

1.152.932



PATENT SPECIFICATION

DRAWINGS ATTACHED

1.152.932

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COMPLETE SPECIFICATION

Cyclododecane Derivatives and Perfume Compositions

We, INTERNATIONAL FLAVORS & FRAGRANCES INC., a Corporation organized under the laws of the State of New York, United States of America, of 521 West 57th Street, New York, State of New York, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

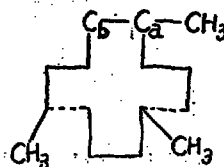
In the perfumer's art there is a considerable need for substances having a woody fragrance note which is at least moderately persistent. Especially desirable are materials which combine a woody fragrance with a camphoraceous fragrance note. Such woody, camphoraceous fragrance materials have a wide utility in the preparation of fragrance-modifying and finished perfume compositions. A limited amount of such materials is available from natural sources, but the natural materials are subject to wide variation in quality, are expensive, and are in limited (and often critically short) supply.

This invention provides novel compositions and components together with novel processes and steps of processes, specific embodiments of which are described hereinafter by way of example and in accordance with which it is now preferred to practice the invention.

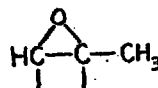
Briefly, the novel cyclic materials of this invention are 1,5,9 - trimethyl - 13 - oxa - bicyclo[10.1.0] - trideca - 4,8 - diene and hydrogenated, cyclized and reduced derivatives thereof, including 1,5,9 - trimethylcyclo - dodeca - 4,8 - dien - 2 - one, and cyclized trimethylcyclododecatriene and epoxy derivatives of the cyclized trimethylcyclododecatriene. The processes of this invention broadly involve the reaction of 1,5,9 - trimethyl -

cyclododecatriene with an epoxidizing agent and if desired a cyclizing agent, in which case either of these agents can be used. Under some conditions the treatment provides a preponderance of an epoxy derivative, and under other conditions a detonic material is obtained as the main product. The substances thus produced can be further treated, as by hydrogenation or reduction, to produce other useful new materials. These novel cyclic materials are:

1,5,9 - Cyclododecatriene - 1,5,9 derivatives of the formula:



wherein $C_6-C_8-CH_3$ is

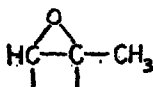


OH O H
 $H_2C-C-CH_3$ or $C-C-CH_3$ and the
 dashed lines represent single or double bonds; the cyclized derivatives when
 $C_6-C_8-CH_3$ is

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Price 25p

SEE DRAWING ATTACHED



or $\text{HC}=\text{C}-\text{CH}_3$; and the epoxy products of said cyclized derivatives when $\text{C}_n-\text{C}_m-\text{CH}_3$ is $\text{HC}=\text{C}-\text{CH}_3$.

The compounds of formula I above are prepared by

- (a) reacting 1,5,9 - trimethylcyclododeca - triene - 1,5,9 with an organic percarboxylic acid under anhydrous conditions in the presence of an alkaline reagent to form 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] - trideca - 4,8 - diene or with an organic percarboxylic acid in the absence of an alkaline reagent to form 1,5,9 - trimethylcyclo - dideca - 5,9 - dien - 2 - one, and/or
- (b) cyclizing the 1,5,9 - trimethyl - 13 - oxabicyclo - [10.1.0] - trideca - 4,8 - diene or 1,5,9 - trimethylcyclododeca - triene - 1,5,9 with a proton donor cyclizing agent,

and, if desired, doing one or more of the following:

- (c) catalytically reducing the products in steps (a) and (b) to reduce one or more unsaturation linkages or to produce mixtures of these,
- (d) reducing the 1,5,9 - trimethyl - 13 - oxabicyclo - [10.1.0] - trideca - 4,8 - diene with an alkali metal hydride to form 1,5,9 - trimethylcyclododeca - 4,8 - dien - 1 - ol,
- (e) epoxidizing the cyclized products formed from the triene in step (b) with a percarboxylic acid in the presence of an alkaline reagent.

