



(86) Date de dépôt PCT/PCT Filing Date: 2001/06/29  
(87) Date publication PCT/PCT Publication Date: 2002/01/10  
(45) Date de délivrance/Issue Date: 2009/02/17  
(85) Entrée phase nationale/National Entry: 2002/12/19  
(86) N° demande PCT/PCT Application No.: US 2001/021072  
(87) N° publication PCT/PCT Publication No.: 2002/001958  
(30) Priorité/Priority: 2000/06/30 (US60/215,571)

(51) Cl.Int./Int.Cl. *A01N 59/14* (2006.01),  
*A01N 33/16* (2006.01), *A01N 37/20* (2006.01),  
*A01N 43/60* (2006.01), *A01N 43/84* (2006.01),  
*B27K 3/52* (2006.01), *B27K 5/00* (2006.01)  
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(54) Titre : COMPOSITIONS A BASE D'UN COMPOSE DU BORE ET D'UN OXYDE D'AMINE  
(54) Title: COMPOSITIONS COMPRISING A BORON COMPOUND AND AN AMINE OXIDE

(57) **Abrégé/Abstract:**

The present invention provides a composition comprising an amine oxide and a boron compound. The boron compound may be boric acid, diboron tetrahydroxide, a borate, a boron oxide, a borane, or any combination of any of the foregoing. Another embodiment of the present invention is a method for preserving and/or waterproofing a wood substrate by contacting the composition with the wood substrate. Yet another embodiment of the present invention is a method for controlling plants, insects, or fungi or regulating the growth of plants comprising applying an insecticidal, herbicidal, fungicidal, or plant growth regulating effective amount of a composition of the present invention to the plants, fungi, insects, the seeds of the plants, or the area on which the plants or fungi grow.



## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
10 January 2002 (10.01.2002)

PCT

(10) International Publication Number  
**WO 02/01958 A3**(51) International Patent Classification<sup>7</sup>: **A01N 59/14**,  
B27K 3/52 // (A01N 59/14, 37:20, 33:16)

(21) International Application Number: PCT/US01/21072

(22) International Filing Date: 29 June 2001 (29.06.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
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— with international search report

(88) Date of publication of the international search report:  
30 May 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: COMPOSITIONS COMPRISING A BORON COMPOUND AND AN AMINE OXIDE

(57) Abstract: The present invention provides a composition comprising an amine oxide and a boron compound. The boron compound may be boric acid, diboron tetrahydroxide, a borate, a boron oxide, a borane, or any combination of any of the foregoing. Another embodiment of the present invention is a method for preserving and/or waterproofing a wood substrate by contacting the composition with the wood substrate. Yet another embodiment of the present invention is a method for controlling plants, insects, or fungi or regulating the growth of plants comprising applying an insecticidal, herbicidal, fungicidal, or plant growth regulating effective amount of a composition of the present invention to the plants, fungi, insects, the seeds of the plants, or the area on which the plants or fungi grow.



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**COMPOSITIONS COMPRISING A BORON COMPOUND**  
**AND AN AMINE OXIDE**

**FIELD OF THE INVENTION**

10           This invention relates to wood preservative and waterproofing compositions and insecticidal, herbicidal, fungicidal, and plant growth regulating compositions containing an amine oxide and a boron compound.

**BACKGROUND OF THE INVENTION**

15           Many boron compounds, including borates, are known to be effective as wood preservatives. However, since borates are water soluble, they often leach out of wood substrates resulting in increased susceptibility to insects and fungi.

          Various boron compounds are also known to be effective as insecticides, herbicides, fungicides, and plant growth regulating agents. These compounds, however,  
20   often do not disperse well when applied to plants and fungi. Therefore, greater concentrations of borates are frequently incorporated into such compositions.

          There is a continuing need for improved boron compound containing wood preservatives and waterproofing compositions which have improved leach resistance and improved penetration and distribution into wood substrates. Also, there is a need for boron  
25   compound containing insecticidal, herbicidal, fungicidal, and plant growth regulating compositions which improve the efficacy of the boron compound and improve the dispersion of the boron compound when applied to plants and fungi.

**SUMMARY OF THE INVENTION**

30           Applicants have discovered that amine oxides enhance the performance of boron compounds as wood preservatives, provide waterproofing properties, and improve the leach resistance of wood substrates to which they are applied. Also, amine oxides improve the efficacy of boron compounds as insecticides, herbicides, fungicides, and plant

growth regulating agents and provide better dispersion of the boron compounds when applied to plants and fungi. The present invention provides a composition comprising an amine oxide and a boron compound. Preferred amine oxides include, but are not limited to, dodecyldimethylamine oxide, tridecyldimethylamine oxide, tetradecyldimethyl amine oxide, pentadecyldimethylamine oxide, or hexadecyldimethylamine oxide. The boron compound may be boric acid, diboron tetrahydroxide, a borate, a boron oxide, a borane or any combination of the foregoing. Preferably, the composition comprises boric acid, a borate, a salt of a borate, or a mixture of boric acid and a borate or a salt thereof.

Another embodiment of the present invention is a method for preserving and/or waterproofing a wood substrate by contacting the composition with the wood substrate.

Yet another embodiment is an article comprising a wood substrate and the composition of the present invention.

According to another embodiment of the invention, a method for controlling plants, insects, or fungi or regulating the growth of plants is provided comprising applying an insecticidal, herbicidal, fungicidal, or plant growth regulating effective amount of the composition of the present invention to the plants, fungi, insects, the seeds of the plants, or the area on which the plants or fungi grow.

In another embodiment the invention provides a use of the composition of the invention as disclosed herein as a wood preservative. In another embodiment the composition of the invention can be used as a water proofer.

### **DETAILED DESCRIPTION OF THE INVENTION**

The present invention provides a composition comprising an amine oxide and a boron compound. The amine oxide enhances penetration of the boron compound into wood substrates and improves leach resistance. Also, the amine oxide enhances the efficacy of the boron compound as an insecticide, herbicide, fungicide, and plant growth regulating agent. The compositions of the present invention have high water solubility and/or dispersibility and low volatility.

The amine oxide may be a trialkylamine oxide; an alkylcyclicamine oxide; a dialkylpiperazine di-N-oxide; an alkyl-di(ethoxylated oxyalkyl)amine oxide; a dialkylbenzylamine oxide; a fatty dimethylaminopropylamine oxide; a diamine oxide; a triamine oxide; and any combination of any of the foregoing.

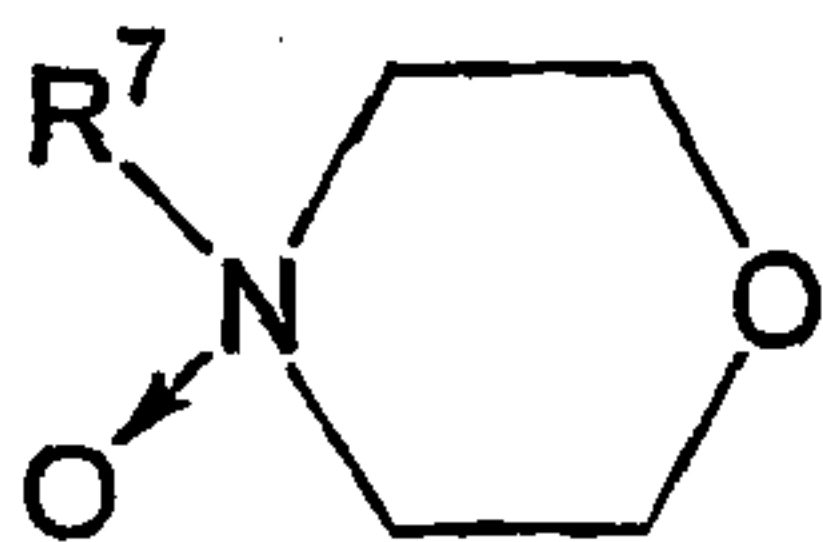
Preferred trialkylamine oxides have the formula  $R^1R^2R^3N\rightarrow O$ , where  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $R^2$  and  $R^3$  independently are linear, branched, or any combination thereof  $C_1$  to  $C_{40}$  alkyl groups.  $R^1$ ,  $R^2$ , and  $R^3$  independently may be alkyl, alkenyl, or alkynyl groups. More preferably,  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group, such as coco, hydrogenated tallow, soya, decyl, and hexadecyl; and  $R^2$  and  $R^3$  independently are linear, branched, or any combination thereof  $C_1$  to  $C_{22}$  alkyl groups, such as coco, hydrogenated tallow, soya, decyl, and hexadecyl.

A preferred trialkylamine oxide is a dialkylmethanamine oxide having the formula  $R^1R^2CH_2N\rightarrow O$ , where  $R^1$  and  $R^2$  are defined as above. Another preferred trialkylamine oxide is an alkyldimethanamine oxide having the formula  $R^1(CH_2)_2N\rightarrow O$ , where  $R^1$  is defined as above. Suitable alkyldimethanamine oxides include, but are not limited to, a  $C_{10}$  alkyldimethanamine oxide, a  $C_{12}$ - $C_{14}$  alkyldimethanamine oxide, a  $C_{16}$ - $C_{18}$  alkyldimethanamine oxide, and any combination of any of the foregoing. According to a preferred embodiment, the alkyldimethyl amine oxide is a  $C_{12}$ - $C_{16}$  alkyldimethyl amine oxide and more preferably a  $C_{12}$  or  $C_{16}$  alkyldimethyl amine oxide.

Preferred alkylcyclicamines oxide have the formula  $R^4R^5R^6N\rightarrow O$  where  $R^4$  is defined as  $R^1$  above and  $R^5$  and  $R^6$  are linked to form a cyclic group. The cyclic group typically contains from 4 to 10 carbon atoms and may optionally contain oxygen, sulfur, nitrogen, or any combination of any of the foregoing. More preferred alkylcyclicamine oxides include, but are not limited to, an alkylmorpholine-oxide, a dialkylpiperazine di-N-oxide, and any combination of any of the foregoing.

