



Polyolefin or Olefin Copolymer Films having improved Light Stability and Pesticide Resistance

This invention pertains to stabilized polyolefin or polyolefin copolymer films in contact with a pesticide, to a process for stabilizing polyolefin or polyolefin copolymer films for agricultural applications, to the corresponding use of a polyolefin or polyolefin copolymer film thus stabilized, and to a novel use of a stabilizer composition comprising a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium.

The use of sterically hindered amines as light stabilizers for polyolefins is known. The combination of sterically hindered amines with metal carboxylates, e.g. calcium stearate, and/or metal oxides, e.g. zinc oxide, in order to attain an improved light stability has been proposed (US-A-5 134 181, US-A-4 929 652, US-A-5 037 870, US-A-5 180 762).

Attaining good stabilization of polyolefin or polyolefin copolymer films for agricultural applications is impeded by the detrimental effect of pesticides, which come in contact with the films in these applications. In order to overcome these negative effects of the application of pesticides, special stabilizer compositions have been proposed, e.g. N-hydrocarbyloxy substituted sterically hindered amines together with calcium stearate (US-A-5 096 950), or conventional sterically hindered amines in combination with a hydrotalcite and optionally an UV absorber (EP-A-500 073, Chem. Abstr. 109:151118q, EP-A-429 731). The stabilization of a polyethylene film against a chlorine containing pesticide by combining a sterically hindered amine with a hydrotalcite has been reported to be better than by combining a sterically hindered amine with magnesium hydroxide.

There is still need to improve the stability of polyolefin or polyolefin copolymer films against pesticides.

It has now been found that, surprisingly, light stability and pesticide resistance of polyolefin or polyolefin copolymer films can be distinctly improved by a combination of sterically hindered amines with a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium. Accordingly, subject of the invention is a polyolefin or polyolefin copolymer film in contact with a pesticide and stabilized against photodegradation, characterized in that the polyolefin or polyolefin copolymer contains a sterically hindered amine and a metal oxide

or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium. Accordingly, the invention also pertains to a composition comprising a pesticide and a polyolefin or polyolefin copolymer film stabilized with a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium.

Preferably, polyolefin or polyolefin copolymer films of the invention are employed in agricultural, especially in greenhouse applications.

The pesticides which may contribute to a faster photodegradation, often are those containing halogen and/or sulfur atoms. Halogen containing pesticides usually embrace compounds containing fluorine, chlorine or bromine, especially chlorine. Compound classes, whose detrimental effects on the photostability of polyolefin or polyolefin copolymer films can be most effectively prevented by the instant invention, include pyrethroids of the permethrin and fenvalerate type, thioureas, dithiocarbamates, thio- and isothiocyanates and compounds generating these compounds, especially permethrin type compounds containing chlorine and dithiocarbamates such as derivatives of vinylidene dichloride and metal salts of alkyldithiocarbamic acid.

Said polyolefins or polyolefin copolymers are usually polymers for agricultural films. Polyolefins or polyolefin copolymers for films of the invention are mainly the materials listed below:

1. Polymers of monoolefins and diolefins, for example polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyisoprene or polybutadiene, as well as polymers of cycloolefins, for instance of cyclopentene or norbornene, polyethylene (which optionally can be crosslinked), for example high density polyethylene (HDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), branched low density polyethylene (BLDPE).

Polyolefins, i.e. the polymers of monoolefins exemplified in the preceding paragraph, preferably polyethylene and polypropylene, can be prepared by different, and especially by the following, methods:

- a) radical polymerisation (normally under high pressure and at elevated

temperature).

- b) catalytic polymerisation using a catalyst that normally contains one or more than one metal of groups IVb, Vb, VIb or VIII of the Periodic Table. These metals usually have one or more than one ligand, typically oxides, halides, alcoholates, esters, ethers, amines, alkyls, alkenyls and/or aryls that may be either π - or σ -coordinated. These metal complexes may be in the free form or fixed on substrates, typically on activated magnesium chloride, titanium(III) chloride, alumina or silicon oxide. These catalysts may be soluble or insoluble in the polymerisation medium. The catalysts can be used by themselves in the polymerisation or further activators may be used, typically metal alkyls, metal hydrides, metal alkyl halides, metal alkyl oxides or metal alkyloxanes, said metals being elements of groups Ia, IIa and/or IIIa of the Periodic Table. The activators may be modified conveniently with further ester, ether, amine or silyl ether groups. These catalyst systems are usually termed Phillips, Standard Oil Indiana, Ziegler (-Natta), TNZ (DuPont), metallocene or single site catalysts (SSC).

2. Mixtures of the polymers mentioned under 1), for example mixtures of polypropylene with polyisobutylene, polypropylene with polyethylene (for example PP/HDPE, PP/LDPE) and mixtures of different types of polyethylene (for example LDPE/HDPE).
3. Copolymers of monoolefins and diolefins with each other or with other vinyl monomers, for example ethylene/propylene copolymers, linear low density polyethylene (LLDPE) and mixtures thereof with low density polyethylene (LDPE), propylene/but-1-ene copolymers, propylene/isobutylene copolymers, ethylene/but-1-ene copolymers, ethylene/hexene copolymers, ethylene/methylpentene copolymers, ethylene/heptene copolymers, ethylene/octene copolymers, propylene/butadiene copolymers, isobutylene/-isoprene copolymers, ethylene/alkyl acrylate copolymers, ethylene/alkyl methacrylate copolymers, ethylene/vinyl acetate copolymers and their copolymers with carbon monoxide or ethylene/acrylic acid copolymers and their salts (ionomers) as well as terpolymers of ethylene with propylene and a diene such as hexadiene, dicyclopentadiene or ethylidene-norbornene; and mixtures of such copolymers with one another and with polymers mentioned in 1) above, for example polypropylene/ethylene-propylene copolymers, LDPE/ethylene-vinyl acetate copolymers (EVA), LDPE/ethylene-acrylic acid copolymers (EAA), LLDPE/EVA, LLDPE/EAA and alternating or random polyalkylene/carbon mon-

oxide copolymers and mixtures thereof with other polymers, for example polyamides.

Of major interest are polymers of monoolefins, especially α -monoolefins, for example polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, as well as polymers of cycloolefins, polyethylene (which optionally can be crosslinked), for example high density polyethylene (HDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), branched low density polyethylene (BLDPE), and copolymers of these monomers or with vinyl acetate. Preferred are polyethylene, ethylene/propylene copolymer, ethylene/vinyl acetate copolymer and polypropylene; especially polyethylene, which is often LDPE.

Metal oxides or hydroxides in the polyolefin or polyolefin copolymer films according to the invention are mainly oxides of zinc, aluminum, calcium or magnesium, or hydroxides of zinc, aluminum or calcium, especially zinc oxide (ZnO), zinc hydroxide ($\text{Zn}[\text{OH}]_2$), ortho or meta aluminum hydroxide ($\text{Al}[\text{OH}]_3$), α - or γ -aluminum oxide (Al_2O_3), or magnesium oxide (MgO), for example ZnO , $\text{Zn}(\text{OH})_2$ or MgO . Preferred are oxide or hydroxide of zinc; most preferred is zinc oxide.

Usually, the polyolefin or polyolefin copolymer film stabilized according to the invention contains from 0.01 to 5 % by weight of the sterically hindered amine and from 0.005 to 3 % by weight of the metal oxide or hydroxide, relative to the weight of the polyolefin or polyolefin copolymer. Advantageous ranges for both stabilizer components are from 0.025 to 2 %, especially from 0.05 to 1 % by weight of the sterically hindered amine, and from 0.005 to 1 %, especially from 0.025 to 0.5 % by weight of the metal oxide or hydroxide, relative to the weight of the polyolefin or polyolefin copolymer.

In many cases, polyolefin or polyolefin copolymer films of the invention contain a salt of a C_1 - C_{30} carboxylic acid, especially a C_8 - C_{22} carboxylic acid; of utmost importance are salts of a C_8 - C_{18} carboxylic acid.

Preferred is a polyolefin or polyolefin copolymer film, in which the polyolefin or polyolefin copolymer contains one or more further components selected from alkaline earth metal salts, zinc salts and aluminum salts of C_1 - C_{30} carboxylic acid, hydrotalcites, and UV absorbers.

Of major interest are polyolefin or polyolefin copolymer films containing a salt of a C_1 - C_{30} carboxylic acid. Metal carboxylates optionally to be added are mainly salts of Al, Ba, Ca,

Mg, Sr or Zn. Preferred are salts of aluminum, calcium, magnesium or zinc, especially of C₁₂-C₁₈carboxylic acids. Most preferred are calcium salts, for example calcium stearate.

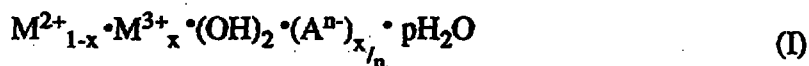
Metal carboxylates are advantageously employed in an amount from 0.05 to 2 %, especially from 0.1 to 1 % by weight of the polyolefin or polyolefin copolymer.

UV absorbers optionally to be added often are selected from 2-(2'-hydroxyphenyl)benzotriazoles, 2-hydroxy-benzophenones, oxamides and/or 2-(2-hydroxyphenyl)-1,3,5-triazines. Preferred are 2-(2'-hydroxyphenyl)-benzotriazole UV absorbers; examples for such compounds are 2-(2'-hydroxy-5'-methylphenyl)-benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chloro-benzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)-benzotriazole, 2-(3',5'-bis-(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, mixture of 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)ethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)-carbonyl]ethyl)-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl)ethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl)ethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)ethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonyl]ethyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, and 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonyl)ethyl)phenyl)benzotriazole, 2,2'-methylene-bis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazole-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonyl)ethyl)-2'-hydroxyphenyl]-2H-benzotriazole with polyethylene glycol 300; $[R-CH_2CH_2-COO(CH_2)_3]_{1/2}$, where R = 3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-ylphenyl.

UV absorbers are advantageously employed in an amount from 0.01 to 5 %, especially from 0.05 to 2 % by weight of the polyolefin or polyolefin copolymer.

Polyolefin or polyolefin copolymer films according to the invention advantageously may contain as further component a hydrotalcite.

Such hydrotalcites include compounds of formula I,



wherein

M^{2+} is Mg, Ca, Sr, Ba, Zn, Pb, Sn and/or Ni,

M^{3+} is Al, B or Bi,

A^n is an Anion of the valency n,

n is a number from 1 to 4,

x is a number from 0 to 0,5,

p is a number from 0 to 2 and

A is OH^- , Cl^- , Br^- , I^- , ClO_4^- , HCO_3^- , CH_3COO^- , $C_6H_5COO^-$, CO_3^{2-} , SO_4^{2-} ,

$\begin{array}{c} COO^- \\ | \\ COO^- \end{array}$

COO^- , $(CHOHCOO)_2^{2-}$, $(CHOH)_4CH_2OHCOO^-$, $C_2H_4(COO)_2^{2-}$, $(CH_2COO)_2^{2-}$,

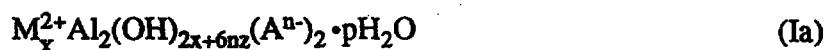
$CH_3CHOHCOO^-$, SiO_3^{2-} , SiO_4^{4-} , $Fe(CN)_6^{3-}$, $Fe(CN)_6^{4-}$, BO_3^{3-} , PO_3^{3-} or HPO_4^{2-} .

Preferred are hydrotalcites of the above formula I, wherein M^{2+} stands for Ca^{2+} , Mg^{2+} or a mixture of Mg^{2+} and Zn^{2+} ,

A^n for CO_3^{2-} , BO_3^{3-} or PO_3^{3-} ,

x is a number from 0 to 0,5 and p is a number from 0 to 2.

Other hydrotalcites, which may be added advantageously, are compounds of formula Ia,



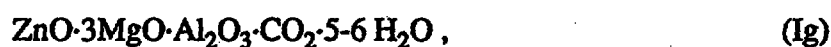
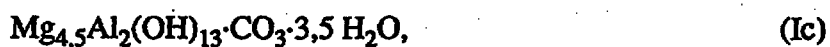
wherein in formula Ia M^{2+} stands for Mg or Zn, preferably for Mg,

A^n for an anion, e.g. an anion selected from the group consisting of CO_3^{2-} , $\begin{pmatrix} COO^- \\ | \\ COO^- \end{pmatrix}^{2-}$, OH^- and S^{2-} , where n is the valency of the anion,

p stands for a positive number, preferably ranging from 0 to 5, for example from 0.5 to 5, and x and z are positive numbers, x ranging preferably from 2 to 6 and z being less than 2.

Most preferred are hydrotalcites corresponding to formulae Ib-Ih

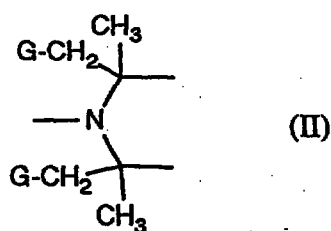




Hydrotalcites are advantageously employed in an amount from 0.01 to 5 %, especially from 0.2 to 3 % by weight of the polyolefin or polyolefin copolymer.

The sterically hindered amine can be an individual compound or a mixture of compounds. In the case of a mixture of compounds, the amounts given refer in each case to the total amount of sterically hindered amines used.

A sterically hindered amine is here to be understood as meaning in particular a compound containing one or more trivalent groups of the formula II

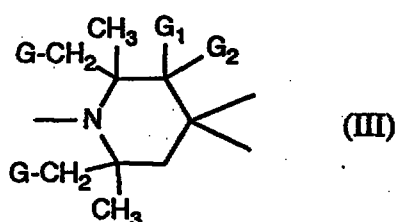


in which G is hydrogen or methyl and in which not more than one of the free valencies in formula II is saturated with hydrogen and 2 or all 3 free valencies constitute bonds to carbon or hetero atoms.

Examples for such compounds can be found in US-patents Nos. 4086204, 4108829, 4263434, 4233412, 4288593, 4315859, 4321374, 4331586, 4413093, 4435555, 4477615, 4335242, 4376836, 4433145, 4459395, 4477615, 4533688, 4540728, 4547548, and 4740544, and in the publications EP-A-22080, EP-A-29522, EP-A-24338, EP-A-42554,

EP-A-44499, EP-A-70386, EP-A-72009, EP-A-75849, EP-A-82244, EP-A-94048, EP-A-107615, EP-A-402889, EP-A-357223, and DE-A-3530666; the disclosure of these documents is regarded as part of the instant specification.

In most cases, the sterically hindered amine is a cyclic sterically hindered amine, in particular a compound from the series of polyalkylpiperidine derivatives containing at least one group of the formula III



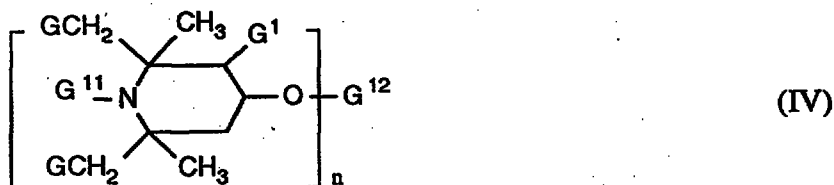
in which G is hydrogen or methyl, and G₁ and G₂ are hydrogen, methyl or together are a substituent =O; preferably the polyalkylpiperidine groups of the formula III are substituted in the 4 position by one or two polar substituents or a polar spiro ring system.