The novel materials disclosed herein can be incorporated into a wide variety of finished perfume compositions and components for finished perfume compositions. It has been found that the novel materials of this invention have persistent fragrances, as more fully described below, which peculiarly adapt them for incorporation into perfume compositions where a distinct woody fragrance note is required.

One of the primary materials provided by this invention is 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] - trideca - 4,8 - diene (hereinafter generally referred to as "bicyclo C-12"). The bicyclo C-12 is prepared by treating 1,5,9 - trimethylcyclododecatriene (hereinafter also referred to as "cyclo C-12") with an organic percarboxylic acid in the presence of an alkaline reagent. This reaction should be conducted under anhydrous conditions since any substantial amount of water is deleterious to the reaction.

Another primary material provided by

carrying out the process of this invention is cyclized trimethylcyclododecatriene (hereinafter also referred to as "cyclized cyclo C-12"). A cyclized bicyclo C-12 can also be obtained according to the present invention. It will be understood from the following description that the cyclized materials are useful perfume and fragrance-modifying substances and intermediates in preparing other perfume and fragrance-modifying substances.

The cyclized materials according to this invention can be obtained by treating the cyclo C-12 or the bicyclo material with a proton donor or an electron acceptor. While the reaction mechanism may not be entirely elucidated, it is presently believed that the proton donor forms an intermediate material in which one of the double bonds contains a proton or a positive charge and that such charge renders it reactive. Exemplary of such proton donor materials are sulfuric acid, and various phosphoric acids including dilute orthophosphoric acid, concentrated phosphoric acid, and higher phosphoric acids such as pyro- and polyphosphoric acids. A preferred cyclizing agent is 85% phosphoric acid. Boron trifluoride is also a useful cyclizing agent. Unless otherwise indicated, all parts, proportions, percentages, and ratios herein are by weight.

The present invention is further illustrated in the accompanying drawings, wherein

Figs. 1 and 2 are, respectively, infrared absorption and NMR spectra of cyclized bicyclo C-12;

Fig. 3 is an infrared absorption spectrum of cyclized cyclo C-12; and

Fig. 4 is an infrared absorption spectrum of epoxy cyclized cyclo C-12.

Cyclo C-12 is generally available at purities of 90% and upwards, and it can be used in this form. It is generally preferred however in the practice of this invention to refine the material to substantially 100% purity. Such purification is readily accomplished by fractional distillation.

An epoxidizing agent used in carrying out the process of this invention is an organic percarboxylic acid. Generally, any organic aliphatic or aromatic percarboxylic acid having from 1 to 10 carbon atoms can be successfully used in this invention. Aromatic percarboxylic acids such as perbenzoic, perphthalic, and chloroperbenzoic acids, and aliphatic percarboxylic acids such as performic acid are desirably used in the process of this invention. A preferred organic carboxylic acid for use herein is peracetic acid. It is generally preferred to use substantially one mole of the organic peracid for each mole of the cyclo C-12 to be treated.

In order to secure good yields of bicyclo C-12 an alkaline reagent should be present. While the reaction mixture of this invention should be substantially anhydrous, the term

"alkaline reagent" as used herein means a material which would make the reaction mixture alkaline in aqueous media. A wide variety of salts of a strong base and a weaker acid can be used for this purpose. A preferred pH-controlling material is anhydrous sodium acetate.

The treatment of cyclo C-12 with epoxidizing agent is preferably carried out in an inert reaction vehicle. Such a reaction vehicle is desirably a solvent for the components of the reaction mixture, or a liquid in which the components of the reaction mixture readily disperse. The vehicle serves to ensure more intimate contact of the ingredients of the reaction mixture and to assist in temperature control, as well as to moderate the reaction. Suitable vehicles for use in the process include chlorinated hydrocarbons such as chloroform and carbon tetrachloride, aromatic materials such as benzene and toluene, and oxygen-containing solvents such as diethyl-ether. A preferred vehicle in the practice of this aspect of the invention is methylene chloride.