Preferred alkylmorpholine-oxides have the formula

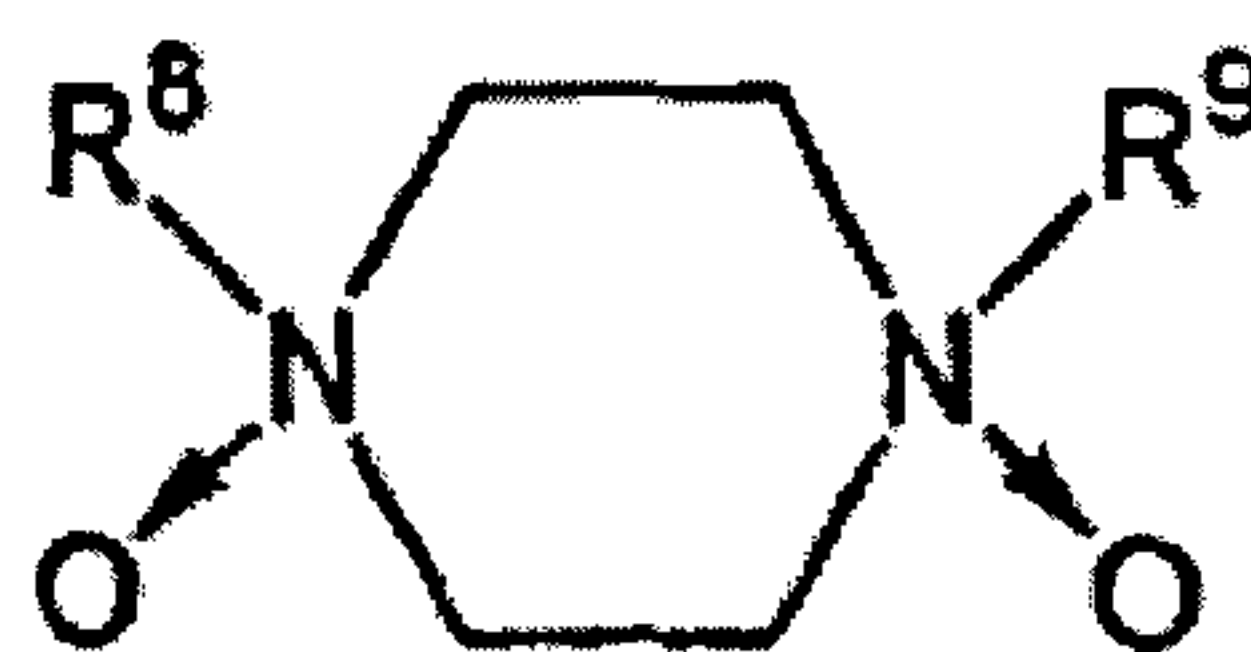
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where  $R^7$  is defined as  $R^1$  above.

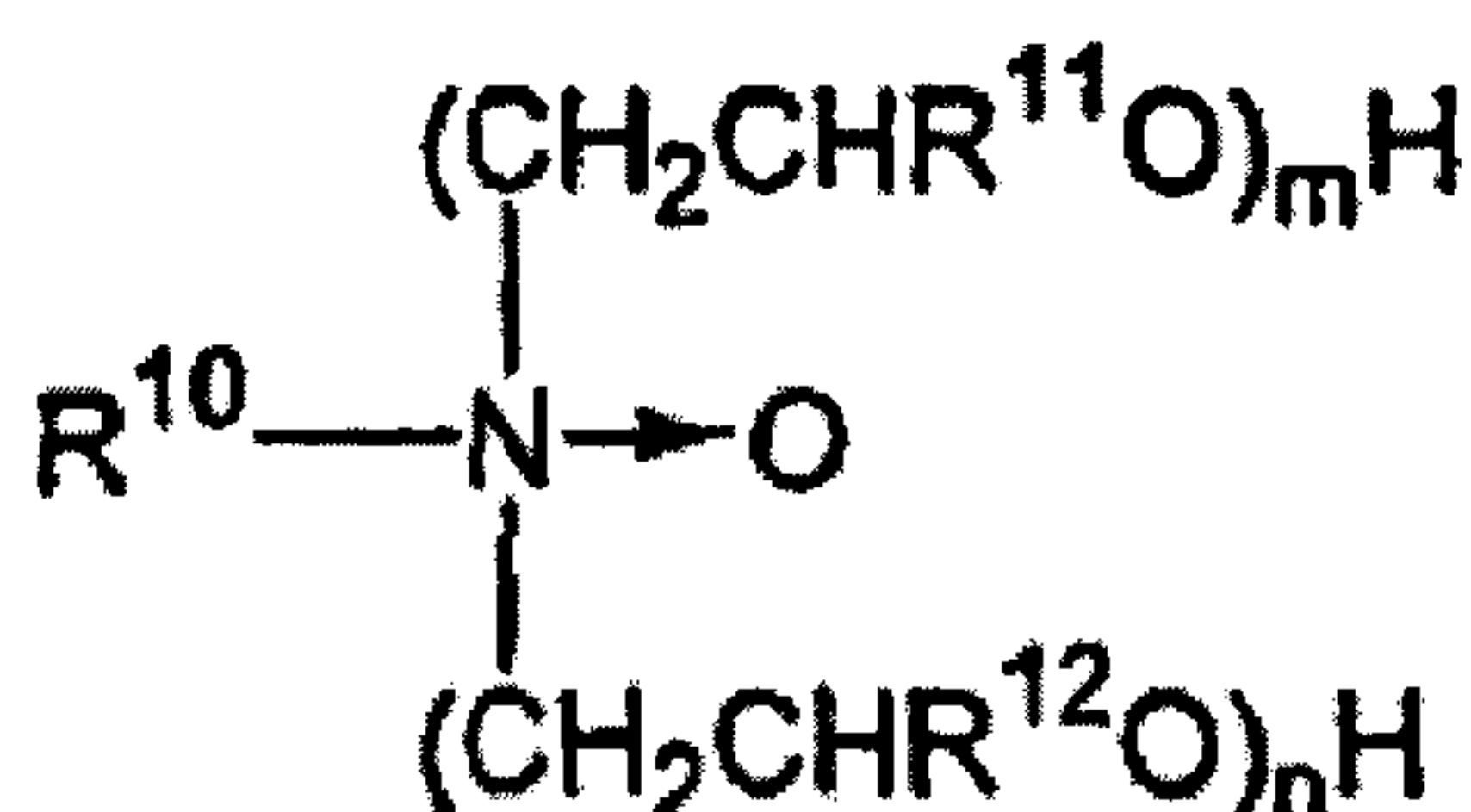
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Preferred dialkylpiperazine di-N-oxides have the formula



- 5 where  $R^8$  is defined as  $R^1$  above and  $R^9$  is defined as  $R^2$  above.

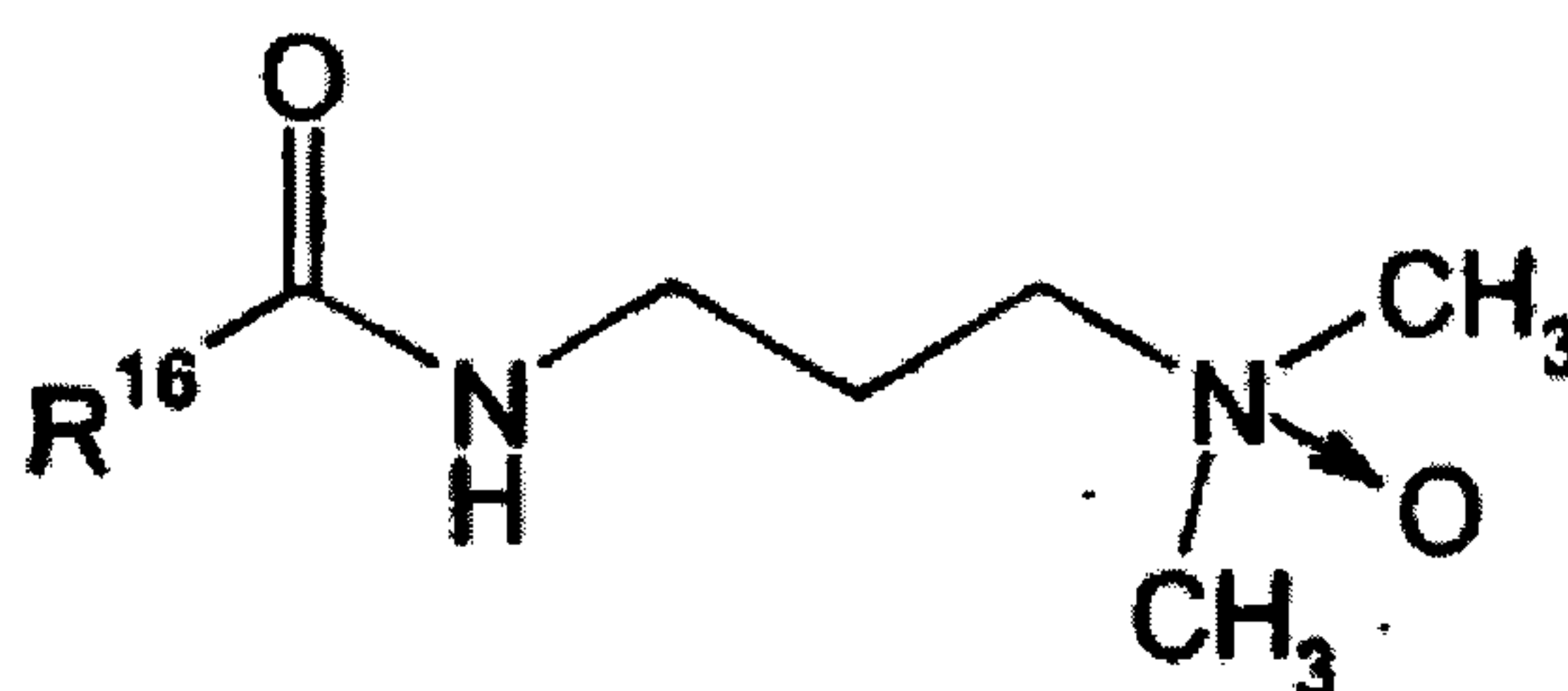
Preferred alkyl-di(ethoxylated oxyalkyl)amine oxides have the formula



- 10 where  $R^{10}$  is defined as  $R^1$  above;  $R^{11}$  and  $R^{12}$  independently are H or  $CH_3$ ; and m and n independently are integers from 1 to 10.