Of importance are cyclic sterically hindered amines containing at least one group of the formula III, in which G is hydrogen and G¹ and G² are hydrogen or together are a substituent =O.

Particularly advantageously, derivatives of 2,2,6,6-tetramethylpiperidine are employed according to the invention.

Of importance is in particular the use of the classes of polyalkylpiperidines described below under (a) to (h), which carry at least one group of the formula III, as mentioned above:

(a) compounds of the formula IV



in which n is a number from 1 to 4, G and G^1 , independently of one another, are hydrogen or methyl,

G^{11} is hydrogen, C_1 - C_{18} alkyl, C_3 - C_8 alkenyl, C_3 - C_8 alkynyl, C_7 - C_{12} aralkyl, C_1 - C_8 alkanoyl, C_3 - C_5 alkenoyl, glycidyl or a group $-CH_2CH(OH)-Z$, in which Z is hydrogen, methyl or phenyl,

G^{11} being preferably H, C_1 - C_4 alkyl, allyl, benzyl, acetyl or acryloyl and

G^{12} , in the case where n is 1, being hydrogen, C_1 - C_{18} alkyl which may be interrupted by one or more oxygen atoms, cyanoethyl, benzyl, glycidyl, a monovalent radical of an aliphatic, cycloaliphatic, araliphatic, unsaturated or aromatic carboxylic acid, carbamic acid, or phosphorus-containing acid, or a monovalent silyl radical, preferably a radical of an aliphatic carboxylic acid having 2 to 18 C atoms, of a cycloaliphatic carboxylic acid having 7 to 15 C atoms, of an α,β -unsaturated carboxylic acid having 3 to 5 C atoms, or of an aromatic carboxylic acid having 7 to 15 C atoms, it being possible for the carboxylic acid in each case to be substituted in the aliphatic, cycloaliphatic or aromatic portion by 1 to 3 groups $-COOZ^{12}$, in which Z^{12} is H, C_1 - C_{20} alkyl, C_3 - C_{12} alkenyl, C_5 - C_7 cycloalkyl, phenyl or benzyl,

G^{12} , in the case where n is 2, being C_2 - C_{12} alkylene, C_4 - C_{12} alkenylene, xylylene, a divalent radical of an aliphatic, cycloaliphatic, araliphatic or aromatic dicarboxylic acid, dicarbamic acid, or phosphorus-containing acid, or a divalent silyl radical, preferably a radical of an aliphatic dicarboxylic acid having 2 to 36 C atoms, of a cycloaliphatic or aromatic dicarboxylic acid having 8-14 C atoms, or of an aliphatic, cycloaliphatic or aromatic dicarbamic acid having 8-14 C atoms, it being possible for the dicarboxylic acid in each case to be substituted in the aliphatic, cycloaliphatic or aromatic moiety by 1 or 2 groups $-COOZ^{12}$,

G^{12} , in the case where n is 3, being a trivalent radical of an aliphatic, cycloaliphatic or aromatic tricarboxylic acid, which may be substituted in the aliphatic, cycloaliphatic or aromatic moiety by $-COOZ^{12}$, of an aromatic tricarbamic acid, or of a phosphorus-containing acid, or a trivalent silyl radical, and

G^{12} , in the case where n is 4, being a tetravalent radical of an aliphatic, cycloaliphatic or aromatic tetracarboxylic acid.

The carboxylic acid radicals given include in each case radicals of the formula $(-CO)_nR$, the meaning of n being given above and the meaning of R being apparent from the definition given.

Any C_1 - C_{12} alkyl substituents present are, for example, methyl, ethyl, n-propyl, n-butyl,

sec-butyl, tert-butyl, n-hexyl, n-octyl, 2-ethylhexyl, n-nonyl, n-decyl, n-undecyl or n-dodecyl.

Examples of G^{11} or G^{12} as C_1 - C_{18} alkyl can be the groups listed above and in addition, for example, n-tridecyl, n-tetradecyl, n-hexadecyl or n-octadecyl.

Examples of G^{11} as C_3 - C_8 alkenyl can be 1-propenyl, allyl, methallyl, 2-butenyl, 2-pentenyl, 2-hexenyl, 2-octenyl, 4-tert-butyl-2-butenyl.

G^{11} as C_3 - C_8 alkynyl is preferably propargyl.

G^{11} as C_7 - C_{12} aralkyl is in particular phenethyl and especially benzyl.

Examples of G^{11} as C_1 - C_8 alkanoyl are formyl, propionyl, butyryl, octanoyl, but preferably acetyl and as C_3 - C_5 alkenoyl in particular acryloyl.

G^{12} as a monovalent radical of a carboxylic acid is, for example, an acetic acid, caproic acid, stearic acid, acrylic acid, methacrylic acid, benzoic acid or β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid radical.

G^{12} as a monovalent silyl radical is, for example, a radical of the formula $-(C_jH_{2j})-Si(Z')_2Z''$, in which j is an integer from the range 2 to 5, and Z' and Z'' , independently of one another, are C_1 - C_4 alkyl or C_1 - C_4 alkoxy.

G^{12} as a divalent radical of a dicarboxylic acid is, for example, a malonic acid, succinic acid, glutaric acid, adipic acid, suberic acid, sebacic acid, maleic acid, itaconic acid, phthalic acid, dibutylmalonic acid, dibenzylmalonic acid, butyl(3,5-di-tert-butyl-4-hydroxybenzyl)malonic acid or bicycloheptenedicarboxylic acid radical.

G^{12} as a trivalent radical of a tricarboxylic acid is, for example, a trimellitic acid, citric acid or nitrilotriacetic acid radical.

G^{12} as a tetravalent radical of a tetracarboxylic acid is, for example, the tetravalent radical of butane-1,2,3,4-tetracarboxylic acid or of pyromellitic acid.

G¹² as a divalent radical of a dicarbamic acid is, for example, a hexamethylenedicarbamic acid or a 2,4-toluylenedicarbamic acid radical.

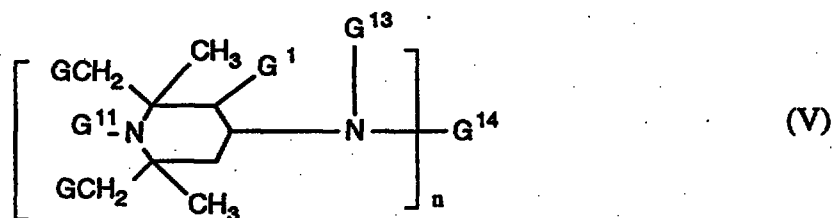
Preference is given to compounds of the formula IV in which G is hydrogen, G¹¹ is hydrogen or methyl, n is 2, and G¹² is the diacyl radical of an aliphatic dicarboxylic acid having 4-12 C atoms.

Examples of polyalkylpiperidine compounds of this class are the following compounds:

- 1) 4-hydroxy-2,2,6,6-tetramethylpiperidine
- 2) 1-allyl-4-hydroxy-2,2,6,6-tetramethylpiperidine
- 3) 1-benzyl-4-hydroxy-2,2,6,6-tetramethylpiperidine
- 4) 1-(4-tert-butyl-2-butenyl)-4-hydroxy-2,2,6,6-tetramethylpiperidine
- 5) 4-stearoyloxy-2,2,6,6-tetramethylpiperidine
- 6) 1-ethyl-4-salicyloyloxy-2,2,6,6-tetramethylpiperidine
- 7) 4-methacryloyloxy-1,2,2,6,6-pentamethylpiperidine
- 8) 1,2,2,6,6-pentamethylpiperidin-4-yl-β-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate
- 9) di(1-benzyl-2,2,6,6-tetramethylpiperidin-4-yl) maleate
- 10) di(2,2,6,6-tetramethylpiperidin-4-yl) succinate
- 11) di(2,2,6,6-tetramethylpiperidin-4-yl) glutarate
- 12) di(2,2,6,6-tetramethylpiperidin-4-yl) adipate
- 13) di(2,2,6,6-tetramethylpiperidin-4-yl) sebacate
- 14) di(1,2,2,6,6-pentamethylpiperidin-4-yl) sebacate
- 15) di(1,2,3,6-tetramethyl-2,6-diethylpiperidin-4-yl) sebacate
- 16) di(1-allyl-2,2,6,6-tetramethylpiperidin-4-yl) phthalate
- 18) 1-acetyl-2,2,6,6-tetramethylpiperidin-4-yl acetate
- 19) trimellitic acid tri(2,2,6,6-tetramethylpiperidin-4-yl) ester
- 20) 1-acryloyl-4-benzyloxy-2,2,6,6-tetramethylpiperidine
- 21) di(2,2,6,6-tetramethylpiperidin-4-yl) diethylmalonate
- 22) di(1,2,2,6,6-pentamethylpiperidin-4-yl) dibutylmalonate
- 23) di(1,2,2,6,6-pentamethylpiperidin-4-yl) butyl(3,5-di-tert-butyl-4-hydroxybenzyl) malonate
- 26) hexane-1',6'-bis(4-carbamoyloxy-1-n-butyl-2,2,6,6-tetramethylpiperidine)
- 27) toluene-2',4'-bis(4-carbamoyloxy-1-n-propyl-2,2,6,6-tetramethylpiperidine)
- 28) dimethyl-bis(2,2,6,6-tetramethylpiperidin-4-oxy)silane
- 29) phenyl-tris(2,2,6,6-tetramethylpiperidin-4-oxy)silane

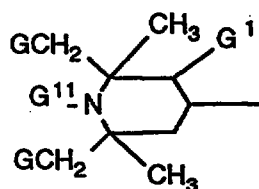
- 30) tris(1-propyl-2,2,6,6-tetramethylpiperidin-4-yl) phosphite
- 31) tris(1-propyl-2,2,6,6-tetramethylpiperidin-4-yl) phosphate
- 32) bis(1,2,2,6,6-pentamethylpiperidin-4-yl) phenylphosphonate
- 33) 4-hydroxy-1,2,2,6,6-pentamethylpiperidine
- 34) 4-hydroxy-N-hydroxyethyl-2,2,6,6-tetramethylpiperidine
- 35) 4-hydroxy-N-(2-hydroxypropyl)-2,2,6,6-tetramethylpiperidine
- 36) 1-glycidyl-4-hydroxy-2,2,6,6-tetramethylpiperidine

(b) compounds of the formula (V)



in which n is 1 or 2, G, G¹ and G¹¹ are as defined under (a),

G¹³ is hydrogen, C₁-C₁₂alkyl, C₂-C₅hydroxyalkyl, C₅-C₇cycloalkyl, C₇-C₈aralkyl, C₂-C₁₈alkanoyl, C₃-C₅alkenoyl, benzoyl or a group of the formula



and

G¹⁴, in the case where n is 1, is hydrogen, C₁-C₁₈alkyl, C₃-C₈alkenyl, C₅-C₇cycloalkyl, C₁-C₄alkyl which is substituted by a hydroxyl, cyano, alkoxy carbonyl or carbamide group, or is glycidyl, a group of the formula -CH₂-CH(OH)-Z or of the formula -CONH-Z, in which Z is hydrogen, methyl or phenyl;

G¹⁴, in the case where n is 2, is C₂-C₁₂alkylene, C₆-C₁₂arylene, xylylene, a -CH₂-CH(OH)-CH₂- group or a group -CH₂-CH(OH)-CH₂-O-D-O-, in which D is C₂-C₁₀alkylene, C₆-C₁₅arylene, C₆-C₁₂cycloalkylene, or, provided G¹³ is not alkanoyl, alkenoyl or benzoyl, G¹⁴ can also be 1-oxo-C₂-C₁₂alkylene, a divalent radical of an aliphatic, cycloaliphatic or aromatic dicarboxylic acid or dicarbamic acid or also the group -CO-, or,

in the case where n is 1, G¹³ and G¹⁴ together can also be the divalent radical of an aliphatic, cycloaliphatic or aromatic 1,2- or 1,3-dicarboxylic acid.

Aryl stands for an aromatic hydrocarbon residue such as, for example, phenyl or naphthyl. Aralkyl means alkyl which is substituted by an aromatic hydrocarbon residue, e.g. a hydrocarbon residue having 6 to 10 carbon atoms; examples for aralkyl include benzyl and α -methylbenzyl.

Any C₁-C₁₂alkyl or C₁-C₁₈alkyl substituents present are already as defined under (a).

Any C₅-C₇cycloalkyl substituents present are in particular cyclohexyl.

G¹³ as C₇-C₈aralkyl is in particular phenylethyl or especially benzyl. G¹³ as C₂-C₅hydroxyalkyl is in particular 2-hydroxyethyl or 2-hydroxypropyl.

Examples of G¹³ as C₂-C₁₈alkanoyl are propionyl, butyryl, octanoyl, dodecanoyl, hexadecanoyl, octadecanoyl, but preferably acetyl and, as C₃-C₅alkenoyl, in particular acryloyl.

Examples of G¹⁴ as C₂-C₈alkenyl are allyl, methallyl, 2-butenyl, 2-pentenyl, 2-hexenyl or 2-octenyl.

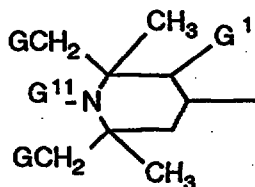
Examples of G¹⁴ as C₁-C₄alkyl substituted by a hydroxyl, cyano, alkoxycarbonyl or carbamide group can be 2-hydroxyethyl, 2-hydroxypropyl, 2-cyanoethyl, methoxycarbonylmethyl, 2-ethoxycarbonyl ethyl, 2-aminocarbonylpropyl or 2-(dimethylaminocarbonyl)ethyl.

Any C₂-C₁₂alkylene substituents present are, for example, ethylene, propylene, 2,2-dimethylpropylene, tetramethylene, hexamethylene, octamethylene, decamethylene or dodecamethylene.

Any C₆-C₁₅arylene substituents present are, for example, o-, m- or p-phenylene, 1,4-naphthylene or 4,4'-diphenylene.

A C₆-C₁₂cycloalkylene is in particular cyclohexylene.

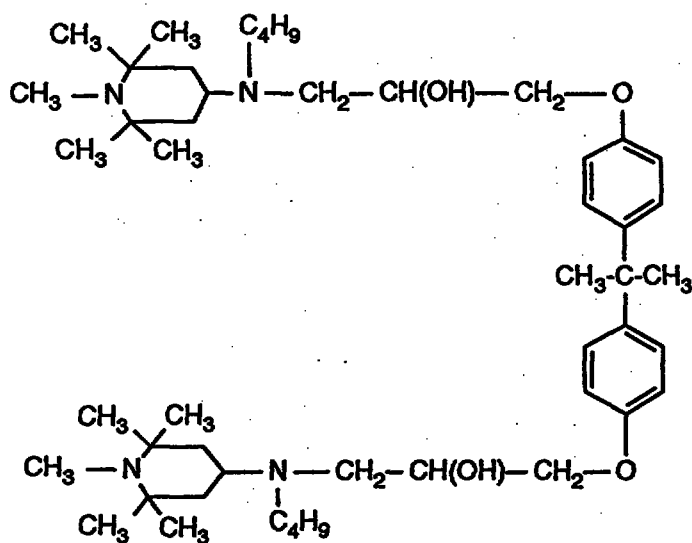
Preference is given to compounds of the formula V in which n is 1 or 2, G is hydrogen, G¹¹ is hydrogen or methyl, G¹³ is hydrogen, C₁-C₁₂alkyl or a group of the formula



and G¹⁴, in the case where n is 1, is hydrogen or C₁-C₁₂alkyl, and, in the case where n is 2, is C₂-C₈alkylene or 1-oxo-C₂-C₈alkylene.