The epoxidation can be carried out over a fairly wide range of temperatures, depending upon the particular concentration of reactants, the size of the reaction vessel and other equipment available, and the like. At too low a temperature, the reaction requires an inordinately long period of time, while at too high a temperature the reaction becomes unduly rapid. In fact, at unduly high temperatures the reaction rate may become so vigorous as to be explosive. Accordingly, it is desirable to carry out the epoxidation reaction at temperatures in the range of from -15°C to 30°C .

The time required for the epoxidation reaction varies inversely with the temperature and should be sufficient to provide a high completeness for the reaction. The reaction is conveniently controlled by introducing the cyclo C-12 and vehicle, if any, into a reaction vessel fitted with mixing means and heat transfer means and then slowly adding the requisite amount of epoxidation agent. The reaction mass can, if necessary, be maintained in the desired temperature range after all the agent is added until the reaction is complete.

Generally, a temperature range of from -15° to 30°C over a period of 2—5 hours is required for the percarboxylic acid addition.

The reaction can be carried out at sub- or superatmospheric pressure, but if a subatmospheric pressure is used it should not be so low as to cause ebullition or substantial evaporation of the vehicle or any of the reactants.

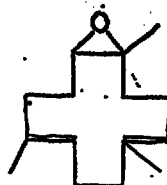
The reaction is preferably carried out at atmospheric pressure. Since this reaction is sensitive to the presence of water, it should not be conducted in a very humid atmosphere, although there is no need to exclude air. If desired, the reaction can be carried out under

an inert atmosphere such as nitrogen or argon.

When the epoxidation reaction is substantially complete, it is terminated by the addition of water. The water is mixed into the organic material and is subsequently removed therefrom, being most readily removed by decantation of the organic layer from the aqueous layer.

The reaction product mixture can be further purified by the addition of a reducing agent to inactivate any traces of the epoxidation agent. For example, the organic layer can be treated with an aqueous solution of a reagent such as ferrous ammonium sulfate. The reaction product is generally further deacidified, for example with aqueous sodium bicarbonate solution, to remove all traces of acidic materials. The bicyclo C-12 is obtained from the reaction mixture by distillation after the washing and decantation of the organic layer.

The reaction product is a clear liquid with an intense and persistent woody-amber odor. It has a boiling point of $106\text{--}108^{\circ}\text{C}$ at 1.0 mm Hg and an n_D^{20} of $1.5046\text{--}1.5053$. The IR, NMR, and mass spectra are consistent with several possible geometric isomers, including one having the structure:



Bicyclo C-12 derivatives are produced by treatment with hydrogen in the presence of a hydrogenation catalyst such as nickel, palladium, platinum, rhodium, or salts thereof. Preferred hydrogenation catalyst are palladium and its salts such as palladium chloride.

Where the dihydro bicyclo C-12 derivative is desired, the material is treated with one mole of hydrogen. The tetrahydro material can be obtained by utilizing two or more moles of hydrogen. It will be understood that mixtures of the bicyclo C-12 and dihydro material or of the dihydro and tetrahydro derivatives can be made by varying the quantity of hydrogen up to two moles. The hydrogenation can be carried out at pressures from atmospheric up to say 200 psig. Superatmospheric pressures of about 100 psig are preferred because the reaction proceeds more rapidly and completely under such pressure conditions.

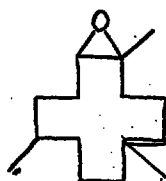
To carry out the hydrogenation, the catalyst can be directly introduced into the bicyclo C-12 and the mixture can then be treated with hydrogen. It is preferred that an inert reaction vehicle be admixed with the bicyclo C-12 in the hydrogenation process. For example,

lower alkanols are desirable reaction vehicles, and ethanol is a preferred reaction vehicle.

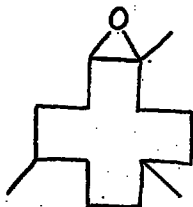
The temperature used can range from room temperature to over 100°C, and is preferably maintained at 80–100°C. At low temperatures the hydrogen is only slowly absorbed, whereas at temperatures greatly in excess of 100°C the reaction proceeds so rapidly as to present problems in controlling it.

