difference in explosive violence between
A cross section view taken through the center of the lead blocks after the explosion, strikingly brings out the difference between the action of the various explosives. Trinitrotoluene produces a pear-shaped cavity showing some enlargement of the upper end of the bored hole, whereas a nitromethane-amine mixture produces a nearly spherical cavity showing very little increase in the upper portion of the bore. This appears to indicate that the detonating velocity of the nitromethane-amine mixture is higher than the detonating velocity of trinitrotoluene.

The relative force of the explosion as produced by the various mixtures may be compared to trinitrotoluene by means of a Brinnell type of apparatus. This test will be more easily understood with reference to the accompanying drawing which shows the Brinnell type of apparatus that was employed in obtaining these data.

Referred to the figure above 10 is provided with an annular collar 11 which is firmly attached to the base. A cylindrical block 12 is machined so that it fits loosely into an annular collar 11 and is axially drilled for a suitable distance by a bore 13 to fit a second solid cylindrical block 14. The bottom of the block 13 is machined so that it has a central hemispherical depression 15 suitable for seating a 3/4" hardened steel ball bearing 16. The base 10 is slotted with a rectangular depression 17 into which a mild steel bar 17 is placed. The ball 15 is so placed that it rests centrally on the surface of the mild steel bar 17. A firing block 18 of the same diameter as the second solid cylindrical block 14 is placed upon the top of the cylinder 14. An axil hole 19 is drilled into the firing block 18 and extends a substantial distance into the block. 1.2 grams of the explosive to be tested are placed in hole 19 and a No. 8 detonating cap, which is preferably fired by electrical contact, is submerged in the explosive. When the charge is fired a portion of the force exerted by the explosion is in a downward direction and the effect of this downward force is measured by the size of the indentation made by the hardened steel ball 15 on the mild steel bar 17. It is desirable to employ the solid cylinder 14 between the cylinder 12 and the cylinder 18 because the explosives which are the subject of my invention usually shatter the testing cylinder 18 into small fragments. Hence, unless some means were taken to protect the block 12 from the bursting force of the explosion no positive indication could be obtained of the effective downward force of the explosion in the cylinder 18.

Meanwhile this apparatus attempts to record the downward thrust of the explosion occurring in the thick-walled cylinder it must be remembered that the results obtained are not indicative of the total force generated by the explosion of the mixture since a large portion of the force generated by the nitromethane-amine mixture is apparently employed in bursting the steel cylinders. Trinitrotoluene usually causes deformation of the test cylinder 18 but does not break it up into small fragments. The test gives, however, some indication of the comparative force of the various nitro-methane-amine explosive mixtures with respect to trinitrotoluene.

The following is a tabulation of the comparative results obtained by this test method. In performing the following test 17.2 grams of samples were used in each case.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Test Sample</th>
<th>Volume of Citrullin</th>
<th>Percent Expanse</th>
<th>Original</th>
<th>After Firing</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 gr. trinitrotoluene</td>
<td>60</td>
<td>397</td>
<td>96</td>
<td>297</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>15 gr. nitromethane 97%</td>
<td>60</td>
<td>567</td>
<td>910</td>
<td>307</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>15 gr. nitromethane 95%</td>
<td>50</td>
<td>445</td>
<td>890</td>
<td>395</td>
<td>40</td>
</tr>
</tbody>
</table>

The indentation caused by exploding trinitrotoluene is used as a standard of comparison.

Mixture explosive: Average diameter—in inches

<table>
<thead>
<tr>
<th>Mixture Explosive</th>
<th>Average Diameter—In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trinitrotoluene</td>
<td>96</td>
</tr>
<tr>
<td>Nitromethane</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +2% aniline</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +4% aniline</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +6% aniline</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +2% diethylamine</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +4% diethylamine</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +6% diethylamine</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +2% tetraethylpentamine</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +4% tetraethylpentamine</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +4% morpholine</td>
<td>91</td>
</tr>
<tr>
<td>Nitromethane +4% morpholine</td>
<td>91</td>
</tr>
</tbody>
</table>

As noted above all of the mixtures of nitromethane plus an amine ruptured the test cylinder when exploded. Therefore, the above results for the nitromethane-amine mixture are only approximate and probably low.

It has been observed that when higher percentages than 2%-3%, by weight, of the amines are added to nitromethane they appreciably increases its sensitivity to detonation. 