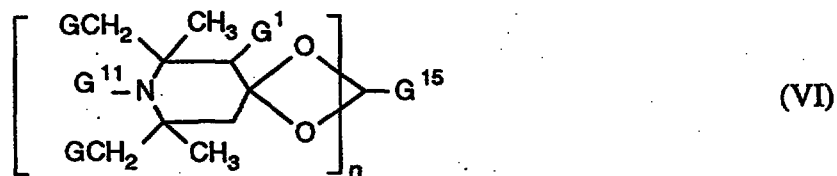
Examples of polyalkylpiperidine compounds of this class are the following compounds:

- 37) N,N'-bis(2,2,6,6-tetramethylpiperidin-4-yl)hexamethylene-1,6-diamine
- 38) N,N'-bis(2,2,6,6-tetramethylpiperidin-4-yl)hexamethylene-1,6-diacetamide
- 39) bis(2,2,6,6-tetramethylpiperidin-4-yl)amine
- 40) 4-benzoylamino-2,2,6,6-tetramethylpiperidine
- 41) N,N'-bis(2,2,6,6-tetramethylpiperidin-4-yl)-N,N'-dibutyladipamide
- 42) N,N'-bis(2,2,6,6-tetramethylpiperidin-4-yl)-N,N'-dicyclohexyl-2-hydroxypropylene-1,3-diamine
- 43) N,N'-bis(2,2,6,6-tetramethylpiperidin-4-yl)-p-xylylenediamine
- 44) N,N'-bis(2,2,6,6-tetramethylpiperidin-4-yl)succinediamide
- 45) di(2,2,6,6-tetramethylpiperidin-4-yl) N-(2,2,6,6-tetramethylpiperidin-4-yl)-β-aminodipropionate
- 46) the compound of the formula



- 47) 4-[bis(2-hydroxyethyl)amino]-1,2,2,6,6-pentamethylpiperidine
 48) 4-(3-methyl-4-hydroxy-5-tert-butylbenzamido)-2,2,6,6-tetramethylpiperidine
 49) 4-methacrylamido-1,2,2,6,6-pentamethylpiperidine

(c) compounds of the formula (VI)



in which n is 1 or 2, G, G¹ and G¹¹ are as defined under (a), and G¹⁵, in the case where n is 1, is C₂-C₈alkylene or -hydroxyalkylene or C₄-C₂₂acyloxyalkylene, and, in the case where n is 2, the group (-CH₂)₂C(CH₂)₂.

Examples of G¹⁵ as C₂-C₈alkylene or -hydroxyalkylene are ethylene, 1-methylethylene, propylene, 2-ethylpropylene or 2-ethyl-2-hydroxymethylpropylene.

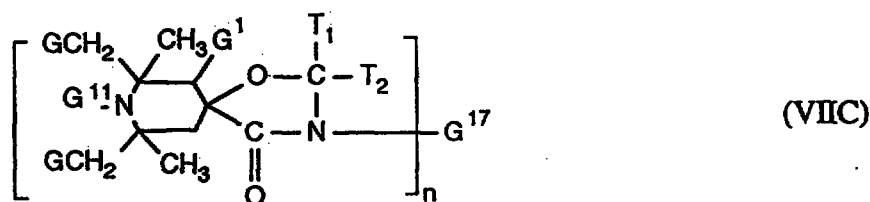
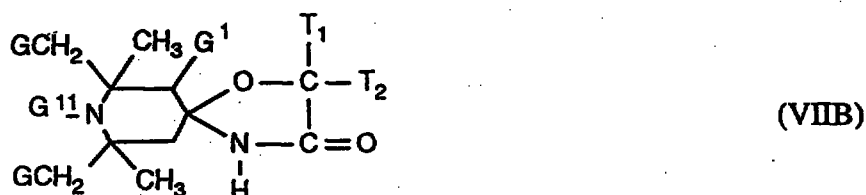
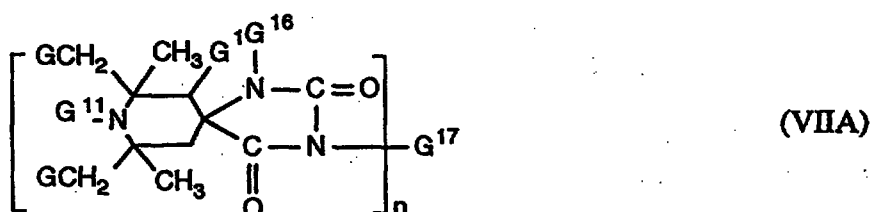
An example of G¹⁵ as C₄-C₂₂acyloxyalkylene is 2-ethyl-2-acetoxymethylpropylene.

Examples of polyalkylpiperidine compounds of this class are the following compounds:

- 50) 9-aza-8,8,10,10-tetramethyl-1,5-dioxaspiro[5.5]undecane
 51) 9-aza-8,8,10,10-tetramethyl-3-ethyl-1,5-dioxaspiro[5.5]undecane

- 52) 8-aza-2,7,7,8,9,9-hexamethyl-1,4-dioxaspiro[4.5]decane
 53) 9-aza-3-hydroxymethyl-3-ethyl-8,8,9,10,10-pentamethyl-1,5-dioxaspiro[5.5]undecane
 54) 9-aza-3-ethyl-3-acetoxymethyl-9-acetyl-8,8,10,10-tetramethyl-1,5-dioxaspiro[5.5]-undecane
 55) 2,2,6,6-tetramethylpiperidine-4-spiro-2'-(1',3'-dioxane)-5'-spiro-5''-(1'',3''-dioxane)-2''-spiro-4'''-(2'''',2''',6'''',6'''-tetramethylpiperidine).

(d) Compounds of the formulae VIIA, VIIB and VIIC, compounds of the formula VIIC being preferred,



in which n is 1 or 2, G , G^1 and G^{11} are as defined under (a),

G^{16} is hydrogen, C_1 - C_{12} alkyl, allyl, benzyl, glycidyl or C_2 - C_6 alkoxyalkyl and

G^{17} , in the case where n is 1, is hydrogen, C_1 - C_{12} alkyl, C_3 - C_5 alkenyl, C_7 - C_9 aralkyl, C_5 - C_7 cycloalkyl, C_2 - C_4 hydroxyalkyl, C_2 - C_6 alkoxyalkyl, C_6 - C_{10} aryl, glycidyl or a group of the formula $-(CH_2)_p\text{-COO-Q}$ or of the formula $-(CH_2)_p\text{-O-CO-Q}$, in which p is 1 or 2 and Q is C_1 - C_4 alkyl or phenyl,

G^{17} , in the case where n is 2, is C_2 - C_{12} alkylene, C_4 - C_{12} alkenylene, C_6 - C_{12} arylene, a group $-\text{CH}_2\text{-CH(OH)-CH}_2\text{-O-D-O-CH}_2\text{-CH(OH)-CH}_2\text{-}$, in which D is C_2 - C_{10} alkylene, C_6 - C_{15} arylene, C_6 - C_{12} cycloalkylene, or a group

$-\text{CH}_2\text{CH(OZ')CH}_2\text{-(OCH}_2\text{-CH(OZ')CH}_2\text{)}_2\text{-}$, in which Z' is hydrogen, C_1 - C_{18} alkyl, allyl,

benzyl, C_2 - C_{12} alkanoyl or benzoyl,

T_1 and T_2 , independently of one another, are hydrogen, C_1 - C_{18} alkyl or C_6 - C_{10} aryl or C_7 - C_9 aralkyl, each of which is unsubstituted or substituted by halogen or C_1 - C_4 alkyl, or T_1 and T_2 together with the C atom linking them form a C_5 - C_{14} cycloalkane ring.

Any C_1 - C_{12} alkyl substituents present are, for example, methyl, ethyl, n-propyl, n-butyl, sec-butyl, tert-butyl, n-hexyl, n-octyl, 2-ethylhexyl, n-nonyl, n-decyl, n-undecyl or n-dodecyl.

Any C_1 - C_{18} alkyl substituents present can be, for example, the groups listed above and in addition, for example, n-tridecyl, n-tetradecyl, n-hexadecyl or n-octadecyl.

Any C_2 - C_6 alkoxyalkyl substituents present are, for example, methoxymethyl, ethoxymethyl, propoxymethyl, tert-butoxymethyl, ethoxyethyl, ethoxypropyl, n-butoxyethyl, tert-butoxyethyl, isopropoxyethyl or propoxypropyl.

Examples of G^{17} as C_3 - C_5 alkenyl are 1-propenyl, allyl, methallyl, 2-butenyl or 2-pentenyl.

G^{17} , T_1 and T_2 as C_7 - C_9 aralkyl are in particular phenethyl or especially benzyl. A cycloalkane ring formed by T_1 and T_2 together with the C atom can be, for example, a cyclopentane, cyclohexane, cyclooctane or cyclododecane ring.

Examples of G^{17} as C_2 - C_4 hydroxyalkyl are 2-hydroxyethyl, 2-hydroxypropyl, 2-hydroxybutyl or 4-hydroxybutyl.

G^{17} , T_1 and T_2 as C_6 - C_{10} aryl are in particular phenyl, α - or β -naphthyl, each of which is unsubstituted or substituted by halogen or C_1 - C_4 alkyl.

Examples of G^{17} as C_2 - C_{12} alkylene are ethylene, propylene, 2,2-dimethylpropylene, tetramethylene, hexamethylene, octamethylene, decamethylene or dodecamethylene.

G^{17} as C_4 - C_{12} alkenylene is in particular 2-butenylene, 2-pentenylene or 3-hexenylene.

Examples of G^{17} as C_6 - C_{12} arylene are o-, m- or p-phenylene, 1,4-naphthylene or 4,4'-diphenylene.

Examples of Z' as C₂-C₁₂alkanoyl are propionyl, butyryl, octanoyl, dodecanoyl, but preferably acetyl.

D as C₂-C₁₀alkylene, C₆-C₁₅arylene or C₆-C₁₂cycloalkylene is as defined under (b).

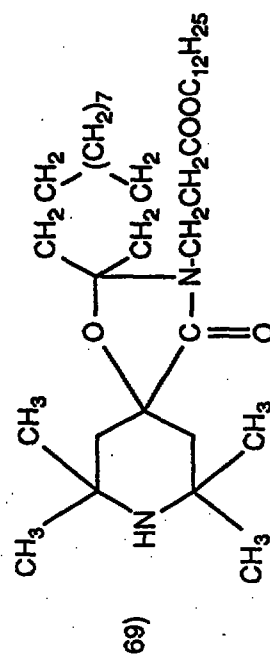
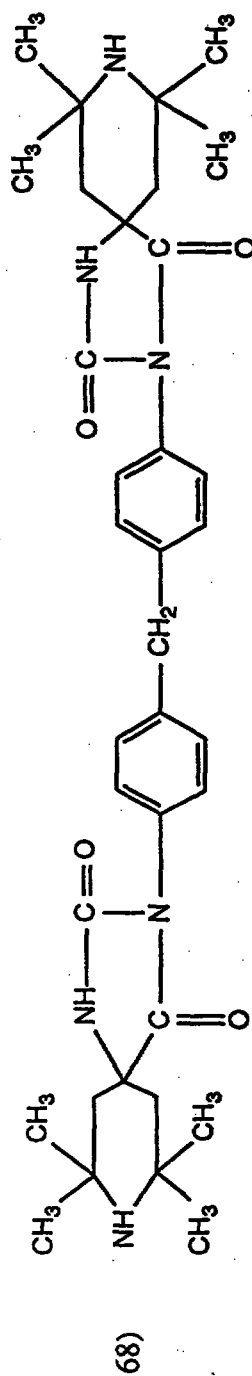
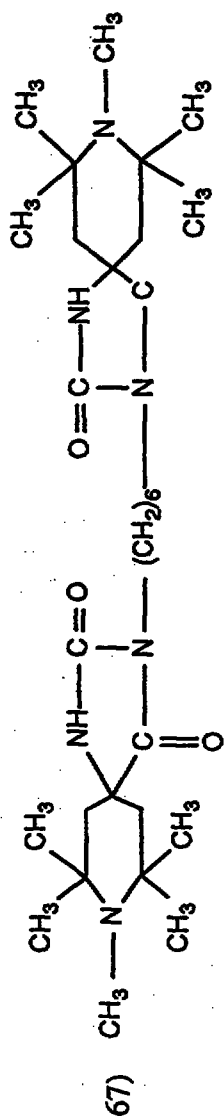
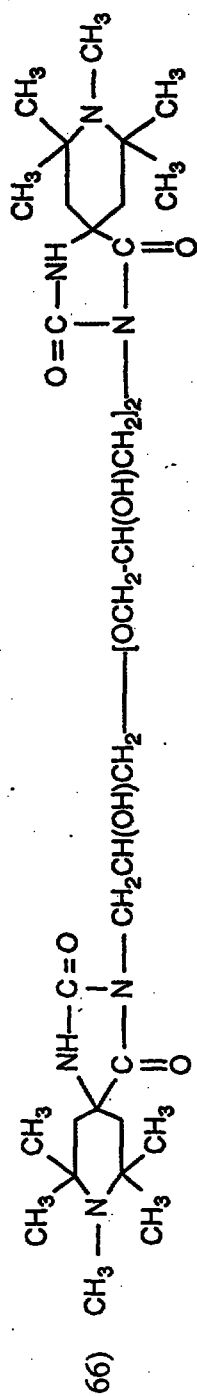
Examples of polyalkylpiperidine compounds of this class are the following compounds:

- 56) 3-benzyl-1,3,8-triaza-7,7,9,9-tetramethylspiro[4.5]decane-2,4-dione
- 57) 3-n-octyl-1,3,8-triaza-7,7,9,9-tetramethylspiro[4.5]decane-2,4-dione
- 58) 3-allyl-1,3,8-triaza-1,7,7,9,9-pentamethylspiro[4.5]decane-2,4-dione
- 59) 3-glycidyl-1,3,8-triaza-7,7,8,9,9-pentamethylspiro[4.5]decane-2,4-dione
- 60) 1,3,7,7,8,9,9-heptamethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione
- 61) 2-isopropyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxospiro-[4.5]decane
- 62) 2,2-dibutyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxospiro-[4.5]decane
- 63) 2,2,4,4-tetramethyl-7-oxa-3,20-diaza-21-oxodispiro[5.1.11.2]heneicosane
- 64) 2-butyl-7,7,9,9-tetramethyl-1-oxa-4,8-diaza-3-oxospiro[4.5]decane

and preferably:

- 65) 8-acetyl-3-dodecyl-1,3,8-triaza-7,7,9,9-tetramethylspiro[4.5]decane-2,4-dione