The hydrogenated bicyclo C-12 is recovered from the reaction mixture by filtration to remove the catalyst solids and by a subsequent distillation to remove any reaction vehicle which has been used. It is preferred that such distillation to remove the vehicle be carried out under a vacuum. If desired, the hydrogenated material can be further purified by fractional distillation.

Hydrogenation of the bicyclo C-12 with one mole of hydrogen produces dihydro compounds including 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] - tridec - 4 - ene. This is a colorless oil having a woody-amber odor, a boiling point of 72°C at 0.2 mm Hg, and an n_D^{20} of 1.5021. Spectral tests indicate a molecular weight of 222 and that the structure of the compound is as follows:



When two moles of hydrogen are used in the hydrogenation, 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] - tridecane is obtained. The material is a colorless oil with a woody-amber fragrance similar to that of the bicyclo C-12; a boiling point of 72°C at 0.2 mm Hg and an n_D^{20} of 1.4975. Mass spectroscopy which indicates a molecular weight of 224 supports the described structure:



The cyclization of the cyclo C-12 or bicyclo C-12 is preferably carried out in the presence of a reaction vehicle, desirably one in which the reactants are soluble or readily dispersed. Examples of desirable solvents are aromatic solvents and substituted aromatic solvents such as benzene, toluene, xylene, and chlorobenzene, aliphatic solvents such as hexane, and

chlorinated aliphatic hydrocarbons. Benzene and toluene are preferred vehicles.

The cyclization of cyclo C-12 is carried out by admixing in any order the vehicle, the cyclizing agent, and the cyclo C-12. The cyclization temperature can range from room temperature or somewhat below, e.g. 25°C, up to 300°C, although upper temperatures of 200°C or below are desirable in many instances. The lower temperatures result in very long reaction times, so that it is preferable to use higher temperatures, depending upon the cyclizing agent and the reaction vehicle used. Temperatures at the upper end of the range may cause side reactions to proceed more rapidly than the desired cyclization and thus lower the yield.

A further factor determining the cyclization temperature is the boiling or melting point of the reaction vehicle. The reaction can be carried out at sub- or superatmospheric temperatures, and atmospheric pressure is usually the most convenient and desirable. Accordingly, it is generally preferred to carry out the cyclization reaction at temperatures at or below the boiling point of the vehicle, and use of a vehicle at reflux temperatures provides ready temperature control. Thus, for cyclizing cyclo C-12, temperatures of 25° to 300°C can be used, although an upper temperature limit of 200° is desirable. This cyclization reaction is most usefully carried out at temperatures of 100° to 130°C. At these temperatures the reaction can be carried out for from 15 minutes to ten hours, the actual time depending upon the cyclizing agent, vehicle, pressure, and type of cyclized product desired.

To cyclize bicyclo C-12 a mixture of vehicles and cyclizing agent is prepared, and the bicyclo C-12 is then added over a period of from 2 to 8 hours while the temperature is desirably maintained in the range from 30°C to 40°C. A preferred temperature range for carrying out the cyclization reaction is from 32 to 35°C. The time required varies inversely with temperature. If the addition is carried out too rapidly and the temperature is very high, some breakdown of the bicyclo C-12 may occur, but very low reaction temperatures require inordinately long times to complete the reaction. Accordingly, it is preferred to perform this reaction under conditions such that 4–8 hours are required substantially to complete the reaction.

After the cyclization reaction is complete water is added to wash the organic material which is then decanted. The reaction product can be subjected to one or more further washings and is then treated with an alkalinizing agent, such as a strong alkali like sodium hydroxide or the salt of a strong base and a weak acid like sodium bicarbonate, to remove all further traces of acidity.

After the cyclization reaction is complete and the reaction-mixture has been neutralized

and washed, the product is preferably further purified, for example, by distillation or extraction. Fractional distillation has been found to be especially satisfactory for purifying the product. When even greater purity is desirable, the product can be purified by preparative chromatographic techniques.

Cyclized cyclo C-12 produced according to this invention can further be treated with an epoxidation agent to form the epoxy derivatives. The epoxy derivatives of cyclized cyclo C-12 are prepared in substantially the same manner as is the bicyclo C-12 prepared from the cyclo C-12.