Test mixtures employing diethylamine, morpholine, tetraethylpentamine in percentages varying from 1% to 5% of the amine by volume have been tried and all of these mixtures detonate violently. When, however, the percentage of aliphatic amines was increased above 15% of the mixture detonation failures have occurred.

As I have already indicated when mixtures of nitromethane and the above-listed amines are employed, limited amounts of other nitroparaffins, such as nitroethane and nitropropene, may be added to the nitromethane. The resulting mixtures have also been made to explode violently in open thin-walled containers when exposed to the shock of a No. 8 blasting cap. For example, as high as 30% by volume of the nitroethane may be employed in a mixture containing 3% tetraethylpentamine and 67% nitromethane by volume before any failure in detonation occurs. 2-nitropropane may be substituted in place of the nitroethane and this mixture will also explode in open thin-walled containers from the shock of a No. 8 blasting cap. However, the amount of nitropropane which may be employed before detonation failures will result is considerably less than the amount of nitroethane. For example, it has been observed that 15% by volume of nitropropane mixed with 3% tetraethylpentamine and 82% nitromethane will detonate, whereas, a mixture containing an amount greater than 15% by volume of nitropropane detonates with great difficulty, if at all.

It has been observed that those mixtures in which a portion of the nitromethane is replaced by nitroethane or nitropropane do not appear to exhibit any more explosive power than the amine-nitromethane mixtures and produce a considerably more viable flame which is not damaged by a nearby violent explosion of the same mixture. These amine-nitromethane explosives appear to be very stable and do not lose their explosive properties on relatively substantial aging or heating to the boiling point. At somewhat higher temperatures than atmospheric the sensitivity of the...
mixtures increases slightly but the explosive power of the mixture is not appreciably affected in any manner.

An outstanding advantage of my explosive resides in the fact that the ingredients may be either mixed beforehand and transported to the place where they are to be used, or the relatively stable components may be transported to the desired locality and mixed shortly before they are to be employed. This relative freedom from shock sensitivity coupled with the extremely high explosive power when the mixture is detonated, produces an explosive compound which may be employed under all types of adverse conditions without subjecting the operator to undue hazards of premature explosions.

Another advantage is that the nitromethane may contain some water without noticeably affecting the explosive properties of the amine-nitromethane mixtures.

I claim:

1. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2%–3% by volume of diethylamine based on the volume of the nitromethane.

2. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2% by volume of tetraethylpentamine based on the volume of the nitromethane.

3. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2% by volume of morpofiline based on the volume of the nitromethane.

4. An explosive composition consisting of a mixture of mononitromethane sensitized with about 2% by volume of aniline based on the volume of the nitromethane.

5. An explosive composition consisting of a mixture of mononitromethane sensitized with 2% by volume of diphenylethlenediamine based on the volume of the nitromethane.

6. An explosive composition consisting of a mixture of mononitromethane sensitized with 2% by volume of phenylbenanaphthylamine based on the volume of the nitromethane.

7. An explosive composition consisting of a mixture of mononitromethane sensitized with from 2 to 3% by volume of the amines from the group consisting of aniline, diphenylethlenediamine, phenylbenanaphthylamine, diethylamine, tetraethylpentamine and morpofiline, based on the volume of the mononitromethane.

8. An explosive composition consisting of a mixture of mononitromethane sensitized with from 2 to 3% by volume of the amines from the group consisting of aniline, diphenylethlenediamine, phenylbenanaphthylamine, diethylamine, tetraethylpentamine and morpofiline, based on the volume of the mononitromethane.

9. An explosive consisting of 97% by weight of mononitromethane and 3% by weight of aniline.

10. An explosive consisting of a predominant proportion of mononitromethane and a minor proportion of morpofiline.

11. An explosive consisting of a predominate proportion of mononitromethane and a minor proportion of an organic amine which is miscible with the mononitromethane and is sufficiently basic to react with weak acids.

12. An explosive consisting of mononitromethane and an organic amine in proportions ranging from a trace to 40% by volume of the mononitromethane, the amine being miscible with the remainder of the explosive and sufficiently basic to form salts with weak acids.

13. An explosive according to claim 12 in which the amine is an aromatic compound.

14. An explosive according to claim 12 in which the amine is an aliphatic compound.

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