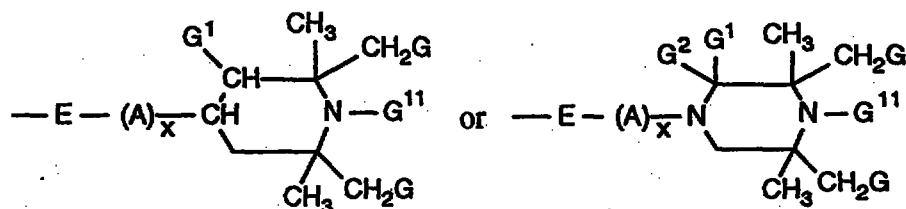
or the compounds of the following formulae:



(e) compounds of the formula VIII, which on their part are preferred,



in which n is 1 or 2 and G¹⁸ is a group of one of the formulae



in which G and G¹¹ are as defined under (a) and G¹ and G² are hydrogen, methyl or together are a substituent =O,

E is -O- or -NG¹³-,

A is C₂-C₆alkylene or -(CH₂)₃-O- and

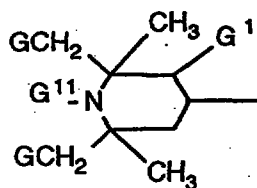
x is 0 or 1,

G¹³ is hydrogen, C₁-C₁₂alkyl, C₂-C₅hydroxyalkyl or C₅-C₇cycloalkyl,

G¹⁹ is identical to G¹⁸ or one of the groups -NG²¹G²², -OG²³, -NHCH₂OG²³ or -N(CH₂OG²³)₂,

G²⁰, in the case where n is 1, is identical to G¹⁸ or G¹⁹ and, if n is 2, is a group -E-B-E-, in which B is C₂-C₈alkylene or C₂-C₈alkylene which is interrupted by 1 or 2 groups -N(G²¹)-,

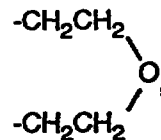
G²¹ is C₁-C₁₂alkyl, cyclohexyl, benzyl or C₁-C₄hydroxyalkyl or a group of the formula



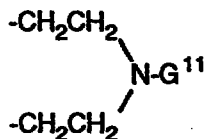
G²² is C₁-C₁₂alkyl, cyclohexyl, benzyl, C₁-C₄hydroxyalkyl, and

G²³ is hydrogen, C₁-C₁₂alkyl or phenyl, or

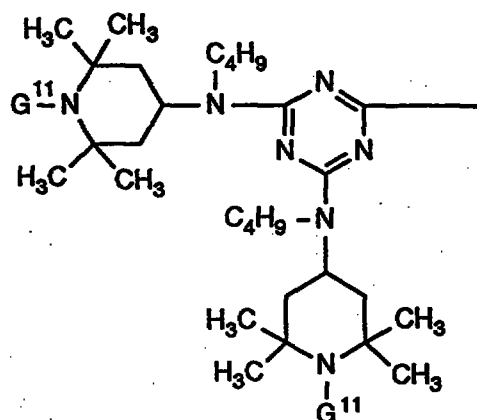
G^{21} and G^{22} together are C_4 - C_5 alkylene or -oxaalkylene, for example



or a group of the formula or



G^{21} is a group of the formula



Any C_1 - C_{12} alkyl substituents present are, for example, methyl, ethyl, n-propyl, n-butyl, sec-butyl, tert-butyl, n-hexyl, n-octyl, 2-ethylhexyl, n-nonyl, n-decyl, n-undecyl or n-dodecyl.

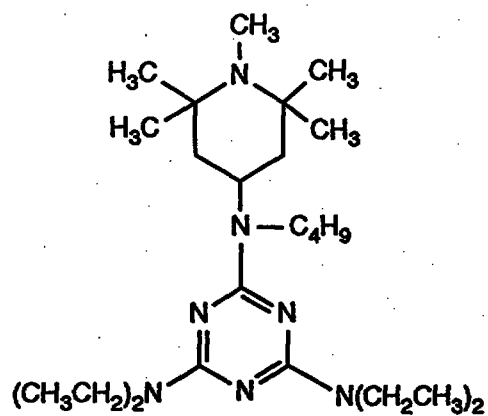
Any C_1 - C_4 hydroxyalkyl substituents present are, for example, 2-hydroxyethyl, 2-hydroxypropyl, 3-hydroxypropyl, 2-hydroxybutyl or 4-hydroxybutyl.

Examples of A as C_2 - C_6 alkylene are ethylene, propylene, 2,2-dimethylpropylene, tetramethylene or hexamethylene.

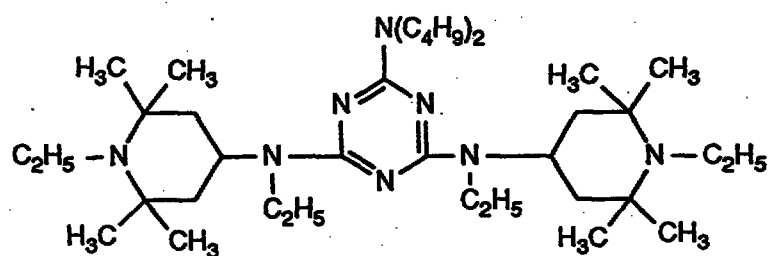
Examples of G^{21} and G^{22} together as C_4 - C_5 alkylene or -oxaalkylene are tetramethylene, pentamethylene or 3-oxapentamethylene.

Examples of polyalkylpiperidine compounds of this class are the compounds of the following formulae:

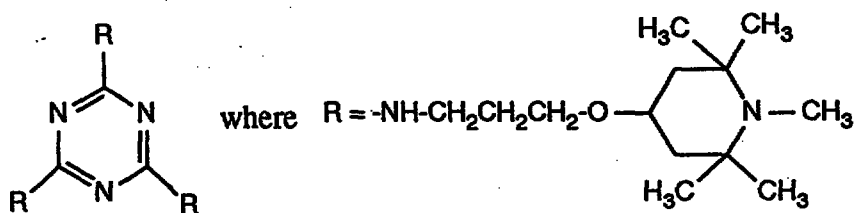
70)



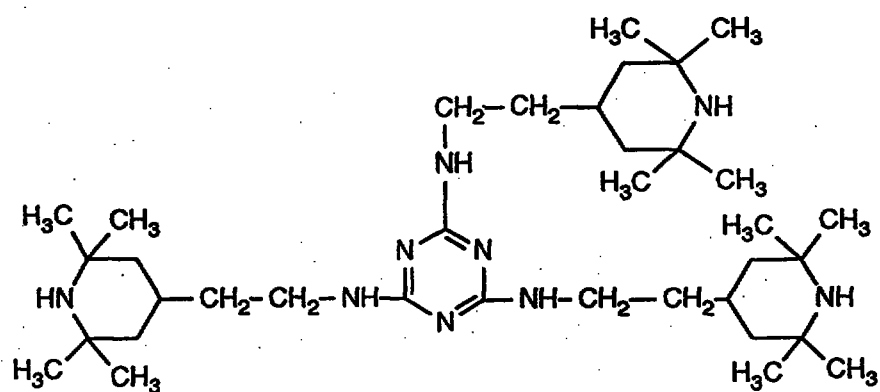
71)

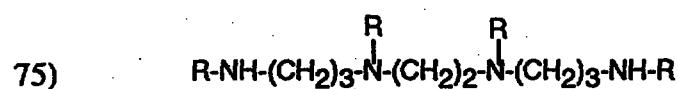
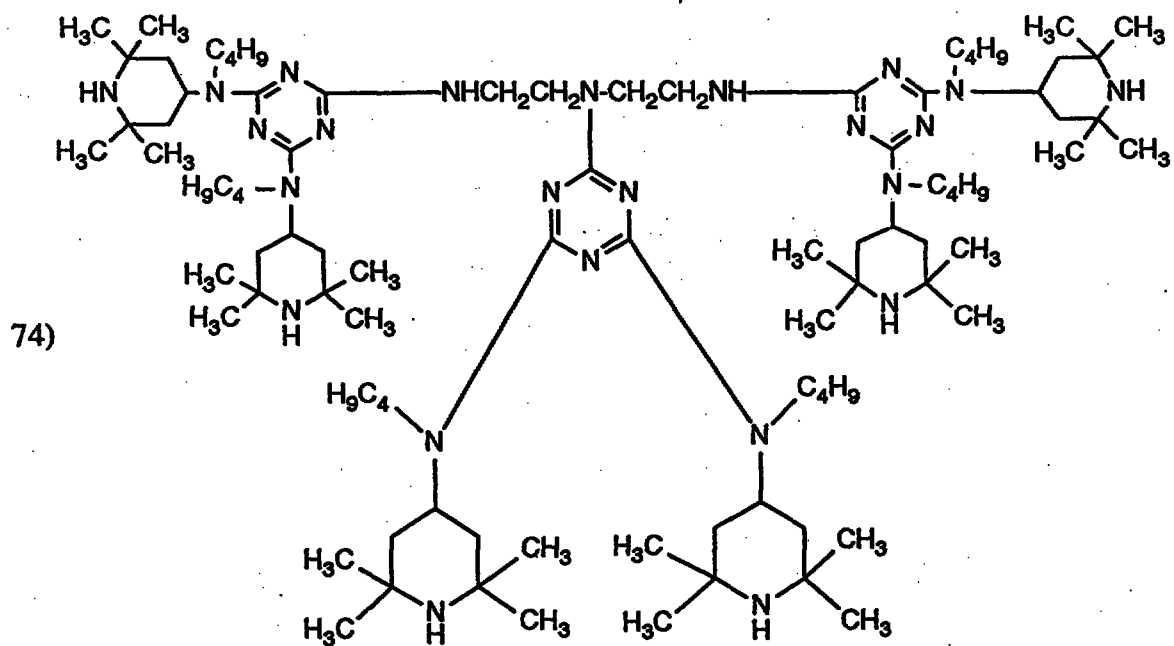


72)

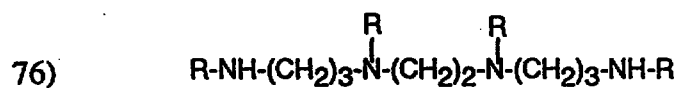
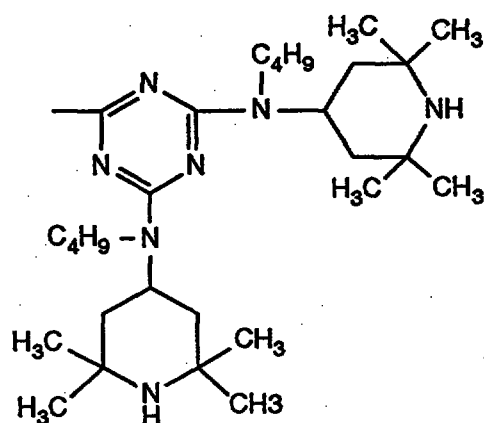


73)



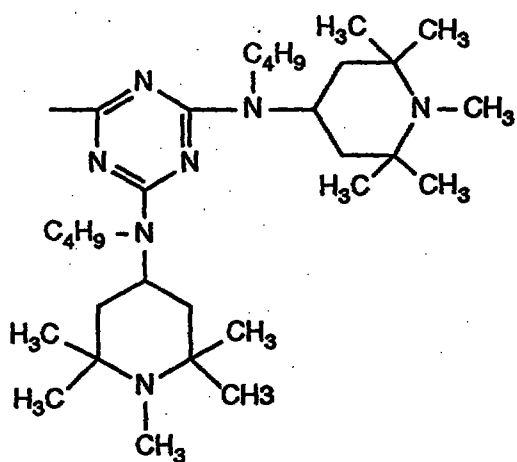


where R is

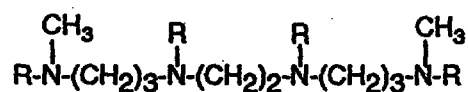


(amine J)

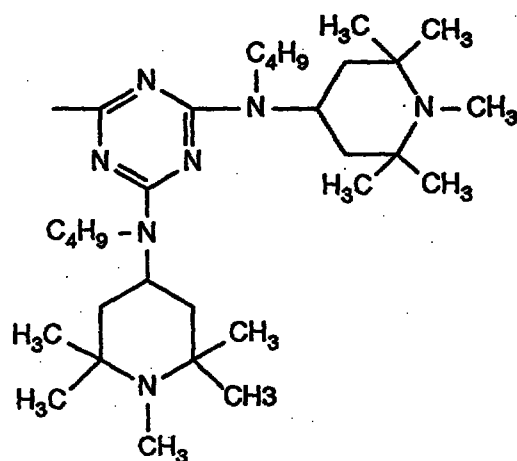
where R is



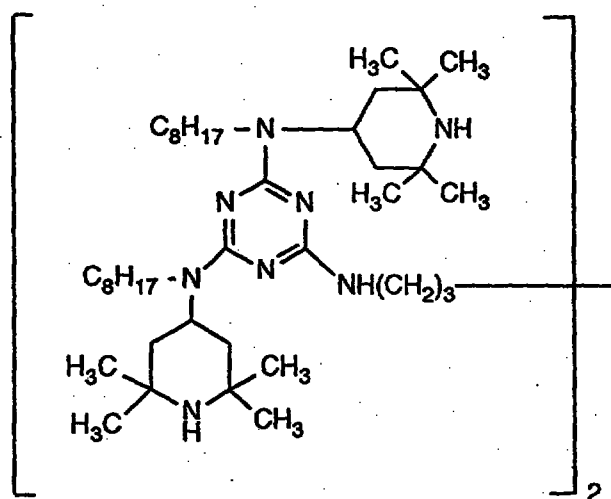
77)



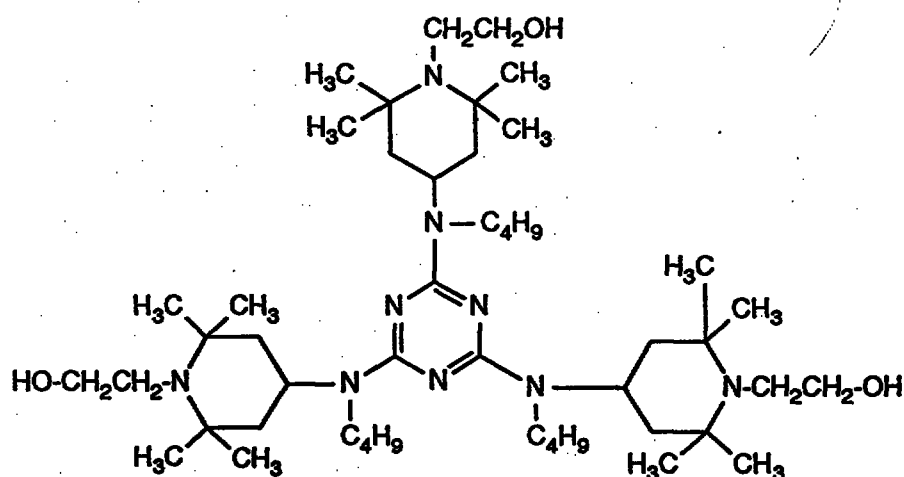
where R is



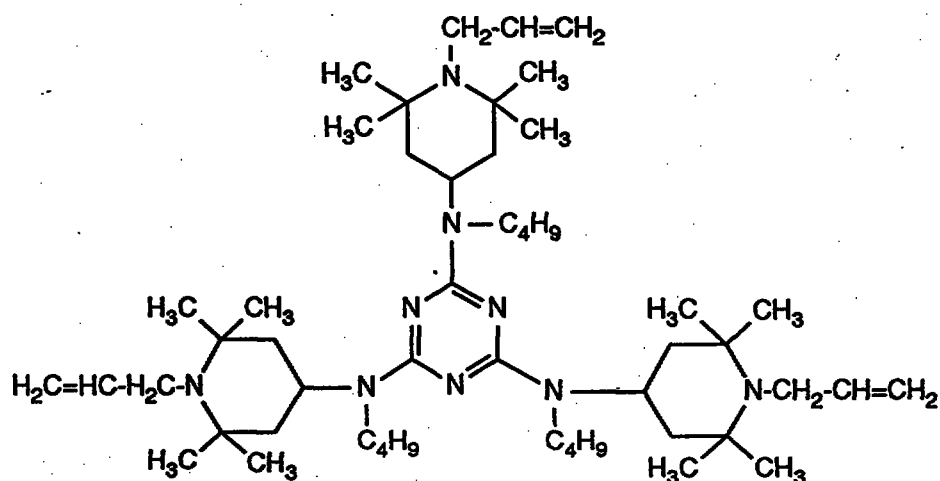
78)