For the distilled cyclized bicyclo C-12, it has been found preferable for perfumery to utilize the cyclized material which forms a constant-boiling mixture as determined by gas-liquid chromatographic analyses. By this method cyclized 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] - trideca - 4,8 - diene is obtained as a clear liquid with a boiling point of 95—100°C at 0.4 mm Hg, an n_D^{20} of 1.5040—1.5101, the infrared (IR) absorption spectrum shown in Fig. 1, and the nuclear magnetic resonance (NMR) spectrum shown in Fig. 2. This material has a pleasant woody, camphoraceous odor. In the Fig. 2 spectrum, the inflection peaking at about 5.3 ppm on the chart is presented in amplified form just above the complete presentation. The IR spectrum is obtained on a Beckman spectrophotometer Model IR 4 under the indicated conditions and the NMR spectrum is obtained on a Varian Model A 60 at the indicated parameters. Beckman is a Registered Trade Mark.

The cyclized cyclo C-12, in a liquid having for example, fractions boiling at 106°C to 128°C at 1.0—1.5 mm Hg with the lower boiling fractions showing an n_D^{20} of 1.5045 and ranging up to 1.5104 for the higher boiling fractions. After further treatment to epoxidize the cyclized material, the epoxy cyclized cyclo C-12 is a liquid having fractions boiling at temperatures of 120°—134°C at 1.6—1.3 mm Hg. The n_D^{20} ranges from 1.4948 for lower boilers to 1.4982 for the higher boilers. The cyclized cyclo C-12 has the infrared absorption spectrum shown in Fig. 3, and the epoxy cyclized cyclo C-12 has the infrared absorption spectrum shown in Fig. 4. The IR spectra of Figs. 3 and 4 are obtained under the indicated conditions. The epoxy cyclized cyclo C-12 has an intense pleasant woody, camphoraceous odor which is persistent. It is noted that the combination of cyclized bicyclo C-12 and epoxy cyclized cyclo C-12 gives a fragrance material having an intense initial odor note with excellent persistence.

The alcohol derivative of bicycle C-12 is prepared by treating the bicyclo material with a reducing agent to form the alcohol. Water and oxygen should be excluded from this reac-

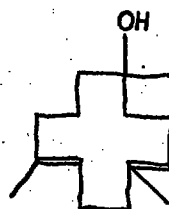
tion, and it is preferred that the reaction be conducted in an inert atmosphere, such as nitrogen or argon. It is especially preferred that the reaction be carried out under a blanket of dry nitrogen.

The desirable reducing agent for use in preparation of the alcohol is lithium aluminum hydride. The reaction is preferably carried out in the presence of a vehicle which is a solvent for the reducing agent. When lithium aluminum hydride is used as the reducing agent, materials such as "Diglyme" (diethyleneglycol dimethyl ether) can be used as solvents, and tetrahydrofuran is particularly suited to the process. Tetrahydrofuran is also valuable in controlling the reaction because the mass can be held at the reflux temperature of the solvent.

The reduction is desirably carried out at temperatures of from 60° to 200°C. The solvents for the reducing agents generally determine the upper temperatures at which the reaction can be carried out. At temperatures below the desired range the reduction is unduly slow. Superatmospheric pressures can be used to raise the ebullition temperature of the solvent or dispersing agent and permit operation at slightly higher temperatures. The time required for the reduction desirably ranges from two to ten hours.

After the alcohol has been formed by the reduction, water is slowly added to the reaction mass and the alkaline materials are then neutralized by the addition of a suitable acid such as acetic acid. The alcohol formed is removed from the reaction mass with a suitable solvent such as diethylether.