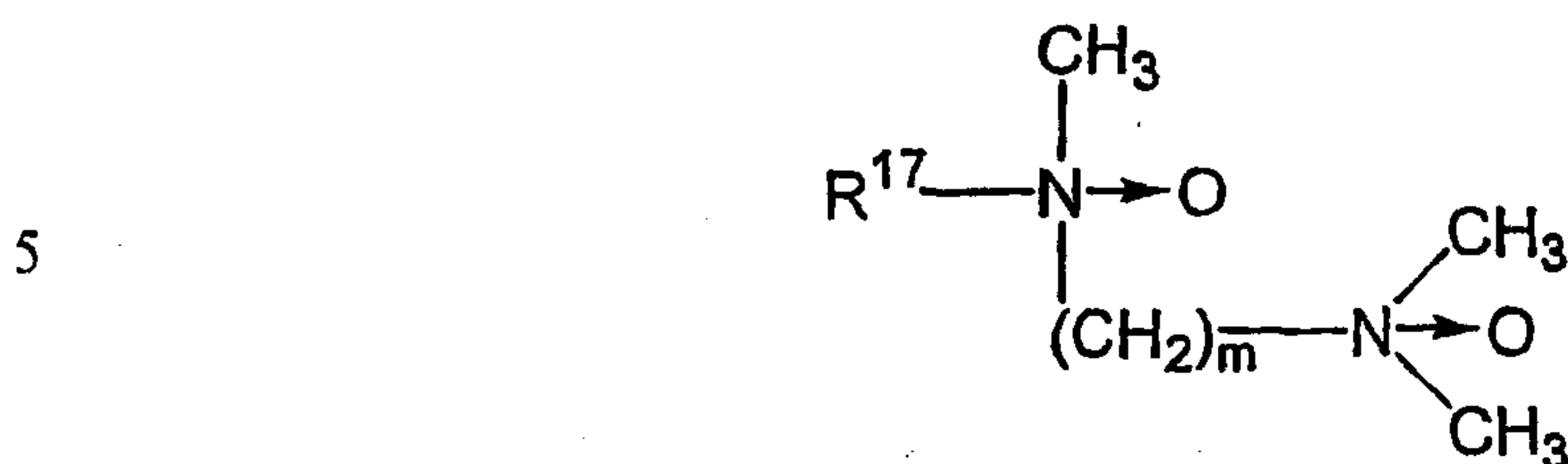
- Preferred dialkylbenzylamine oxides have the formula  $R^{13}R^{14}R^{15}N \rightarrow O$ , where  $R^{13}$  is defined as  $R^1$  above;  $R^{14}$  is defined as  $R^2$  above; and  $R^{15}$  is benzyl. More preferred dialkylbenzylamine oxides include, but are not limited to, alkylbenzylmethylamine oxides having the formula  $R^{13}R^{15}CH_3N \rightarrow O$  where  $R^{13}$  and  $R^{15}$  are defined as above.

Preferred fatty dimethylaminopropylamine oxides have the formula



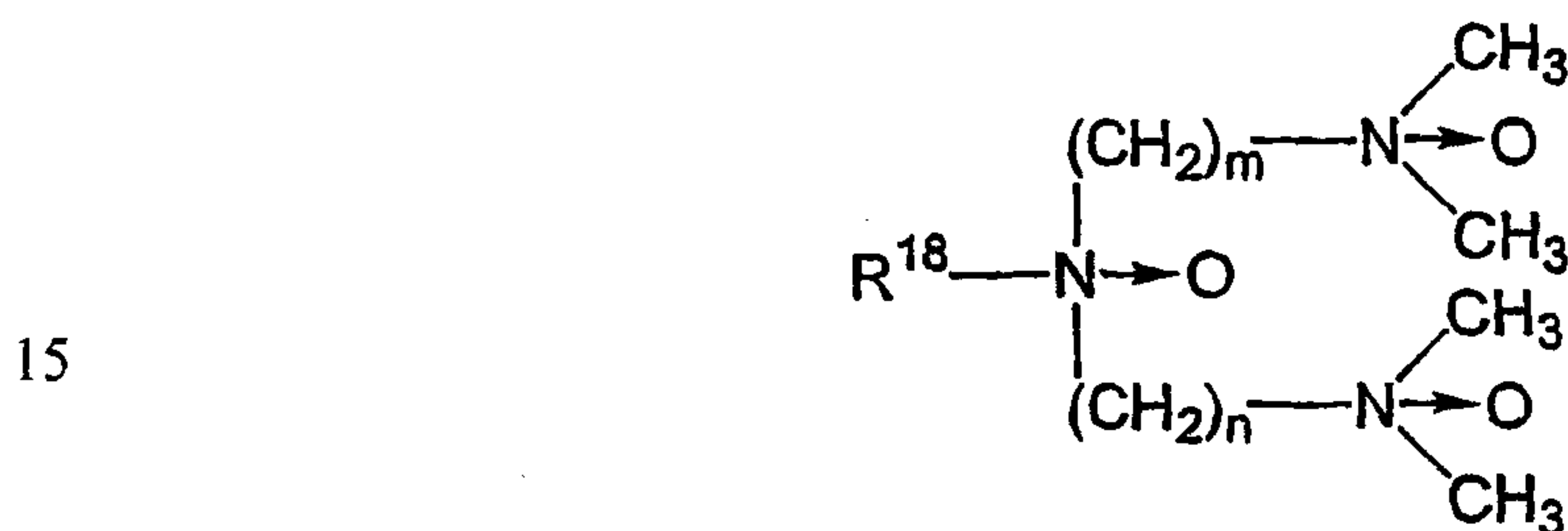
where  $R^{16}$  is defined as  $R^1$  above.

Preferred diamine oxides have the formula



where  $\text{R}^{17}$  is defined as  $\text{R}^1$  above; and  $m$  is an integer from 1 to 10.

10 Preferred triamine oxides have the formula



where  $\text{R}^{18}$  is defined as  $\text{R}^1$  above; and  $m$  and  $n$  independently are integers from 1 to 10.

20 Long chain ( $\text{C}_{16}$  or greater) amine oxides, such as hexadecylamine oxides and hydrogenated tallow amine oxides, are particularly preferable for imparting waterproofing properties to the composition. Short chain ( $\text{C}_{14}$  and shorter) amine oxides aid in solubilizing the boron compound and long chain amine oxides.

25 The boron compound may be boric acid, diboron tetrahydroxide, a borate, a boron oxide, a borane, or any combination of any of the foregoing. Suitable boron compounds, include, but are not limited to, boranes and borate esters that produce oxides of boron in aqueous media. In a preferred embodiment, the boron compound is boric acid, a borate (*e.g.*, basic sodium borate (borax)), or a mixture of boric acid and a borate.

30 Suitable borates include, but are not limited to, perborates, metaborates, tetraborates, octaborates, borate esters, and any combination of any of the foregoing. Preferred borates include, but are not limited to, metallic borates (*e.g.*, sodium borate, zinc borate and potassium borate), such as disodium tetraborate decahydrate, disodium octaborate tetrahydrate, sodium metaborate, sodium perborate monohydrate, disodium octaborate, sodium tetraborate pentahydrate, sodium tetraborate, copper metaborate, zinc

borate, barium metaborate, and any combination of any of the foregoing; bis(2-aminoethyl) borate; and any combination of any of the foregoing. More preferably, the borate is disodium octaborate tetrahydrate, available as Tim-Bor™ from U.S. Borax Inc. of Valencia, CA. A preferred boron oxide is boric oxide.

5               The composition may include a solvent, such as water and water miscible solvents, including, but not limited to, alcohols; glycols, such as ethylene glycol; esters; ethers; polyethers; and any combination of any of the foregoing. Compositions of the present invention containing boranes and/or borate esters preferably also contain water in order to hydrolyze them to produce oxides of boron.

10              The weight ratio of amine oxide to boron compound broadly ranges from 1:50 to 50:1 and preferably from 1:5 to 5:1.

                According to one embodiment of the invention, the composition in concentrated form contains broadly from 1 to 100%, preferably from 10 to 30%, and more preferably from 10 to 30% by weight of combined amine oxide and boron compound  
15   based upon 100% weight of total composition.

                Wood preservative and/or waterproofing use dilutionsofthe composition typically comprise a biocidally effective amount of boron compound and a preservative enhancing and/or waterproofing effective amount of the amine oxide. Wood preservative and/or waterproofing use dilutions preferably comprise from 0.5 to 2% by weight of amine  
20   oxide and from 0.5 to 2% by weight of boron compound based upon 100% weight of total composition.