79)

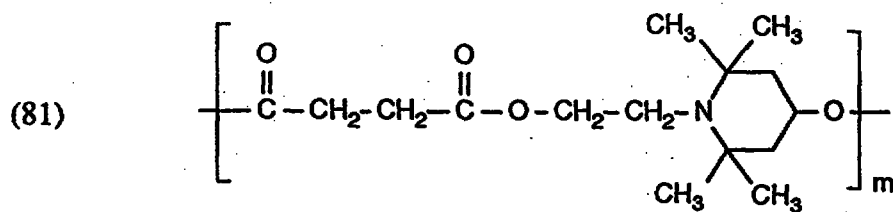


(80)

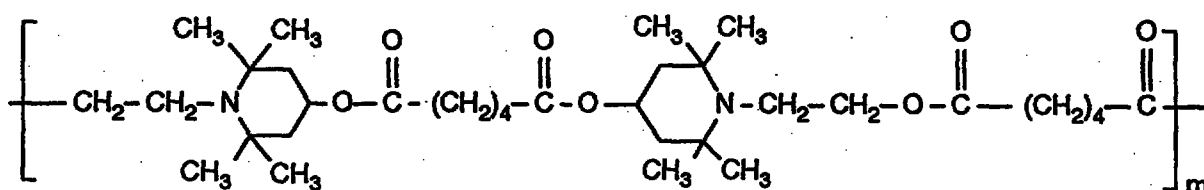


(f) oligomer or polymer compounds whose recurring structural unit contains a 2,2,6,6-tetraalkylpiperidine radical of the formula III, in particular polyesters, polyethers, polyamides, polyamines, polyurethanes, polyureas, polyaminotriazines, poly(meth)acrylates, poly(meth)acrylamides and copolymers thereof containing such radicals.

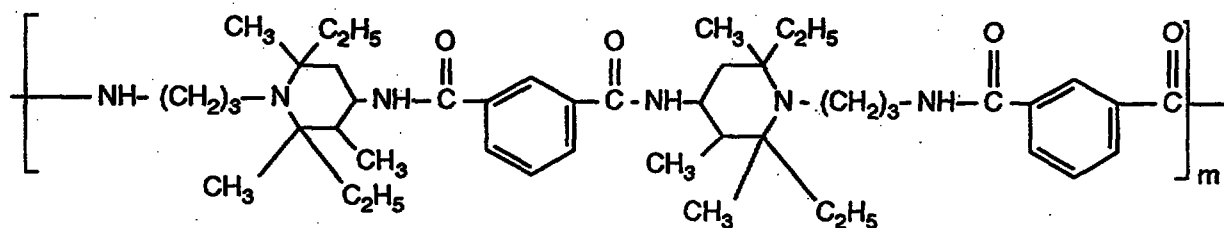
Examples of 2,2,6,6-polyalkylpiperidine light stabilizers of this class are the compounds of the following formulae, m being a number from 2 to about 200.



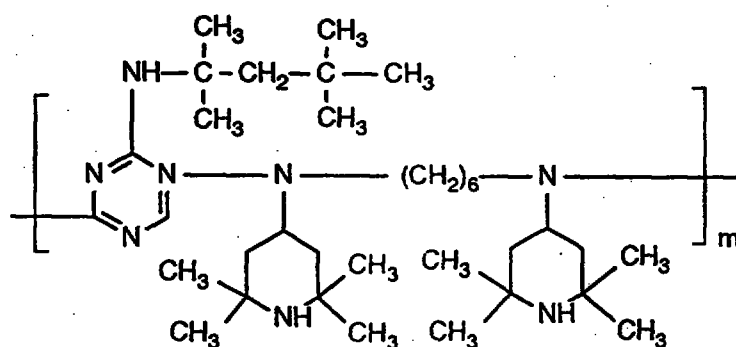
(82)



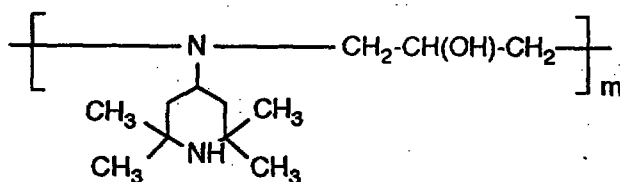
(83)

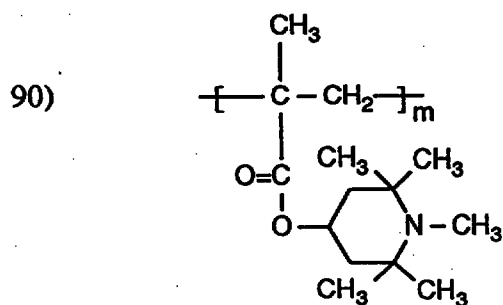
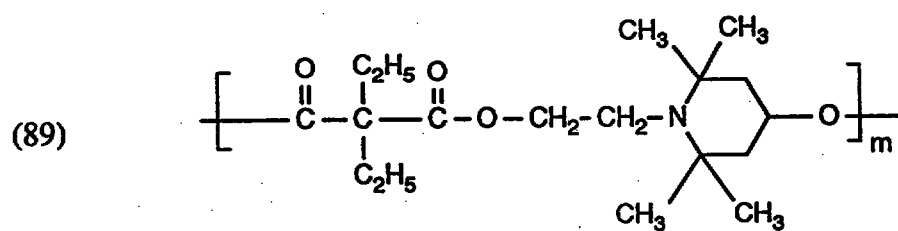
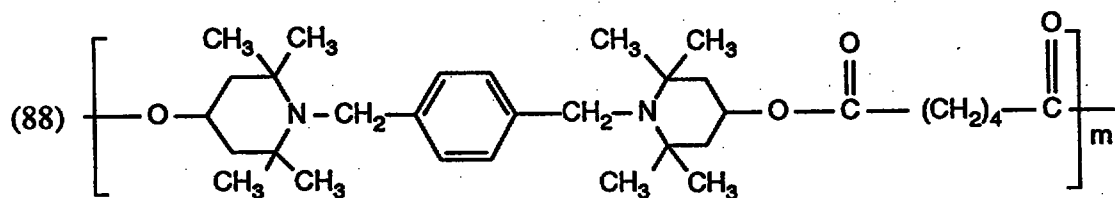
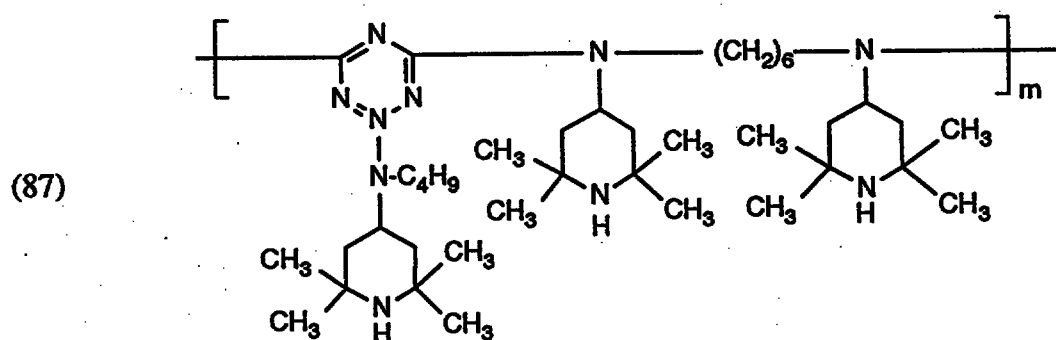
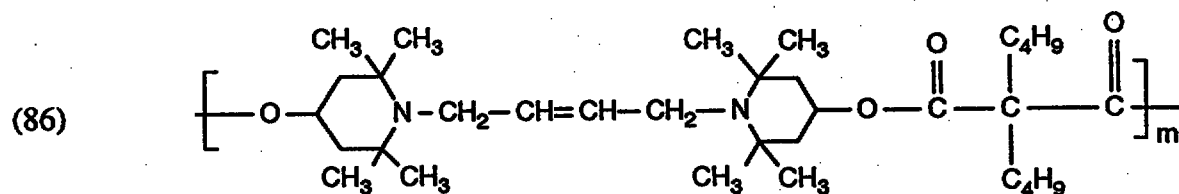


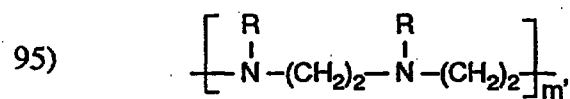
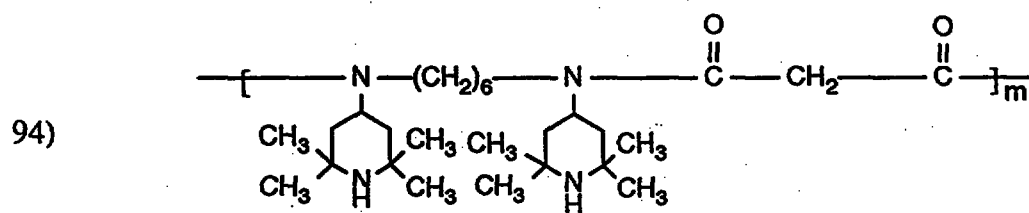
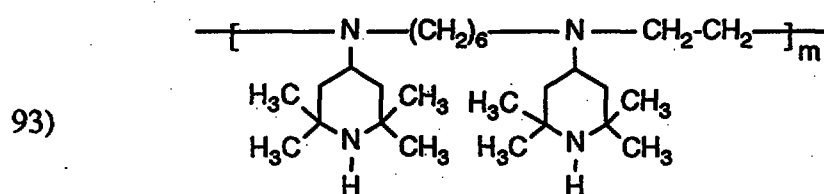
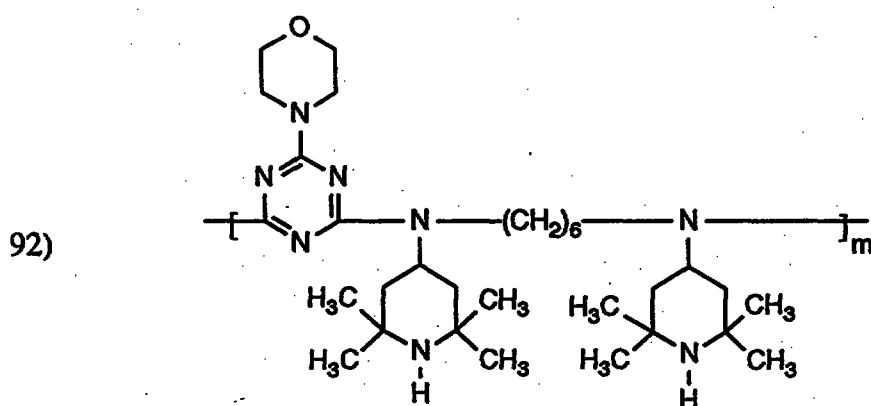
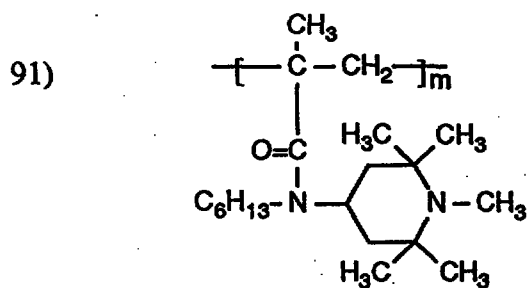
(84)



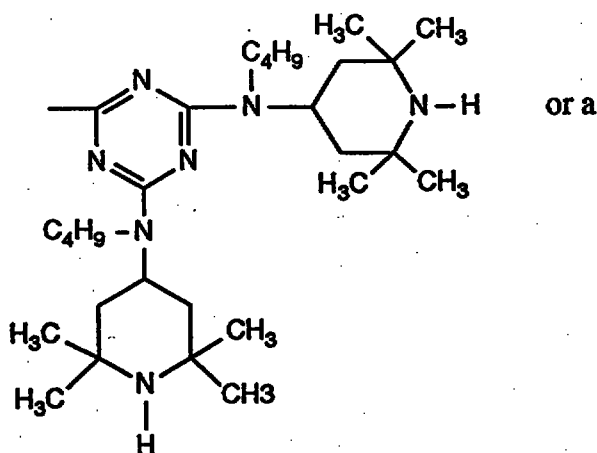
(85)





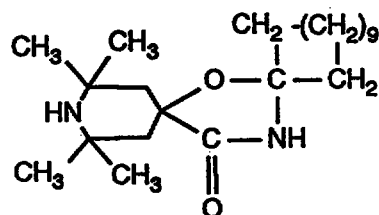


where R is



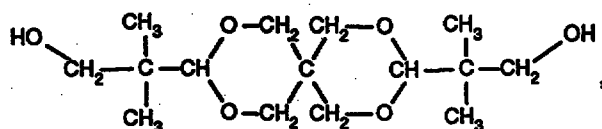
branching of the chain $-(CH_2)_2-\overset{\overset{R}{|}}{N}-\left[CH_2\right]_{m''}$, m' and m'' are each an integer from the range 0-200, on condition that $m' + m''$ is m .