                Insecticidal, herbicidal, fungicidal, and/or plant growth regulating use dilutions of the composition typically comprise an insecticidal, herbicidal, fungicidal, and/or plant growth regulating effective amount of the boron compound and an  
25   insecticidal, herbicidal, fungicidal, and/or plant growth regulating enhancing effective amount of the amine oxide. Insecticidal, herbicidal, fungicidal, and/or plant growth regulating use dilutions preferably comprise from 0.01 to 10% by weight of amine oxide and from 0.01 to 5% by weight of boron compound based upon 100% weight of total use dilution.

30              Other adjuvants may be included in the composition as known to one of ordinary skill in the art.

                Another embodiment of the present invention is a method for preserving and/or waterproofing a wood substrate by contacting the composition of the present

invention with the wood substrate. The composition may be applied to the wood substrate by any method known to one of ordinary skill in the art including, but not limited to, brushing, dipping, soaking, vacuum impregnation, and pressure treatment using various cycles.

5 Yet another embodiment of the present invention is a method for controlling plants, insects, or fungi or regulating the growth of plants comprising applying an insecticidal, herbicidal, fungicidal, or plant growth regulating effective amount of the composition of the present invention to the plants, fungi, insects, the seeds of the plants, or the area on which the plants or fungi grow. The composition of the present invention may  
10 be applied to the plants, fungi, insects, the seeds of the plants, or the area on which the plants or fungi grow by any method known to one of ordinary skill in the art including, but not limited to, spraying.

Generally the composition of the present invention is applied at a rate ranging from 1 to 1,000 g/ha (grams/hectare) to plants or fungi, the seeds of the plants,  
15 and/or the area on which the plants or fungi grow.

The composition of the present invention may be prepared by mixing the boron compound, amine oxide, solvents, and adjuvants. The mixture may be heated and/or stirred to expedite mixing.

The following example illustrates the invention without limitation. All parts  
20 and percentages are given by weight unless otherwise indicated. The abbreviation "DMAO" stands for dimethylamine oxide.

#### Example

##### Evaluation of Penetration of Borate-Amine Oxide Formulations

Pieces of permeable southern pine, impermeable Douglas Fir, and  
25 intermediately permeable Hem-Fir were treated with solutions containing (i) 2 or 5% by weight of a boron compound (*i.e.*, Tim-Bor™, borax or boric acid) and optionally (ii) 0.4 or 1% by weight of Barlox® 12 or a mixture of Barlox® 16S and Barlox® 12. Tim-Bor™ is a 98% solution of disodium octaborate tetrahydrate available from U.S. Borax Inc. of Valencia, CA. Barlox® 12 is an aqueous solution containing 30% by weight of  
30 dodecyldimethylamine oxide available from Lonza Inc. of Fair Lawn, NJ. Barlox® 16S is an aqueous solution containing 30% by weight of hexadecyl dimethylamine oxide available from Lonza Inc.

End-matched samples of each type of wood were prepared by cutting 2" by 4" boards into 8" lengths. One end of each sample was coated with epoxy to preclude penetration of the treating solutions.

The samples were treated with the solutions by either dipping them into the solution or by vacuum impregnation as indicated in Tables 1 through 4 below. Immediately after treatment, the samples were cut in half and sprayed with an indicator solution, which was a mixture of curcumin and salicylic acid, to monitor borate penetration. The penetration was measured. At weekly intervals thereafter, approximately 1/8" was removed from the cut ends of the samples and penetration was reevaluated with the indicator spray. In some cases, the indicator spray gave very light, diffuse color changes that were difficult to interpret.

The treating solutions tested and their results are shown in Tables 1 through 4 below.

Table 1

| Treating Solution                                                                                             | Species of Wood | Penetration (mm) at Day |    |    |    |    |
|---------------------------------------------------------------------------------------------------------------|-----------------|-------------------------|----|----|----|----|
|                                                                                                               |                 | 0                       | 8  | 14 | 22 | 29 |
| 2% Borax                                                                                                      | Southern Pine   | 2                       | 10 | 11 | 12 | 15 |
| 2% Borax and<br>0.4% Dodecyl DMAO                                                                             | Southern Pine   | 2                       | 10 | 19 | 19 | 19 |
| 2% Borax and<br>0.4% of total Dodecyl DMAO and<br>Hexadecyl DMAO (at a weight ratio of<br>2:5)                | Southern Pine   | 1                       | 12 | 19 | 19 | 19 |
| 2% Boric Acid                                                                                                 | Hem-Fir         | 0                       | 5  | 6  | 7  | 7  |
| 2% Boric Acid and<br>0.4% Dodecyl DMAO                                                                        | Hem-Fir         | 1                       | 6  | 7  | 9  | 8  |
| 2% Boric Acid – Bx16/12                                                                                       | Hem-Fir         | 2                       | 7  | 8  | 9  | 9  |
| 2% Tim-Bor <sup>®</sup> (active)                                                                              | Douglas Fir     | 4                       | 5  | 4  | 7  | 8  |
| 2% Tim-Bor <sup>®</sup> (active) and<br>0.4% Dodecyl DMAO                                                     | Douglas Fir     | 2                       | 5  | 7  | 9  | 8  |
| 2% Tim-Bor <sup>®</sup> and<br>0.4% of total Dodecyl DMAO and<br>Hexadecyl DMAO (at a weight ratio of<br>2:5) | Douglas Fir     | 0                       | 3  | 2  | 3  | 3  |

For Tables 2 through 4 below, the following abbreviations have the following definitions:

BX - Aqueous solution containing 2% borax.

BXA1 - Aqueous solution containing 2% borax and 0.4% dodecyl DMAO.

BXA2 - Aqueous solution containing 2% borax and 0.4% of total dodecyl DMAO and hexadecyl DMAO at a weight ratio of 2:5.

5%-BX - Aqueous solution containing 5% borax.

5%-BXA1 - Aqueous solution containing 5% borax and 1% dodecyl DMAO.

5%-BXA2 - Aqueous solution containing 5% borax and 1% of total dodecyl DMAO and hexadecyl DMAO at a weight ratio of 2:5.

TB - Aqueous solution containing 2% Tim-Bor<sup>®</sup> (active).

TBA1 - Aqueous solution containing 2% Tim-Bor<sup>®</sup> and 0.4% dodecyl DMAO.

TBA2 - Aqueous solution containing 2% Tim-Bor<sup>®</sup> and 0.4% of total dodecyl DMAO and hexadecyl DMAO at a weight ratio of 2:5.

H - Aqueous solution containing 2% boric acid.

HA1 - Aqueous solution containing 2% boric acid and 0.4% dodecyl DMAO.

HA2 - Aqueous solution containing 2% boric acid and 0.4% of total dodecyl DMAO and hexadecyl DMAO at a weight ratio of 2:5.

NV - Not Visible

? - Questionable due to lightness

Table 2

Penetration Results (mm) for Southern Pine

| Treating Solution | Treatment Type | Treatment Time (min) | Penetration (mm) at Day |    |     |     |     |
|-------------------|----------------|----------------------|-------------------------|----|-----|-----|-----|
|                   |                |                      | 0                       | 8  | 14  | 22  | 29  |
| 5%-BXA1           | Vacuum         | 10                   | 2                       | 10 | All | 14  | All |
| 5%-BX             | Vacuum         | 10                   | 2                       | 10 | 11  | 12  | 15  |
| 5%-BXA2           | Vacuum         | 10                   | 1                       | 12 | All | All | All |
| 5%-BXA1           | Vacuum         | 10                   | 3                       | 10 | 8   | 14  | 15  |
| 5%-BX             | Vacuum         | 10                   | 3                       | 6  | 7   | 12  | 11  |
| 5%-BXA2           | Vacuum         | 10                   | 2                       | 8  | 9   | 13  | 15  |
| BXA1              | Vacuum         | 10                   | 4                       | 7  | 6   | 12  | 10  |
| BX                | Vacuum         | 10                   | 7                       | 10 | 11  | 13  | 14  |
| BX                | Vacuum         | 10                   | 3                       | 5  | 6   | 7   | 9   |
| BXA2              | Vacuum         | 10                   | 7                       | 8  | 9   | 11  | 11  |

| Treating Solution | Treatment Type | Treatment Time (min) | Penetration (mm) at Day |    |     |      |     |
|-------------------|----------------|----------------------|-------------------------|----|-----|------|-----|
|                   |                |                      | 0                       | 8  | 14  | 22   | 29  |
| BXA1              | Dip            | 6                    | NV                      | NV | NV  | -    | -   |
| BXA1              | Dip            | 6                    | NV                      | NV | NV  | -    | -   |
| BXA1              | Dip            | 6                    | NV                      | NV | NV  | -    | -   |
| BXA1              | Dip            | 30                   | NV                      | NV | NV  | NV   | NV  |
| TBA1              | Vacuum         | 10                   | 4                       | 6  | 6   | 9    | 7   |
| TB                | Vacuum         | 10                   | 3                       | 10 | 9   | All? | 12  |
| TBA2              | Vacuum         | 10                   | 3                       | 7  | 6   | 10   | 11  |
| TBA1              | Dip            | 3                    | NV                      | NV | NV  | -    | -   |
| TB                | Dip            | 3                    | NV                      | NV | 3?  | -    | -   |
| TBA1              | Dip            | 6                    | NV                      | NV | NV  | -    | -   |
| TB                | Dip            | 6                    | NV                      | 3  | NV  | -    | -   |
| TBA1              | Dip            | 30                   | NV2                     | NV | NV  | 2    | 2   |
| TBA2              | Dip            | 30                   |                         | 5  | 4   | 6    | 7   |
| HA1               | Vacuum         | 10                   | 5                       | 10 | 12  | 13   | 13  |
| H                 | Vacuum         | 10                   | 9                       | 9  | All | All  | All |
| HA2               | Vacuum         | 10                   | 5                       | 10 | 9   | 11   | 11  |
| HA1               | Dip            | 6                    | NV                      | NV | NV  | -    | -   |
| H                 | Dip            | 6                    | NV                      | NV | NV  | -    | -   |
| HA2               | Dip            | 6                    | NV                      | NV | NV  | -    | -   |

Table 3Penetration Results (mm) for Douglas Fir

| Treating Solution | Treatment Type | Treatment Time (min) | Penetration (mm) at Day |   |    |      |      |
|-------------------|----------------|----------------------|-------------------------|---|----|------|------|
|                   |                |                      | 0                       | 8 | 14 | 22   | 29   |
| BXA1              | Vacuum         | 10                   | NV                      | 1 | 2  | 3    | 3    |
| BX                | Vacuum         | 10                   | 3                       | 2 | 2  | 3    | 3    |
| BX                | Vacuum         | 10                   | NV                      | 2 | 2  | 3    | All? |
| BXA2              | Vacuum         | 10                   | 3                       | 2 | 2  | 3    | 3    |
| BXA1              | Dip            | 6                    | NV                      | 3 | 2  | 9    | 8    |
| BXA1              | Dip            | 6                    | NV                      | 1 | 5  | 9    | 7    |
| BXA1              | Dip            | 6                    | 1                       | 4 | 5  | 9    | 8    |
| BXA1              | Dip            | 30                   | 2                       | 4 | 6  | All? | 10   |
| TBA1              | Vacuum         | 10                   | NV                      | 2 | 2  | 3    | 4    |
| TB                | Vacuum         | 10                   | NV                      | 3 | 2  | 4    | 4    |
| TBA2              | Vacuum         | 10                   | NV                      | 3 | 3  | 3    | 4    |
| TBA1              | Dip            | 3                    | 4                       | 5 | 4  | 7    | 7    |
| TB                | Dip            | 3                    | NV                      | 2 | 4  | 7    | 8    |
| TBA1              | Dip            | 6                    | NV                      | 7 | 5  | 7    | 7    |
| TB                | Dip            | 6                    | 2                       | 4 | 5  | 7    | 8    |
| TBA1              | Dip            | 30                   | 2                       | 5 | 7  | 9    | 8    |
| TBA2              | Dip            | 30                   | NV                      | 3 | 2  | 3    | 3    |
| HA1               | Vacuum         | 10                   | NV                      | 4 | 3  | 3    | 3    |
| H                 | Vacuum         | 10                   | NV                      | 2 | 3  | 4    | 3    |
| HA2               | Vacuum         | 10                   | NV                      | 3 | 3  | 4    | 3    |
| HA1               | Dip            | 6                    | NV                      | 2 | 2  | 8    | 8    |
| H                 | Dip            | 6                    | 2                       | 5 | 4  | 9    | 8    |
| HA2               | Dip            | 6                    | NV                      | 7 | 5  | 10   | 8    |

Table 4

Sample Penetration Results (mm) for Hem-Fir

| Treating Solution | Treatment Type | Treatment Time (min) | Penetration (mm) at Day |    |    |      |      |
|-------------------|----------------|----------------------|-------------------------|----|----|------|------|
|                   |                |                      | 0                       | 8  | 14 | 22   | 29   |
| BXA1              | Vacuum         | 10                   | 1                       | 4  | 5  | 3    | 4    |
| BX                | Vacuum         | 10                   | 2                       | 4  | 4  | 4    | 4    |
| BX                | Vacuum         | 10                   | 2                       | 4  | 4  | 4    | 3    |
| BXA2              | Vacuum         | 10                   | NV                      | 2  | 3  | 3    | 3    |
| BXA1              | Dip            | 6                    | NV                      | NV | NV | -    | -    |
| BXA1              | Dip            | 6                    | NV                      | NV | NV | -    | -    |
| BXA1              | Dip            | 6                    | NV                      | NV | NV | -    | -    |
| BXA1              | Dip            | 30                   | NV                      | NV | 10 | All? | All? |
| TBA1              | Vacuum         | 10                   | NV                      | 1  | 2  | 5    | 3    |
| TB                | Vacuum         | 10                   | 1                       | 3  | 3  | 6    | 4    |
| TBA2              | Vacuum         | 10                   | NV                      | 4  | 4  | 6    | 3    |
| TBA1              | Dip            | 3                    | NV                      | NV | 3  | All? | All? |
| TB                | Dip            | 3                    | NV                      | NV | 3  | All? | All? |
| TBA1              | Dip            | 6                    | NV                      | NV | 3  | 10   | 10   |
| TB                | Dip            | 6                    | NV                      | 5? | 6  | 10   | 10   |
| TBA1              | Dip            | 30                   | NV                      | NV | 4  | All? | All? |
| TBA2              | Dip            | 30                   | NV                      | 3  | 3  | 8    | 6    |
| HA1               | Vacuum         | 10                   | 1                       | 6  | 7  | 9    | 8    |
| H                 | Vacuum         | 10                   | 1                       | 5  | 6  | 7    | 7    |
| HA2               | Vacuum         | 10                   | 2                       | 7  | 8  | 9    | 9    |
| HA1               | Dip            | 6                    | NV                      | NV | 5  | All? | All? |
| H                 | Dip            | 6                    | NV                      | 7  | 5  | All? | All? |
| HA2               | Dip            | 6                    | NV                      | 1  | 6  | All? | All? |

Many variations of the present invention will suggest themselves to those skilled in the art in light of the above detailed description. Such obvious variations are within the full intended scope of the appended claims.

## WE CLAIM:

1. Use of a composition comprising
  - (A) an amine oxide; and
  - 5 (B) a boron compound selected from the group consisting of boric acid, diboron tetrahydroxide, a borate, a boron oxide, a borane, and any combination of any of the foregoing, as a preservative and/or waterproofer for wood.
2. A use as defined in claim 1, wherein said amine oxide is selected from the
  - 10 group consisting of
    - (i) a trialkylamine oxide;
    - (ii) an alkylcyclicamine oxide;
    - (iii) a dialkylpiperazine di-N-oxide;
    - (iv) an alkyl-di(ethoxylated oxyalkyl)amine oxide;
    - 15 (v) a dialkylbenzylamine oxide;
    - (vi) a fatty dimethylaminopropylamine oxide;
    - (vii) a diamine oxide; (viii) a triamine oxide; and (ix) any combination of any of the foregoing.
- 20 3. A use as defined in claim 2, wherein said trialkylamine oxide has the formula  $R^1R^2R^3N \rightarrow O$ , wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $R^2$  and  $R^3$  independently are linear, branched, or any combination thereof  $C_1$  to  $C_{40}$  alkyl groups.
- 25 4. A use as defined in claim 3, wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group; and  $R^2$  and  $R^3$  independently are linear, branched, or any combination thereof  $C_1$  to  $C_{22}$  alkyl groups.
5. A use as defined in claim 4, wherein  $R^2$  and  $R^3$  independently are linear,
  - 30 branched, or any combination thereof  $C_8$  to  $C_{22}$  alkyl groups.

6. A use as defined in claim 3, wherein said trialkylamine oxide is a dialkylmethanamine oxide having the formula  $R^1R^2CH_2N \rightarrow O$ , wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $R^2$  is a linear, branched, or any combination thereof  $C_1$  to  $C_{40}$  alkyl group.

5

7. A use as defined in claim 6, wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group; and  $R^2$  is a linear, branched, or any combination thereof  $C_1$  to  $C_{22}$  alkyl group.

10 8. A use as defined in claim 3, wherein said trialkylamine oxide is an alkyldimethanamine oxide having the formula  $R^1(CH_2)_2N \rightarrow O$ , wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group.

9. A use as defined in claim 8, wherein  $R^1$  is a linear, branched, cyclic or any  
15 combination thereof  $C_8$  to  $C_{22}$  alkyl group.

10. A use as defined in claim 8, wherein said alkyldimethanamine oxide is selected from the group consisting of a  $C_{10}$  alkyldimethanamine oxide,  $C_{12}$ - $C_{14}$  alkyldimethanamine oxide,  $C_{16}$ - $C_{18}$  alkyldimethanamine oxide, and any combination  
20 of any of the foregoing.

11. A use as defined in claim 2, wherein said alkylcycloamine oxide has the formula  $R^4R^5R^6N \rightarrow O$  wherein  $R^4$  is a linear, branched, cyclic, or any combination thereof  $C_8$ - $C_{40}$  alkyl group and  $R^5$  and  $R^6$  are linked to form a cyclic group containing  
25 from 4 to 10 carbon atoms and optionally oxygen, sulfur, nitrogen, or any combination of any of the foregoing.

12. A use as defined in claim 11, wherein  $R^4$  is a linear, branched, cyclic, or any combination thereof  $C_8$ - $C_{22}$  alkyl group.

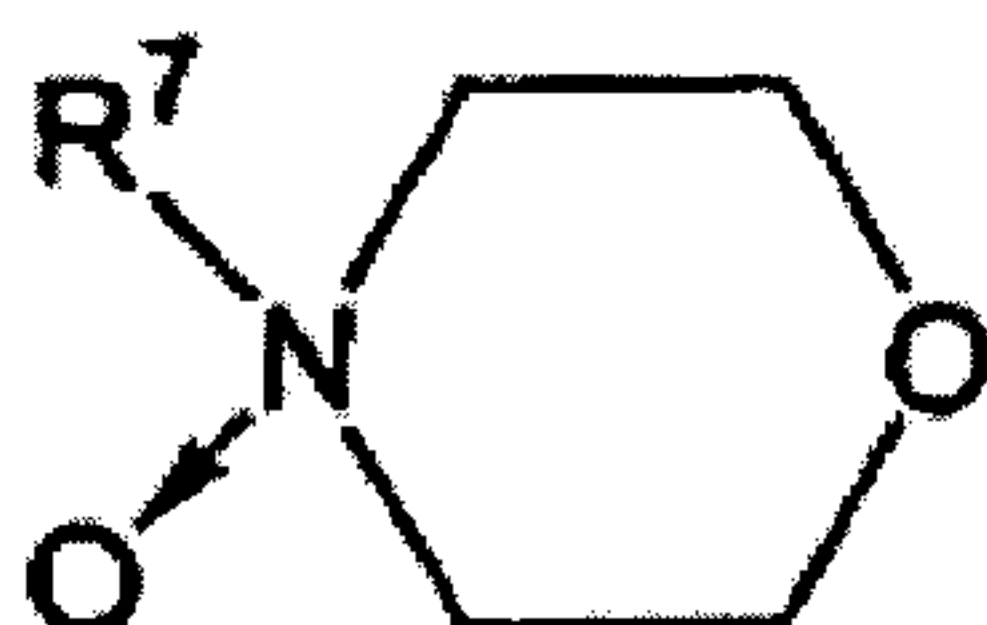
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13. A use as defined in claim 11, wherein the cyclic group contains from 4 to 10 carbon atoms.