Further examples of polymer light stabilizers are reaction products of compounds of the formula



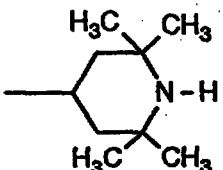
with epichlorohydrin;

polyesters obtained from butane-1,2,3,4-tetracarboxylic acid with a bifunctional alcohol of the formula

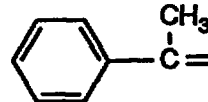


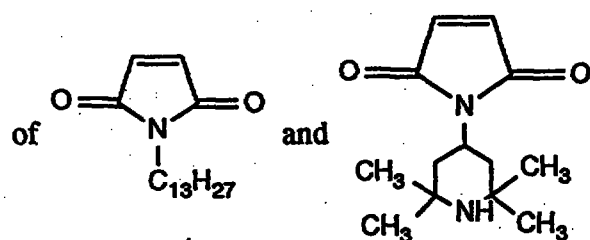
whose carboxyl side chains originating from the tetracarboxylic acid have been esterified with 2,2,6,6-tetramethyl-4-hydroxypiperidine;

compounds of the formula $\left[\begin{array}{c} \text{CH}_3 \\ | \\ -CH_2-C-CH_2-CH- \\ | \quad \quad | \\ O=C \quad O=C \\ | \quad \quad | \\ OCH_3 \quad OR \end{array} \right]_m$, about one third of the radicals R

being $-C_2H_5$ and the others being , and m being a number from the range

2 to 200; or

copolymers whose recurring unit consists of 2 units  and 1 unit each



(g) compounds of the formula IX



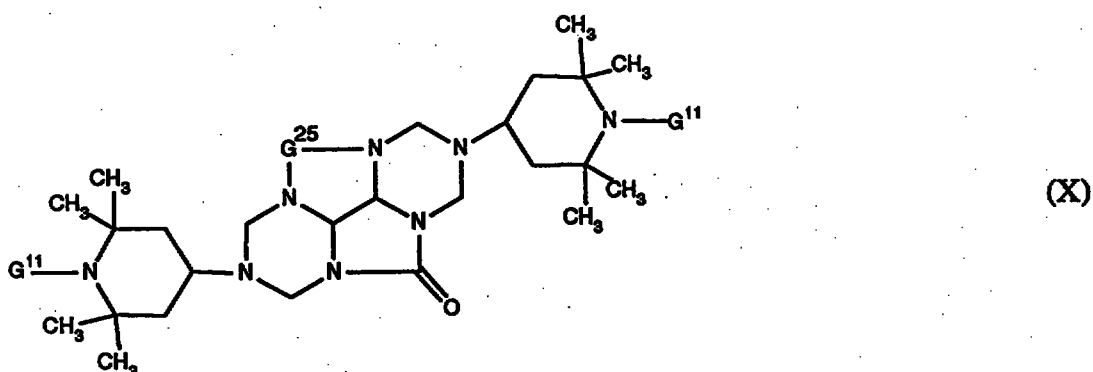
in which G, G¹ and G¹¹ are as defined under (a).

Preference is given to compounds of the formula IX in which G is hydrogen or methyl and G¹¹ is hydrogen or methyl.

Examples of such compounds are:

- 96) 2,2,6,6-tetramethyl-4-piperidone (triacetoneamine)
- 97) 1,2,2,6,6-pentamethyl-4-piperidone
- 98) 2,3,6-trimethyl-2,6-diethyl-4-piperidone

(h) compounds of the formula X



in which G^{11} is as defined under (a) and G^{25} is a direct bond, methylene or preferably carbonyl, as disclosed in DE-A-3530666;

Particular preference for use in the composition according to the invention is given to the following amines:

Compounds of the formula IV in which n is an integer from the range 1 to 4, G and G^1 are hydrogen, and

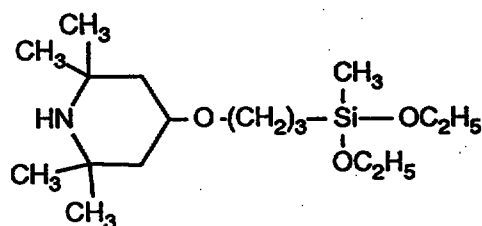
G^{11} is hydrogen or C_1 - C_{18} alkyl, and

G^{12} , in the case where n is 1, is a radical of the formula $-(C_jH_{2j})-Si(Z')_2Z''$, in which j is an integer from the range 2 to 5 and Z' and Z'' , independently of one another, are C_1 - C_4 alkyl or C_1 - C_4 alkoxy, and

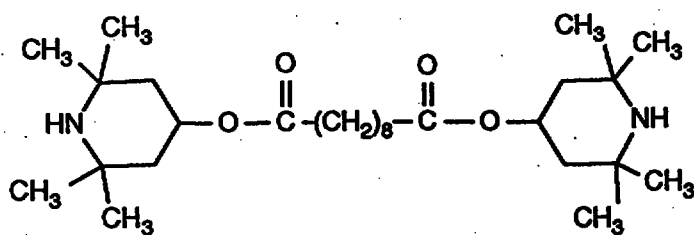
G^{12} , in the case where n is 2, is a radical of an aliphatic dicarboxylic acid having 2 to 12 C atoms which may be substituted by $-COOZ^{12}$, Z^{12} being C_1 - C_{20} alkyl,

G^{12} , in the case where n is 3, is a radical of an aromatic tricarboxylic acid having 9 to 15 C atoms,

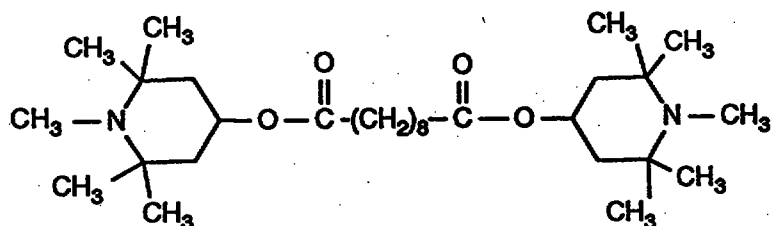
G^{12} , in the case where n is 4, is a radical of an aliphatic tetracarboxylic acid having 8 to 12 C atoms; amines from this class which are of particular technical interest are those of the formulae



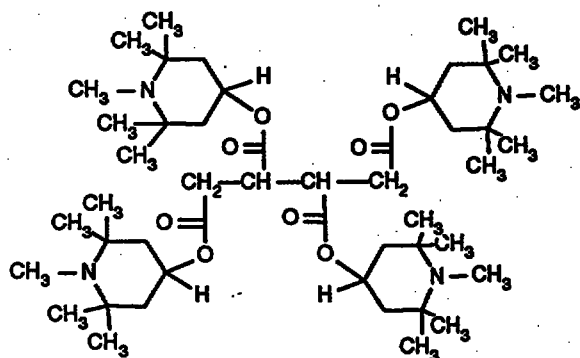
(amine B),



(amine C),



(amine D),



(amine E),

and

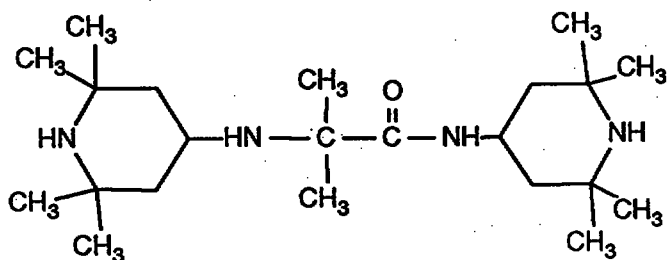
esters of butane-1,2,3,4-tetracarboxylic acid containing 2 units each of 1,2,2,6,6-pentamethyl-4-hydroxy-piperidine and $C_{13}H_{27}OH$ (amine F);

compounds of the formula V in which n is 2, G and G^1 are hydrogen,

G^{11} is hydrogen or methyl and

G^{13} is hydrogen or C_1 - C_8 alkyl, and

G^{14} is C_2 - C_8 alkylene or 1-oxo- C_2 - C_8 alkylene; an amine from this class which is of particular technical interest is the compound of the formula

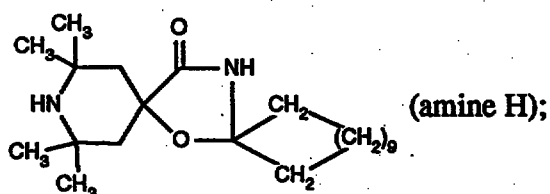


(amine G);

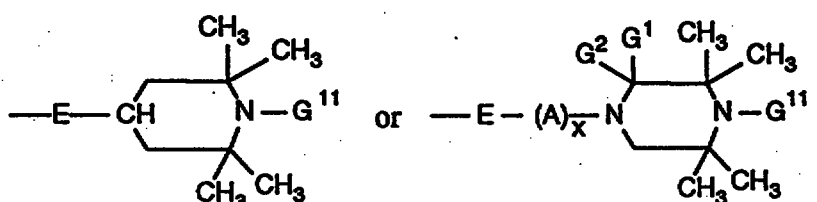
compounds of the formula VIIC in which n is 1, G, G^1 and G^{17} are hydrogen,

G^{11} is hydrogen or methyl and

T₁ and T₂ together with the C atom linking them form a C₅-C₁₄cycloalkane ring; an amine from this class which is of particular technical interest is the compound of the formula



compounds of the formula VIII in which n is 1 or 2,
G¹⁸ and G¹⁹ are a group of one of the formulae



G¹¹ is hydrogen or methyl,

G¹ and G² are hydrogen or together are a substituent =O,

E is -O- or -NG¹³-,

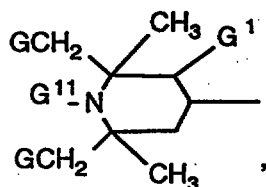
A is C₂-C₆alkylene, and

x is 0 or 1,

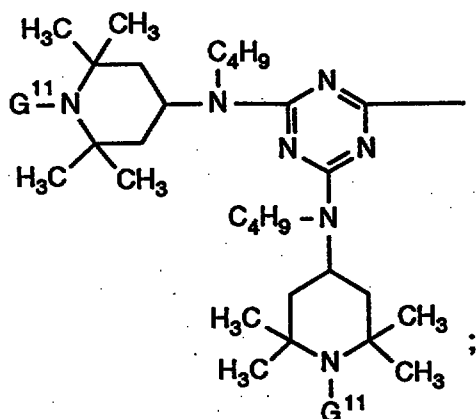
G¹³ is hydrogen, C₁-C₁₂alkyl or cyclohexyl,

G²⁰, in the case where n is 1, is identical to G¹⁸ and, in the case where n is 2, is a group -E-B-E-, in which B is C₂-C₈alkylene or C₂-C₈alkylene which is interrupted by 1 or 2 groups -N(G²¹)-,

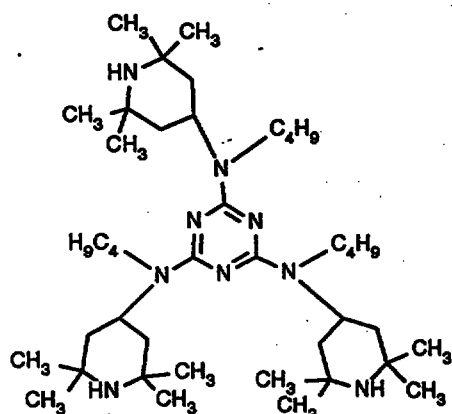
G²¹ is C₁-C₁₂alkyl, cyclohexyl, benzyl or C₁-C₄hydroxyalkyl or a group of the formula



or G²¹ is a group of the formula



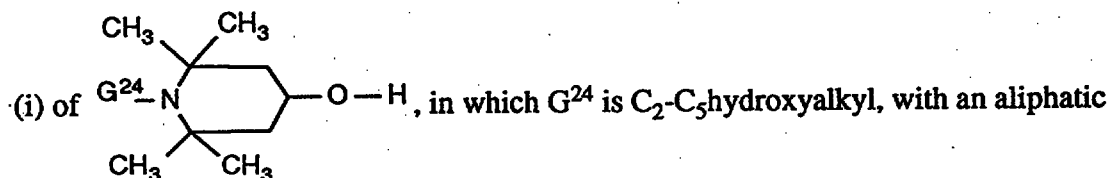
amines from this class which are of particular technical interest are the compound (76) [= amine J] described above and the compound of the formula



as disclosed in EP-A-107615 (amine K);

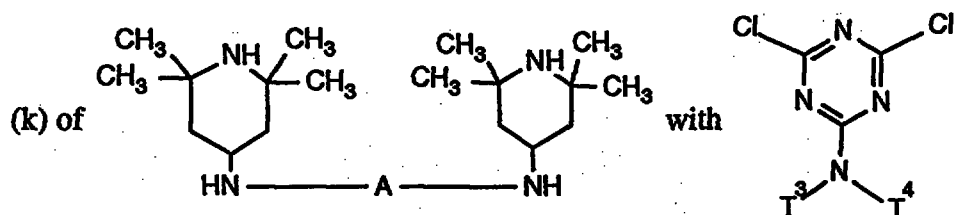
compounds of the formula X wherein G^{11} is hydrogen or methyl;
and

oligomer compounds having 2 to 10 recurring units, such as are obtainable by reaction

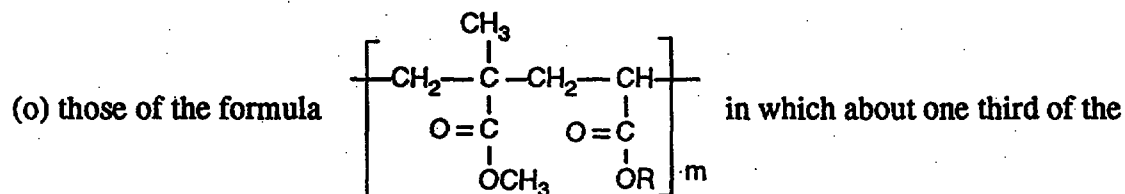
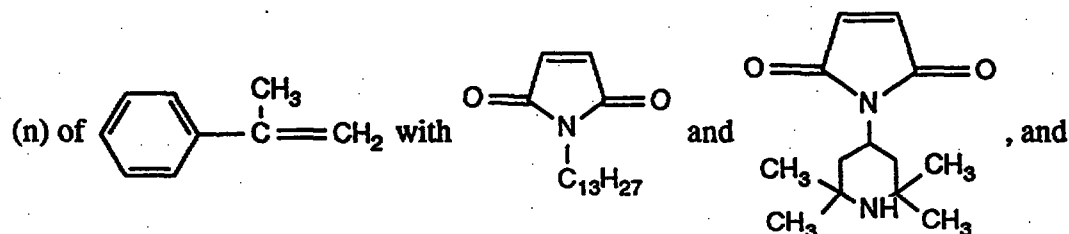
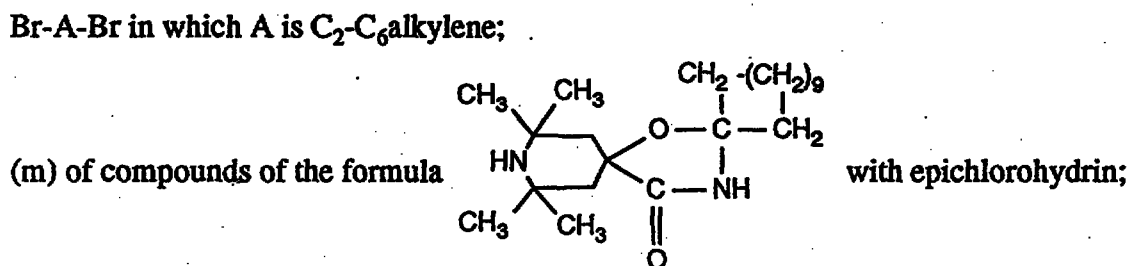
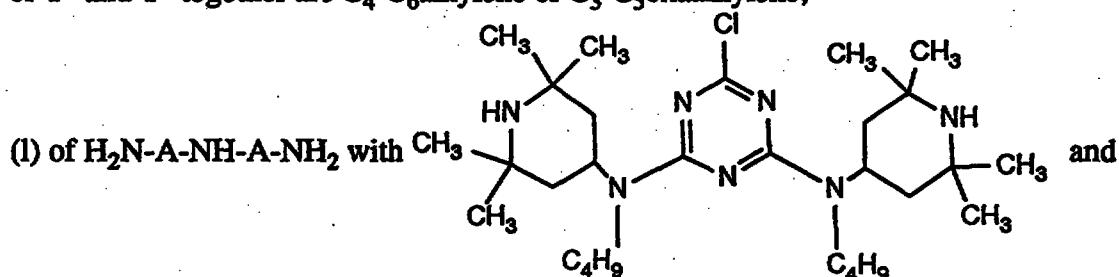