14. A use as defined in claim 11, wherein the ring of the cyclic group contains oxygen, sulfur, nitrogen, or any combination of any of the foregoing.

5 15. A use as defined in claim 2, wherein said alkylcyclicamine oxide is selected from the group consisting of an alkylmorpholine N-oxide, a dialkylpiperazine di-N-oxide, and any combination of any of the foregoing.

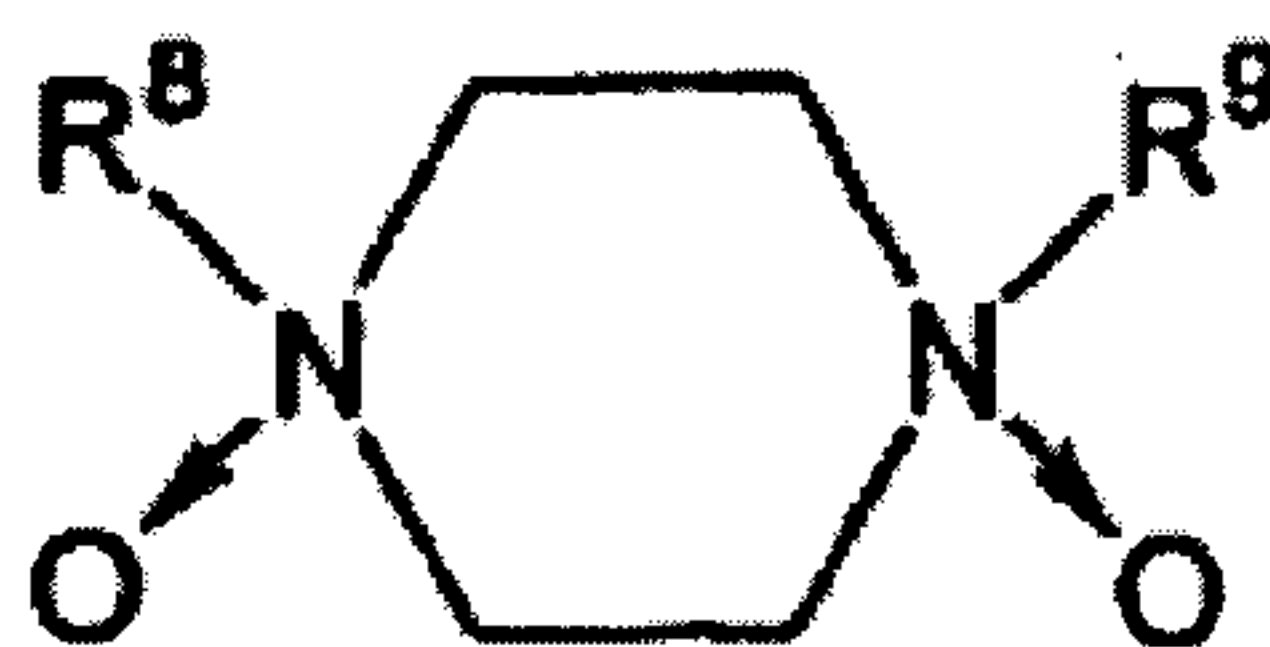
16. A use as defined in claim 15, wherein said alkylmorpholine  
10 N-oxide has the formula



wherein  $R^7$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl  
15 group.

17. A use as defined in claim 16, wherein  $R^7$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group.

20 18. A use as defined in claim 2, wherein said dialkylpiperazine di-N-oxide has the formula

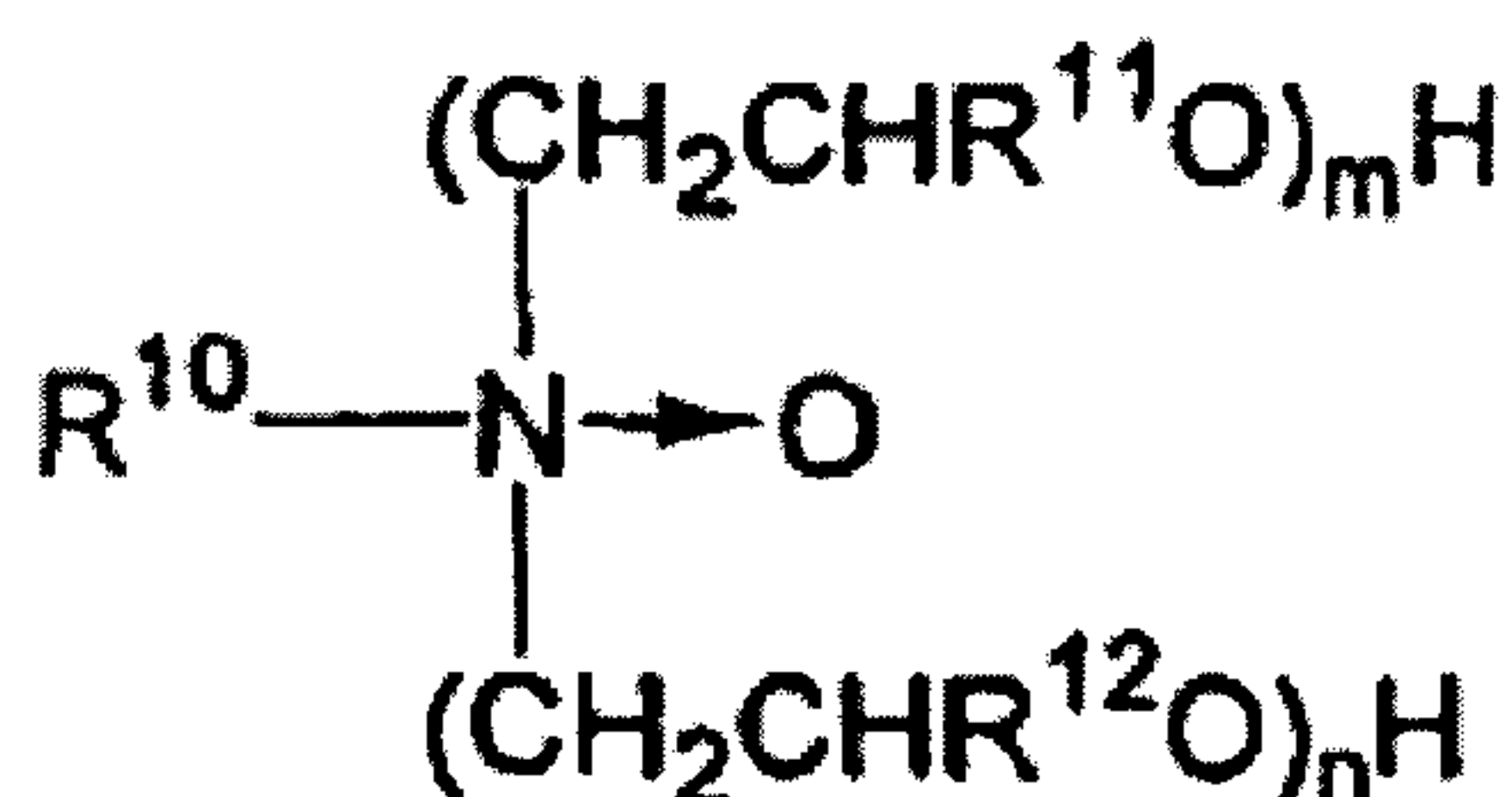


wherein  $R^8$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl  
25 group; and  $R^9$  is a linear, branched, cyclic or any combination thereof  $C_1$  to  $C_{40}$  alkyl

group.

19. A use as defined in claim 18, wherein  $R^8$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group; and  $R^9$  is a linear, branched, cyclic or any combination thereof  $C_1$  to  $C_{22}$  alkyl group.

20. A use as defined in claim 2, wherein said alkyldi(ethoxylated oxyalkyl)amine oxide has the formula



- wherein  $R^{10}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group;  $R^{11}$  and  $R^{12}$  independently are H or  $\text{CH}_3$ ; and m and n independently are integers from 1 to 10.

21. A use as defined in claim 20, wherein  $R^{10}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group.

22. A use as defined in claim 2, wherein said dialkylbenzylamine oxide has the formula  $\text{R}^{13}\text{R}^{14}\text{R}^{15}\text{N}\rightarrow\text{O}$ , wherein  $R^{13}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group;  $R^{14}$  is a linear, branched, cyclic or any combination thereof  $C_1$  to  $C_{40}$  alkyl group; and  $R^{15}$  is benzyl.

23. A use as defined in claim 22, wherein  $R^{13}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group; and  $R^{14}$  is a linear, branched, cyclic or any combination thereof  $C_1$  to  $C_{22}$  alkyl group.