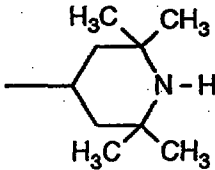
C_2 - C_{12} dicarboxylic acid or a suitable reactive derivative, such as the diester, dichloride or anhydride;

(j) of a linear oligomer polyester obtained from a dialcohol and butane-1,2,3,4-tetracarboxylic acid with 2,2,6,6-tetramethyl-4-hydroxypiperidine;



in which A is C₂-C₆alkyl, T³ is C₁-C₁₈alkyl or cyclohexyl, T⁴ is hydrogen or C₁-C₁₈alkyl, or T³ and T⁴ together are C₄-C₆alkylene or C₃-C₅oxaalkylene;



radicals R is -C₂H₅ and the others are  and m is a number from the range

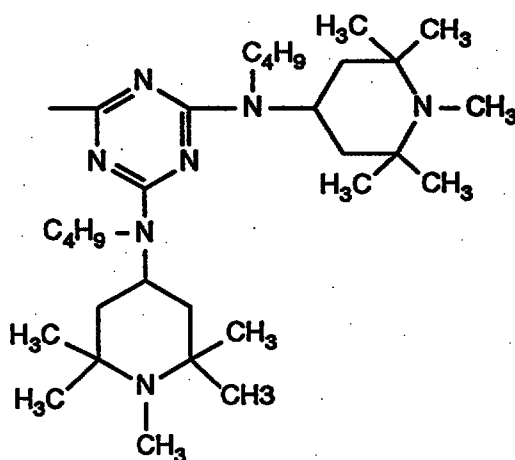
2 to 10.

The oligomer amines are often mixtures of compounds which differ from one another with respect to their chain length.

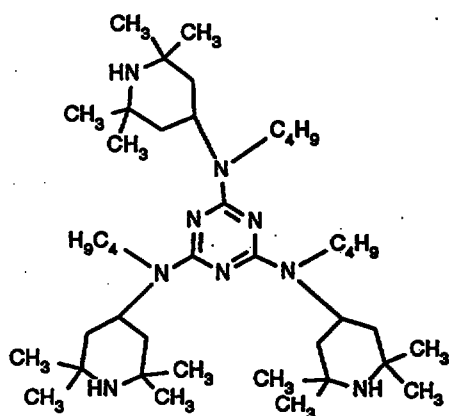
A preferred class of sterically hindered amines are those containing triazine rings.

Of these classes of sterically hindered amines, amines of particularly high technical interest are those of the following formulae (m again is a number from the range 2 to 10):

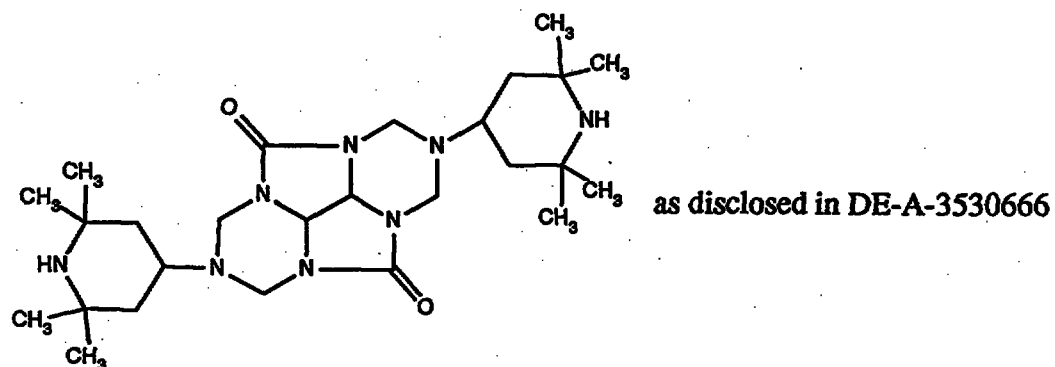
$R-NH-(CH_2)_3-N(R)-(CH_2)_2-N(R)-(CH_2)_3-NH-R$ where R is



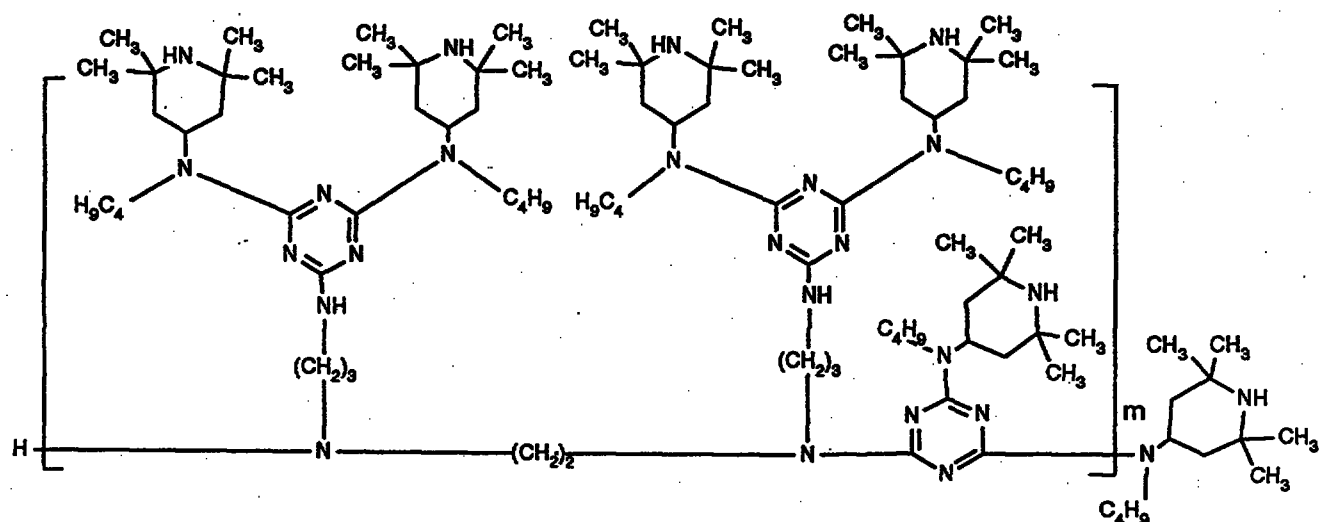
as disclosed in US-A-4108829 and US-A-4263434 (amine J);



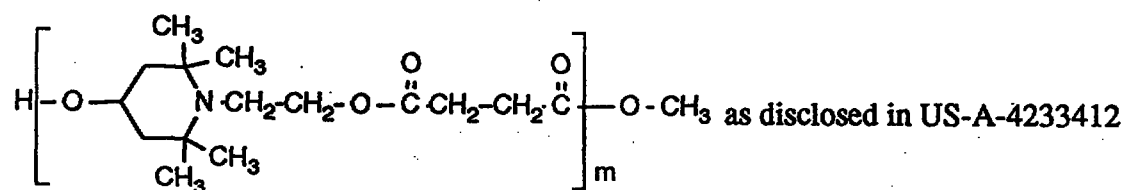
as disclosed in EP-A-107615 (amine K);



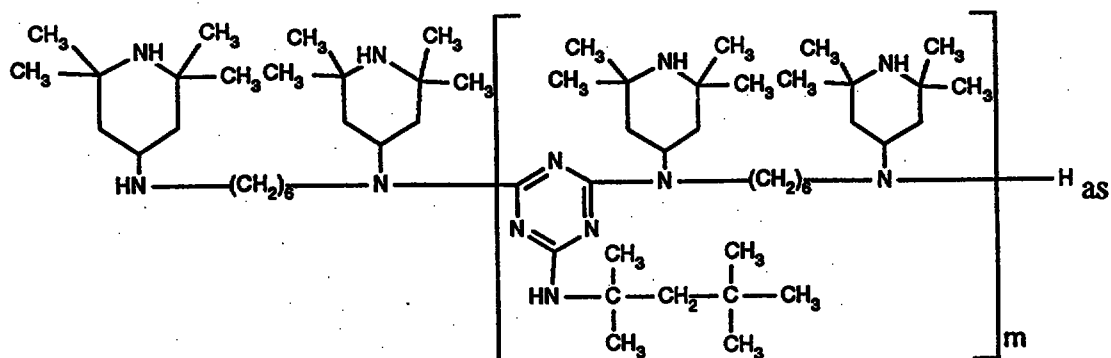
(amine L):



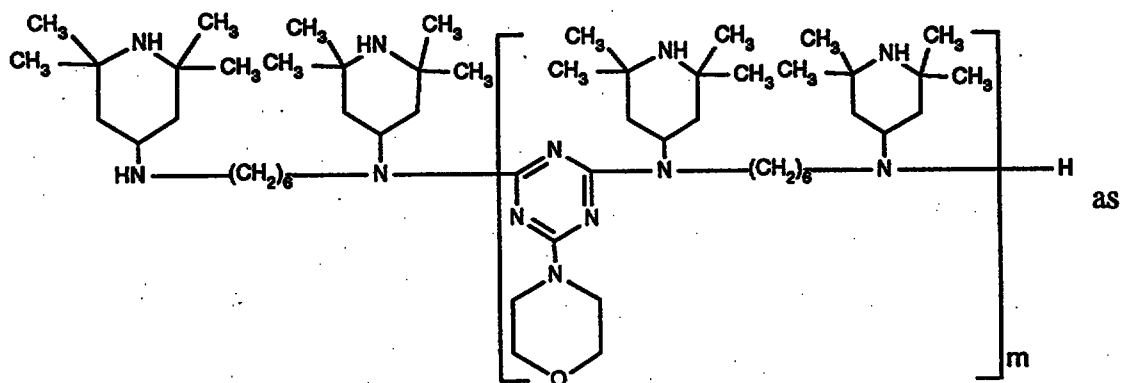
(amine M);



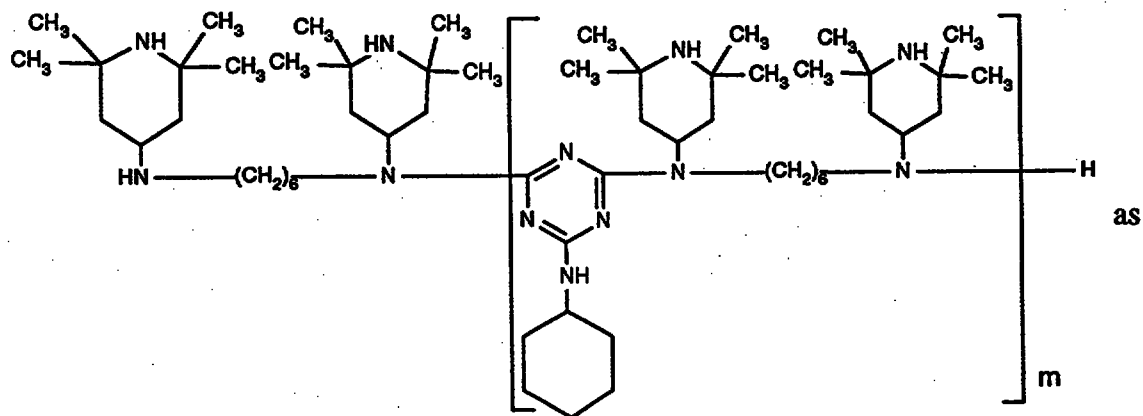
(amine N);



disclosed in US-A-4086204 (amine P);

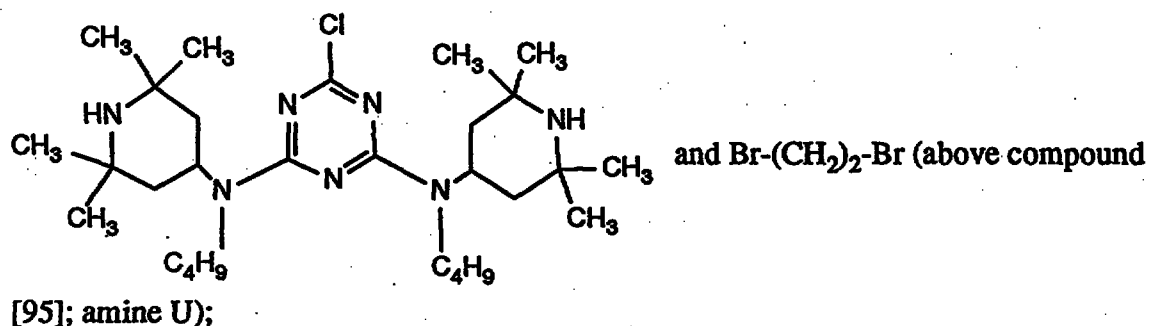


disclosed in US-A-4331586 (amine Q);

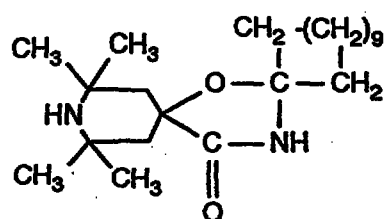


disclosed in EP-A-357223 (amine R);

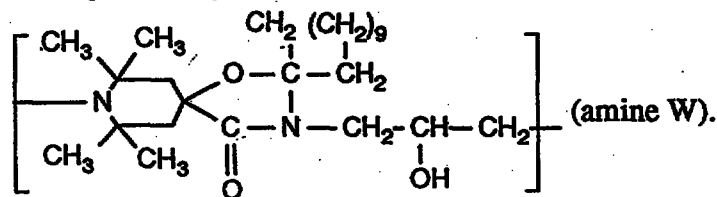
the reaction product of $\text{H}_2\text{N}-(\text{CH}_2)_2-\text{NH}-(\text{CH}_2)_2-\text{NH}_2$ with



and the reaction product of the compound of the formula



with epichlorohydrin as disclosed in EP-A-402889, having the recurring structural unit



For compositions according to the invention, in particular the addition of those sterically hindered amines is preferred whose molecular weight or average molecular weight is in the range 300 to 10,000, in particular in the range 1000 to 10,000. Of these, those sterically hindered amines whose molecular weight or average molecular weight is in the range 1500 to 10,000, for example in the range 2000 to 7500 may again be mentioned in particular.

All components of the stabilizer composition according to the invention mentioned are known compounds; many of them are commercially available.

Incorporation of the stabilizers into the polyolefin or polyolefin copolymer can be effected by adding the stabilizers according to the invention and, if desired, other additives by the methods conventional in industry. Incorporation can be effected advantageously before or during shaping, for example by mixing the pulverulent components or by adding the stabilizer to the melt or solution of the polymer, or by applying the dissolved or dispersed stabilizers to the polymer, followed if desired by the evaporation of the solvent. A further possibility for incorporating the stabilizers according to the invention into polymers

consists in their addition before or during the polymerization of the corresponding monomers or before crosslinking.

The stabilizers according to the invention or mixtures thereof can also be added to the polyolefin or polyolefin copolymer to be stabilized in the form of a masterbatch which contains these stabilizers in, for example, a concentration of from 2.5 to 25 % by weight.

The stabilizers according to the invention are advantageously incorporated by the following possible methods:

- as emulsion or dispersion (e.g. to latices or emulsion polymers)
- as a dry mixture during the mixing of additional components or polymer mixtures
- by direct addition to the processing apparatus (e.g. extruder, calender etc.)
- as solution or melt.

The resulting stabilized polyolefin or polyolefin copolymer compositions can be converted into films by the conventional methods.

The invention therefore also relates to a process for the stabilization of polyolefin or polyolefin copolymer films for agricultural applications, especially greenhouse applications, this polyolefin or polyolefin copolymer film having improved light stability and pesticide resistance, comprising incorporation of a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium, into the polyolefin or polyolefin copolymer. A further subject of the invention is a greenhouse, characterized in that it is covered by a polyolefin or polyolefin copolymer film having improved light stability and pesticide resistance and stabilized with a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium, and a process for stabilizing a polyolefin or polyolefin copolymer greenhouse film against detrimental effects of pesticides and light, oxygen and/or heat, which process comprises incorporation of a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium, into said greenhouse film.

Further subjects of the invention are the use of a polyolefin or polyolefin copolymer film stabilized with a sterically hindered amine and a metal oxide or hydroxide selected from

oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium for agricultural applications involving pesticides, especially greenhouse applications, and the use of a sterically hindered amine in combination with a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium for the stabilization of polyolefin or polyolefin copolymer films in contact with pesticides against photodegradation and damage by pesticides.

The following examples further illustrate the embodiments of the instant invention. All parts given are by weight unless otherwise noted.

Example 1: Greenhouse Application

The compounds reported in table 1 are mixed via master batch with LDPE (polyethylene of low density) pellets (Riblene[®] EF 2100 V, supplied by ENICHEM, Milano, Italy), characterized by a density of 0.921 g/cm³ and a melt flow index (190°C/2.16 kg) of 0.25, in a slow mixer.

The master batches had previously been prepared by extruding powdered LDPE and 10 % by weight of the sterically hindered amine compound A and the relevant concentrations of compounds B (= metal oxide or hydroxide), C (= salt of carboxylic acid) and D (hydrotalcite).

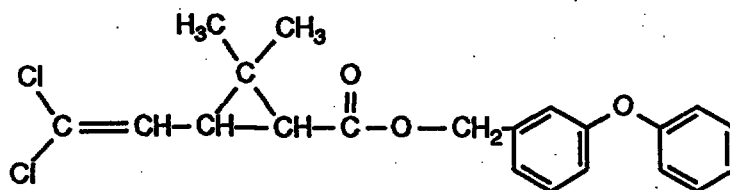
The mixtures are blow extruded at 200°C, and films of 150 microns thickness are obtained.

The films are exposed on the south-facing roof of a greenhouse in Pontecchio Marconi (Bologna, Italy) without backing.

The following pesticides are applied in the greenhouse:

VAPAM[®] (BASLINI SpA, Treviglio/BG, Italy), which is an aqueous solution of 382 g per liter of metam-sodium having the formula CH₃-NH-CS-SNa;

SESMETRIN[®] (BIMEX SpA, Isola/VI, Italy), which is a 23.75 % (% w/w) aqueous solution of permethrin having the formula



The greenhouse is treated with a solution of 4 liters of VAPAM in 10 liters of water every 6 months, and with SESMETRIN (5 g in 5 liters of water) every month.

During the exposure, the performance is periodically evaluated measuring the residual elongation (in % of the initial elongation of the new polyethylene film) by means of a dynamometer at constant speed.

In table 1, the residual elongation after 16 months of exposure, corresponding to 137 kilolanglely (Klys.; energy per unit area), and 22 months (= 198 Klys.) of exposure are reported. All concentrations given are by weight of the polymer.

Table 1: Residual Elongation (in % of the Initial Elongation) after 16 Months and 22 Months Exposure

A	Compound (Concentration)			Residual Elongation after	
	B*	C**	D***	16 months	22 months
amine P(0.4)	none	none	none	84 %	16 %
amine P(0.4)	(0.2)	(0.2)	none	100 %	69 %
amine J(0.4)	none	none	none	64 %	8 %
amine J(0.4)	(0.2)	(0.2)	none	88 %	59 %
amine J(0.4)	(0.2)	(0.2)	(0.5)	92 %	65 %

* compound B is ZnO

** compound C is calcium stearate

*** compound D is a hydrotalcite of formula $Mg_{4.5}Al_2(OH)_{13}CO_3$

The superiority of films stabilized according the invention, containing a metal oxide and optional further components is evident.

Example 2: Comparison without Application of Pesticides.

For the purpose of comparison, further films prepared as in example 1 are exposed on galvanized iron and on pine wood supports without application of pesticides. The film surfaces are fixed in a 45° inclination towards south. Residual elongation is monitored as described in example 1.

Table 2 gives the residual elongation after 34 months of exposure, corresponding to 310 kilolanglely (Klys.; energy per unit area). All concentrations given are by weight of the polymer.

Table 2: Residual Elongation (in % of the Initial Elongation) after 34 Months Exposure

Compound (Concentration)			Residual Elongation after 34 months	
A	B*	C**	Pine Wood	Galvanized Iron
amine J(0.4)	none	none	37 %	42 %
amine J(0.4)	(0.2)	(0.2)	51 %	83 %

* compound B is ZnO

** compound C is calcium stearate

A comparison with the data given in example 1, table 1, shows the strong effect of the pesticide treatment in example 1.

Example 3

Stabilized LDPE films are manufactured by mixing ground LDPE (RIBLENE® FF 29; ENICHEM, Milano/Italy), characterized by a density of 0.921 g/cm³ and a melt flow index (190°C/2.16 kg) of 0.6, with the compounds reported in tables 3 and 4 in a turbo mixer. Application of pesticides and exposure is as described in example 1.

During the exposure, the performance is periodically evaluated measuring the residual elongation (in % of the initial elongation of the new polyethylene film) by means of a dynamometer at constant speed, and the carbonyl increase with an IR-FT spectrometer (IR Fourier transformation spectrometer by Perkin Elmer).

The results after 14 months of exposure, corresponding to 110 kilolangleys, are presented in the following tables 3 and 4.

Table 3: Residual Elongation (in % of the Initial Elongation) after 14 Months Exposure

Compound (Concentration)			Residual Elongation after 14 months
A	B*	C**	
amine W(0.4)	none	none	25 %
amine W(0.4)	(0.2)	(0.2)	47 %
amine W(0.8)	none	none	30 %
amine W(0.8)	(0.2)	(0.2)	93 %
amine N(0.6)	none	none	13 %
amine N(0.6)	(0.2)	(0.2)	39 %

* compound B is ZnO

** compound C is calcium stearate

Table 4: Carbonyl Increase after 14 Months Exposure

Compound (Concentration)				Carbonyl Increase after 14 months
A	B*	C**	D***	
amine P(0.4)	none	none	none	0.46
amine P(0.4)	(0.2)	(0.2)	none	0.08
amine J(0.4)	none	none	none	0.44
amine J(0.4)	(0.2)	(0.2)	none	0.08
amine J(0.4)	(0.2)	none	none	0.25
amine J(0.4)	(0.2)	(0.2)	(0.5)	0.06

* compound B is ZnO

** compound C is calcium stearate

*** compound D is a hydrotalcite of formula $Mg_{4.5}Al_2(OH)_{13}CO_3$

It is evident from these results, that the lifetime of the polymer film is tremendously improved when zinc oxide is used as additional stabilizer besides the hindered amine. Further improvements can be achieved by adding a metal carboxylate or a hydrotalcite compound.

Example 4

LDPE films stabilized with the compounds reported in table 5 are manufactured from ground LDPE (RIBLENE[®] FF 29; ENICHEM, Milano/Italy), characterized by a density of 0.921 g/cm³ and a melt flow index (190°C/2.16 kg) of 0.6, as described in example 1, except that the masterbatches used contain 5 % by weight of the hindered amine (compound A) and the corresponding concentrations of compounds B or C (metal oxide) and D (salt of carboxylic acid). Application of pesticides and exposure is as described in example 1.

During the exposure, the performance is periodically evaluated measuring the residual elongation (in % of the initial elongation of the new polyethylene film) by means of a dynamometer at constant speed.

The results are presented in the following table 5.

Table 5: Residual Elongation (in % of the Initial Elongation) after Months Exposure (corresponding to kilolanglely)

A	Compound (Concentration)			Residual Elongation after months
	B*	C**	D***	
amine P(0.4)	none	none	none	
amine P(0.4)	(0.2)	none	none	
amine P(0.4)	none	(0.2)	none	
amine P(0.4)	none	(0.2)	(0.2)	

* compound B is ZnO

** compound C is MgO

*** compound D is calcium stearate

Example 5

Stabilized LDPE films are manufactured by mixing ground LDPE (RIBLENE® FF 29; ENICHEM, Milano/Italy), characterized by a density of 0.921 g/cm³ and a melt flow index (190°C/2.16 kg) of 0.6, with the compounds reported in tables 6 and 7 in a turbo mixer. Application of pesticides and exposure is as described in example 1.

During the exposure, the performance is periodically evaluated measuring the residual elongation (in % of the initial elongation of the new polyethylene film) by means of a dynamometer at constant speed, and the carbonyl increase with an IR-FT spectrometer (IR Fourier transformation spectrometer by Perkin Elmer).

The results after months of exposure, corresponding to kilolangley, are presented in the following tables 6 and 7.

Table 6: Residual Elongation (in % of the Initial Elongation) after Months Exposure

A	Compound (Concentration)			Residual Elongation after months
	B*	C**	D***	
amine M(0.4)	none	none	none	
amine M(0.4)	(0.2)	(0.2)	none	
amine Q(0.4)	none	none	none	
amine Q(0.4)	(0.2)	(0.2)	none	
amine P(0.4)	none	none	none	
amine P(0.4)	(0.2)	(0.2)	none	
amine J(0.4)	none	none	none	
amine J(0.4)	(0.2)	(0.2)	none	
amine J(0.4)	(0.2)	none	none	
amine J(0.4)	(0.4)	none	none	
amine J(0.4)	(0.2)	(0.2)	(0.5)	

* compound B is ZnO

** compound C is calcium stearate

*** compound D is a hydrotalcite of formula $Mg_{4.5}Al_2(OH)_{13}CO_3$

Table 7: Carbonyl Increase after Months Exposure

Compound (Concentration)				Carbonyl Increase after months
A	B*	C**	D***	
amine W(0.4)	none	none	none	
amine W(0.4)	(0.2)	(0.2)	none	
amine W(0.8)	none	none	none	
amine W(0.8)	(0.2)	(0.2)	none	
amine N(0.6)	none	none	none	
amine N(0.6)	(0.2)	(0.2)	none	
amine M(0.4)	none	none	none	
amine M(0.4)	(0.2)	(0.2)	none	
amine Q(0.4)	none	none	none	
amine Q(0.4)	(0.2)	(0.2)	none	
amine P(0.4)	none	none	none	
amine P(0.4)	(0.2)	(0.2)	none	
amine J(0.4)	none	none	none	
amine J(0.4)	(0.2)	(0.2)	none	
amine J(0.4)	(0.2)	none	none	
amine J(0.4)	(0.4)	none	none	
amine J(0.4)	(0.2)	(0.2)	(0.5)	

* compound B is ZnO

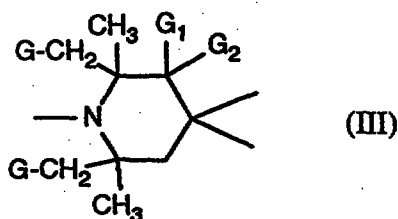
** compound C is calcium stearate

*** compound D is a hydrotalcite of formula $Mg_{4.5}Al_2(OH)_{13}CO_3$



WHAT IS CLAIMED IS:

1. A polyolefin or polyolefin copolymer film in contact with a pesticide and stabilized against photodegradation, said polyolefin or polyolefin copolymer film having improved light stability and pesticide resistance, characterized in that the polyolefin or polyolefin copolymer contains a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium.
2. A polyolefin or polyolefin copolymer film according to claim 1, in which the pesticide contains halogen and/or sulfur atoms.
3. A polyolefin or polyolefin copolymer film according to claim 1, in which the polyolefin or polyolefin copolymer is polyethylene, ethylene/propylene copolymer, ethylene/vinyl acetate copolymer or polypropylene.
4. A polyolefin or polyolefin copolymer film according to claim 1, in which the sterically hindered amine is a cyclic sterically hindered amine containing at least one group of the formula III



in which G is hydrogen or methyl and G₁ and G₂ are hydrogen, methyl or together are =O.

5. A polyolefin or polyolefin copolymer film according to claim 1, in which the metal oxide or hydroxide is selected from zinc oxide, zinc hydroxide and magnesium oxide.
6. A polyolefin or polyolefin copolymer film according to claim 1, in which the polyolefin or polyolefin copolymer contains from 0.005 to 3 % by weight of the metal oxide or hydroxide and from 0.01 to 5 % by weight of the sterically hindered amine, relative to the weight of the polyolefin or polyolefin copolymer.



7. A polyolefin or polyolefin copolymer film according to claim 1, in which the polyolefin or polyolefin copolymer contains one or more further components selected from alkaline earth metal salts, zinc salts and aluminum salts of C_1 - C_{30} carboxylic acid, hydrotalcites, and UV absorbers.
8. A polyolefin or polyolefin copolymer film according to claim 7, in which the polyolefin or polyolefin copolymer contains a 2-(2'-hydroxyphenyl)-benzotriazole UV absorber.
9. A polyolefin or polyolefin copolymer film according to claim 7, in which the polyolefin or polyolefin copolymer contains a salt of a C_{12} - C_{18} carboxylic acid with aluminum, calcium, magnesium or zinc.
10. A polyolefin or polyolefin copolymer film according to claim 7, in which the polyolefin or polyolefin copolymer contains as further component a hydrotalcite.
11. Greenhouse, characterized in that it is covered by a polyolefin or polyolefin copolymer film having improved light stability and pesticide resistance and stabilized with a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium.
12. Process for stabilizing a polyolefin or polyolefin copolymer greenhouse film against detrimental effects of pesticides and light, oxygen and/or heat, which process comprises incorporation of a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium, into said greenhouse film.
13. Use of a polyolefin or polyolefin copolymer film stabilized with a sterically hindered amine and a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium, for agricultural applications involving pesticides.
14. Use of a sterically hindered amine in combination with a metal oxide or hydroxide selected from oxides of zinc, aluminum, calcium and magnesium, and hydroxides of zinc, aluminum and calcium, for the stabilization of polyolefin or polyolefin copolymer films in contact with pesticides against photodegradation and damage by pesticides.