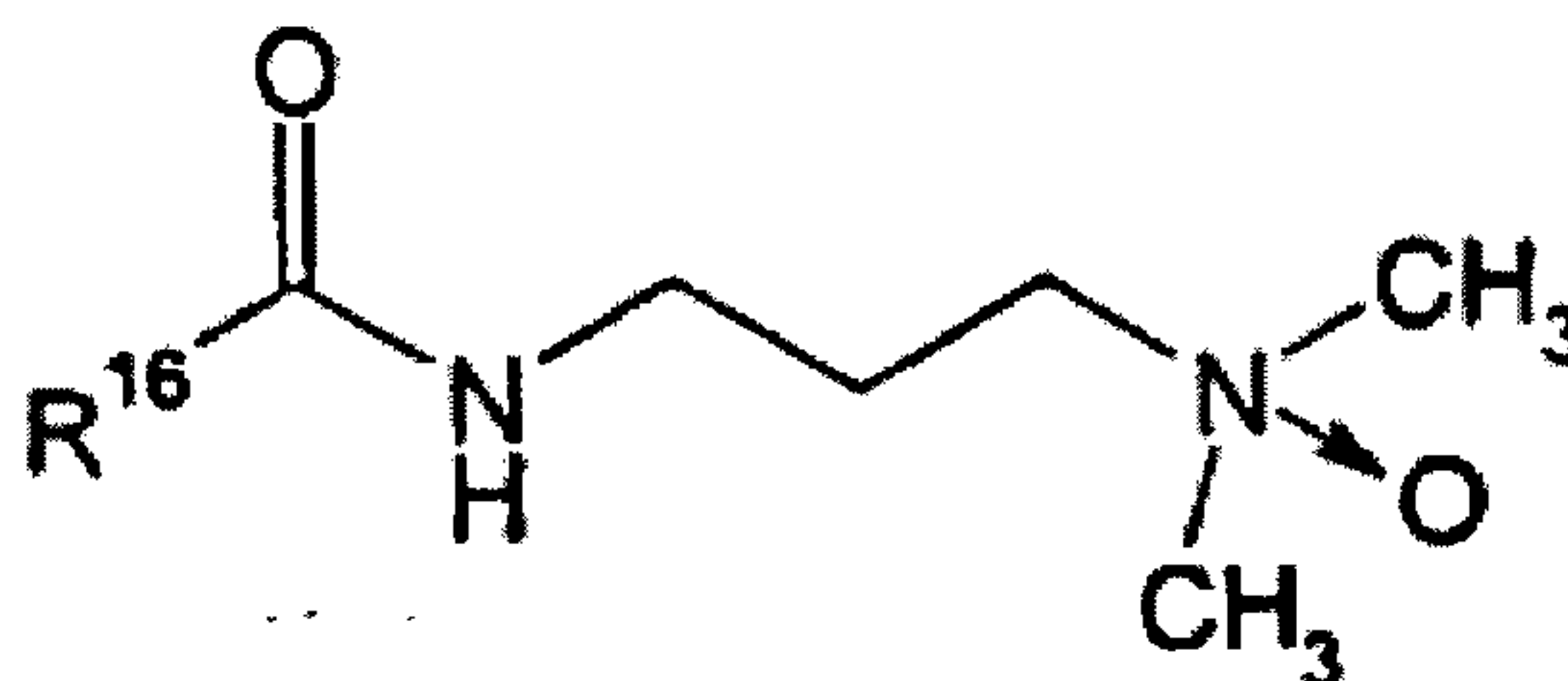
24. A use as defined in claim 2, wherein said dialkylbenzylamine oxide is an alkylbenzylmethylaniline oxide having the formula  $\text{R}^{13}\text{R}^{15}\text{CH}_3\text{N}\rightarrow\text{O}$ , wherein  $R^{13}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $R^{15}$  is

benzyl.

25. A use as defined in claim 24, wherein  $R^{13}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group.

5

26. A use as defined in claim 2, wherein said fatty dimethylaminopropylamine oxide has the formula

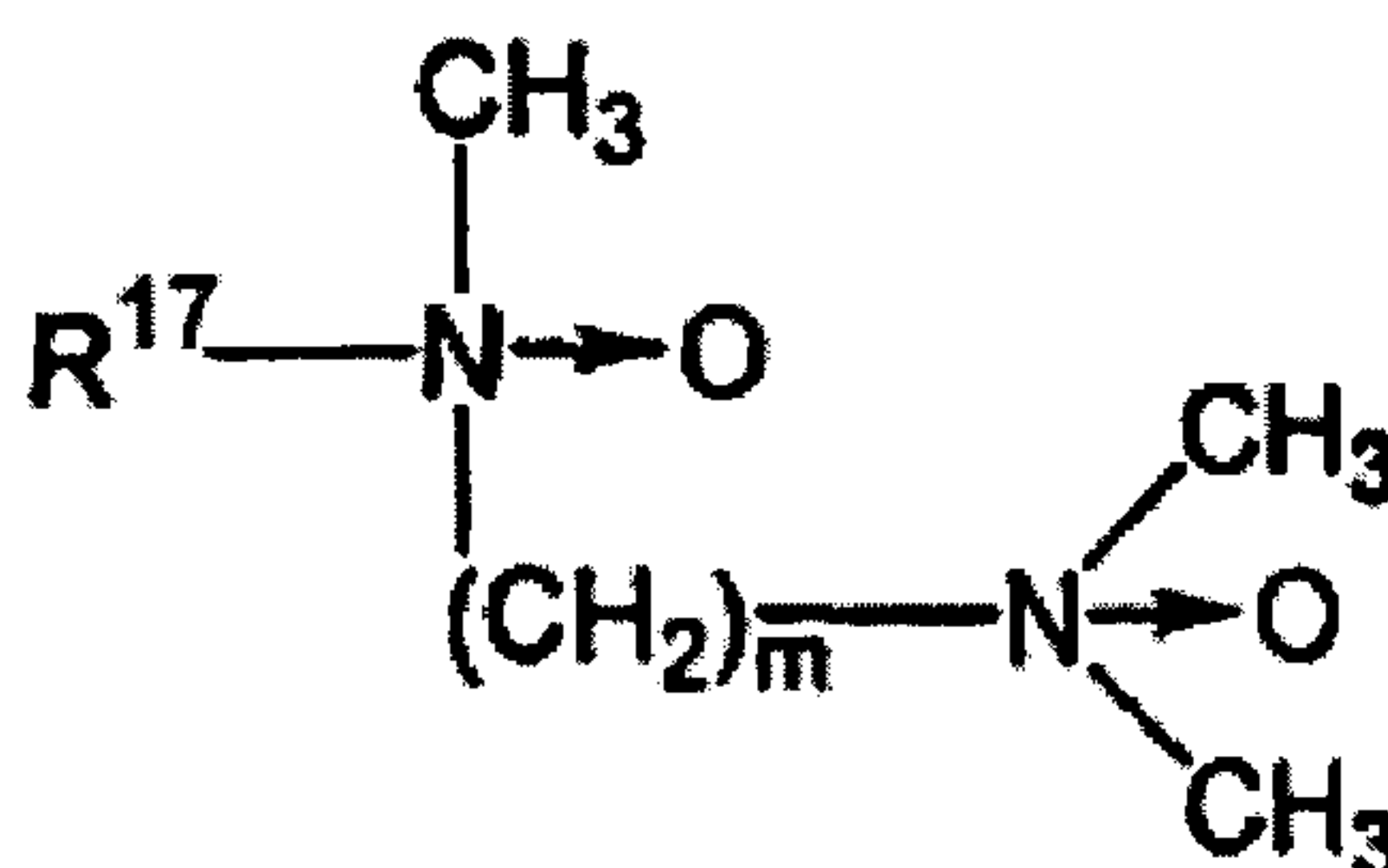


10 wherein  $R^{16}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group.

27. A use as defined in claim 26, wherein  $R^{16}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group.

15

28. A use as defined in claim 2, wherein said diamine oxide has the formula



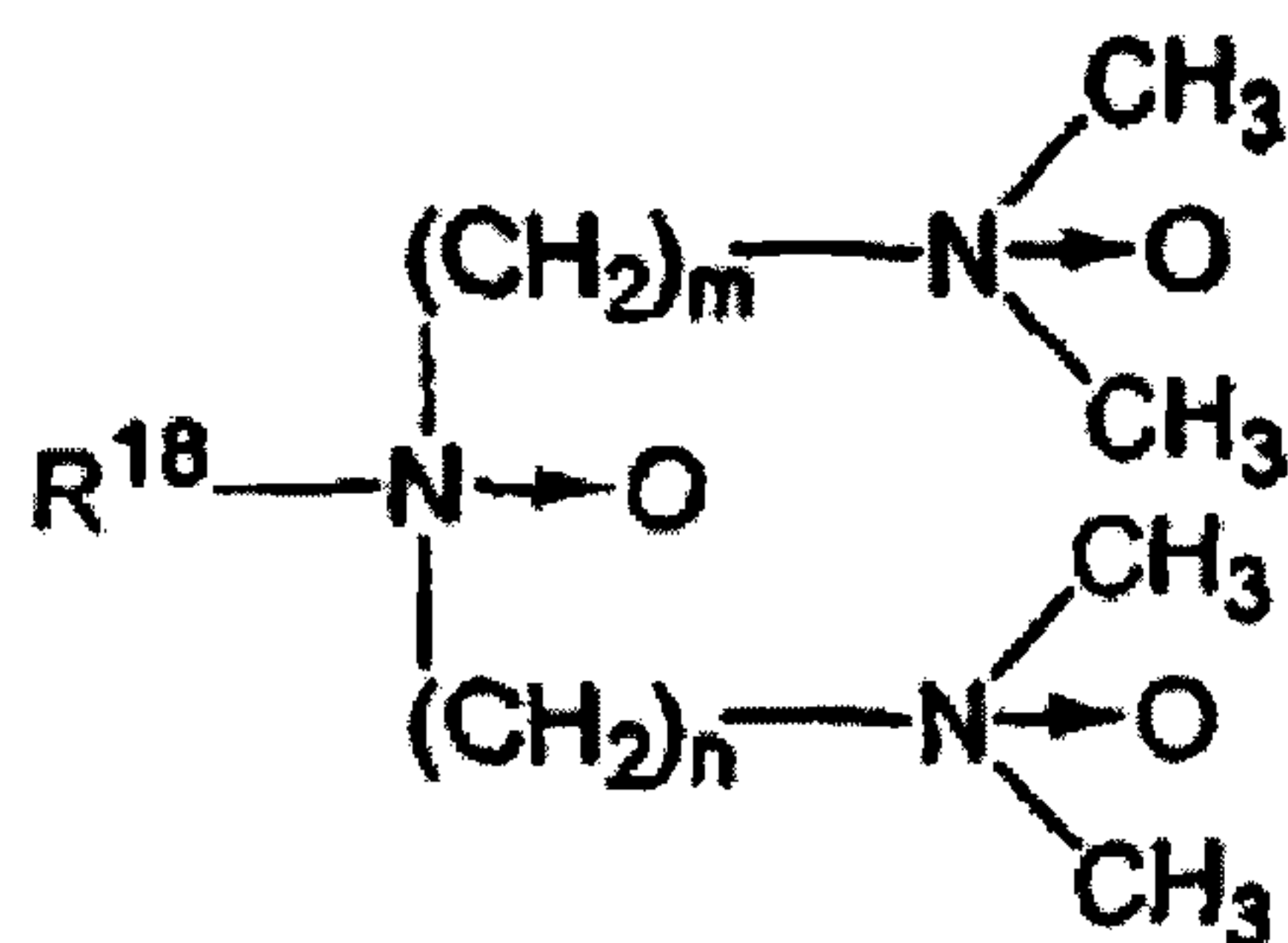
20 wherein  $R^{17}$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $m$  is an integer from 1 to 10.

29. A use as defined in claim 28, wherein the linear, branched, cyclic or any

combination thereof C<sub>8</sub> to C<sub>40</sub> alkyl group is a linear, branched, cyclic or any combination thereof C<sub>8</sub> to C<sub>22</sub> alkyl group.

30. A use as defined in claim 2, wherein triamine oxide has the formula

5



wherein R<sup>18</sup> is a linear, branched, cyclic or any combination thereof C<sub>8</sub> to C<sub>40</sub> alkyl group; and m and n independently are integers from 1 to 10.

10 31. A use as defined in claim 30, wherein R<sup>18</sup> is a linear, branched, cyclic or any combination thereof C<sub>8</sub> to C<sub>22</sub> alkyl group.

32. A use as defined in claim 1, wherein said borate is selected from the group consisting of a perborate, a metaborate, a tetraborate, an octaborate, a borate ester, and  
15 any combination of any of the foregoing.

33. A use as defined in claim 1, wherein said borate is a metallic borate.

34. A use as defined in claim 1, wherein said borate is selected from the group consisting of disodium tetraborate decahydrate, disodium octaborate tetrahydrate,  
20 sodium metaborate, sodium perborate monohydrate, disodium octaborate, sodium tetraborate pentahydrate, sodium tetraborate, copper metaborate, zinc borate, barium metaborate, bis(2-aminoethyl) borate and any combination of any of the foregoing.

25 35. A use as defined in claim 34, wherein said borate is disodium octaborate tetrahydrate.

36. A use as defined in claim 1, wherein said boron oxide is boric oxide.
37. A use as defined in claim 1, wherein the composition further comprises a  
5 solvent.
38. A use as defined in claim 37, wherein said solvent is water.
39. A use as defined in claim 37, wherein said solvent is selected from the group  
10 consisting of alcohols, glycols, esters, ethers, polyethers, and any combination of any  
of the foregoing.
40. A use as defined in claim 39, wherein said solvent comprises ethylene glycol.
- 15 41. A use as defined in claim 1, wherein the weight ratio of said amine oxide to  
said boron compound ranges from 1:50 to 50:1.
42. A use as defined in claim 41, wherein said weight ratio ranges from 1:5 to 5:1.
- 20 43. A use as defined in claim 1, wherein said composition comprises from 0.01 to  
10% by weight of amine oxide and from 0.01 to 5% by weight of boron compound  
based upon 100% weight of total composition.
44. A use as defined in claim 1, wherein said composition comprises from 0.5 to  
25 2% by weight of amine oxide and from 0.5 to 2% by weight of boron compound  
based upon 100% weight of total composition.
45. A method for preserving a wood substrate, said method comprising contacting  
said wood substrate with a composition as defined in claim 1.  
30
46. A method for waterproofing a wood substrate, said method comprising  
contacting said wood substrate with a composition as defined in claim 1.

47. An article comprising
- (A) a wood substrate; and
  - (B) a composition as defined in claim 1.

5

48. A wood preservative and/or waterproofing composition comprising
- (A) a trialkyl amine oxide; and
  - (B) a boron compound selected from the group consisting of diboron tetrahydroxide, octaborate, borate esters, bis(2-aminoethyl) borate, a borane, disodium octaborate tetrahydrate, disodium octaborate, sodium tetraborate pentahydrate, copper metaborate, zinc borate, barium metaborate, and any combination of any of the foregoing.

10

49. A composition as defined in claim 48, wherein said trialkylamine oxide has the formula  $R^1R^2R^3N \rightarrow O$ , wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $R^2$  and  $R^3$  are independently a linear, branched, or any combination thereof  $C_1$  to  $C_{40}$  alkyl group.

15

50. A composition as defined in claim 49, wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group; and  $R^2$  and  $R^3$  are independently a linear, branched, or any combination thereof  $C_1$  to  $C_{22}$  alkyl group.

20

51. A composition as defined in claim 50, wherein  $R^2$  and  $R^3$  are independently a linear, branched, or any combination thereof  $C_8$  to  $C_{22}$  alkyl group.

25

52. A composition as defined in claim 49, wherein said trialkylamine oxide is a dialkylmethylaniline oxide having the formula  $R^1R^2CH_3N \rightarrow O$ , wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{40}$  alkyl group; and  $R^2$  is a linear, branched, or any combination thereof  $C_1$  to  $C_{40}$  alkyl group.

30

53. A composition as defined in claim 52, wherein  $R^1$  is a linear, branched, cyclic or any combination thereof  $C_8$  to  $C_{22}$  alkyl group; and  $R^2$  is a linear, branched, or any

combination thereof C<sub>1</sub> to C<sub>22</sub> alkyl group.

54. A composition as defined in claim 49, wherein said trialkylamine oxide is an alkyldimethylamine oxide having the formula  $R^1(CH_3)_2N \rightarrow O$ , wherein R<sup>1</sup> is a linear, branched, cyclic or any combination thereof C<sub>8</sub> to C<sub>40</sub> alkyl group.

55. A composition as defined in claim 54, wherein R<sup>1</sup> is a linear, branched, cyclic or any combination thereof C<sub>8</sub> to C<sub>22</sub> alkyl group.

56. A composition as defined in claim 54, wherein said alkyldimethylamine oxide is selected from the group consisting of a C<sub>10</sub> alkyldimethylamine oxide, C<sub>12</sub>-C<sub>14</sub> alkyldimethylamine oxide, C<sub>16</sub>-C<sub>18</sub> alkyldimethylamine oxide, and any combination of any of the foregoing.

57. A composition as defined in claim 48, wherein said boron compound is selected from the group consisting of disodium octaborate tetrahydrate, disodium octaborate, sodium tetraborate pentahydrate, copper metaborate, an octaborate, a borate ester, and any combination of any of the foregoing.

58. A composition as defined in claim 48, wherein said boron compound is disodium octaborate tetrahydrate.

59. A composition as defined in claim 48, further comprising a solvent.

60. A composition as defined in claim 59, wherein said solvent is water.

61. A composition as defined in claim 59, wherein said solvent is selected from the group consisting of alcohols, glycols, esters, ethers, polyethers, and any combination of any of the foregoing.

62. A composition as defined in claim 61, wherein said solvent comprises ethylene glycol.

63. A composition as defined in claim 48, wherein said composition comprises a biocidally effective amount of said boron compound.

5 64. A composition as defined in claim 48, wherein said composition comprises an insecticidal, herbicidal, fungicidal, or plant growth regulating effective amount of said boron compound.

65. A composition as defined in claim 48, wherein said composition comprises a  
10 preservative enhancing and/or waterproofing effective amount of amine oxide.

66. A composition as defined in claim 48, wherein said composition comprises an insecticidal, herbicidal, fungicidal, or plant growth regulating enhancing effective amount of amine oxide.

15

67. A composition as defined in claim 48, wherein the weight ratio of said amine oxide to said boron compound ranges from 1:50 to 50:1.

68. A composition as defined in claim 67, wherein said weight ratio ranges from  
20 1:5 to 5:1.

69. A composition as defined in claim 48, wherein said composition comprises from 0.01 to 10% by weight of amine oxide and from 0.01 to 5% by weight of boron compound based upon 100% weight of total composition.

25

70. A composition as defined in claim 48, wherein said composition comprises from 0.5 to 2% by weight of amine oxide and from 0.5 to 2% by weight of boron compound based upon 100% weight of total composition.

30 71. A method for preserving a wood substrate, said method comprising contacting said wood substrate with a composition as defined in claim 48.

72. A method for waterproofing a wood substrate, said method comprising contacting said wood substrate with a composition as defined in claim 48.

73. An article comprising

- 5 (A) a wood substrate; and  
(B) a composition as defined in claim 48.