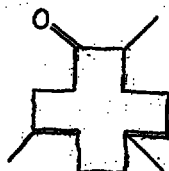
The mixture of geometric isomers 1,5,9 - trimethylcyclododeca - 4,8 - dien - 1 - ol so prepared is a clear liquid having a boiling point of 113—118°C at 0.1 mm Hg and an n_D^{20} of 1.5134—1.5143. This alcohol has a persistent woody, vertiver odor. One component of this mixture can be represented by the structural formula:



The ketone isomer mixture of this invention can be prepared by a reaction similar to that used to form the epoxide, except that the alkalizing or pH-controlling agent is omitted from the percarboxylic acid. The same times, temperatures, pressures, and inert vehicles are used for the ketone production as are set forth above in connection with the bicyclo C-12. The ketonic reaction product

mixture is washed with water and an aqueous reducing agent to decompose any unreacted percarboxylic acid. The organic layer after washing until it is neutral to litmus is vacuum-distilled to remove any inert reaction vehicle. Treatment of the product with an alkalinizing agent such as aqueous sodium bicarbonate can be used to assure removal of any residual acid.

5. The product is then fractionally distilled to obtain 1,5,9 - trimethylcyclododeca - 5,9 - dien - 2 - one as a clear liquid with a boiling point of 128—131°C at 2.6 mm Hg and an n_D^{20} of 1.5050—1.5057. The material can be represented by the structural formula:



- The novel cyclododecadiene derivatives of this invention are particularly suited for use as perfume materials, as fragrance-modifying materials, and in the preparation of perfume compositions. They are very well adapted to perfumery where a woody aroma is required. The cyclized bicyclo C-12 is particularly remarkable for its persistent woody, camphoraceous odor, and the epoxy cyclized C-12 for its intense woody odor. The bicyclo C-12 and the alcohol also possess a persistent woody amber odor with camphoraceous overtones. To make a woody amber type of perfume the materials of this invention can be combined with many types of odor materials such as floral, musk, spice, aldehydic, oak-moss, oriental, and fougere. The novel materials of this invention can also be combined with customary perfume additives such as natural oils, synthetic oils, esters, aldehydes, ketones, alcohols, lactones, fixatives, solvents, dispersants, emulsifiers, surface-active agents or aerosol propellants.

- It will be understood that the cyclized materials of the alcohol, and the ketone can be hydrogenated if desired to produce the dihydro or tetrahydro derivatives as described above in connection with the production of the dihydro and tetrahydro derivatives of bicyclo C-12 itself.

- The following examples serve to illustrate embodiments of the invention as it is now preferred to practice it. It will be understood that these examples are illustrative and the invention is to be considered restricted thereto only as indicated in the appended claims.

EXAMPLE I

Preparation of the Bicyclo C-12

- A mixture of 3 liters of anhydrous

methylene chloride, 820 g. (10 moles) anhydrous sodium acetate and 1020 g. (5 moles) of 1,5,9 - trimethylcyclododeca - 1,5,9 - triene is introduced into a reaction vessel fitted with a stirrer, thermometer, and dropping funnel. The stirred reaction mass is brought to 0°C and maintained at that temperature during a 3-hour period while 1005 g. (5.5 moles) of 40% peracetic acid is added. The reaction mass is maintained at 0—5°C for an additional hour.

The organic layer is then washed with 2 liters of water to stop the reaction and decanted. The organic layer is washed with an equal volume of a 5% aqueous solution of ferrous ammonium sulfate to remove any residual peracetic acid. The organic layer is then decanted, treated with a saturated aqueous solution of sodium bicarbonate and distilled to obtain 944 g. of 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0]trideca - 4,8 - diene.

This material is a clear liquid with an intense woody amber odor. It has a B.P. of 106—108°C at 1.0 mm Hg and an n_D^{20} of 1.5046—1.5033. The NMR, IR, and mass spectrographic data are entirely consistent with the described structure.

Similar results are obtained when perbenzoic, chloroperbenzoic, performic, and perphthalic acids are utilized in lieu of the peracetic acid in the foregoing procedure.

EXAMPLE II

Partial Hydrogenation of the Bicyclo C-12

A mixture of 500 g. of the bicyclo C-12 of Example I and 25 g. of palladium chloride is diluted with 500 g. of anhydrous ethanol, and one mole of hydrogen is introduced into the reaction mixture and absorbed at 100°C and 100 psig. The solid catalyst material is removed by filtration, and the resulting liquid is vacuum distilled to remove the ethanol. 1,5,9 - Trimethyl - 13 - oxabicyclo - [10.1.0]trideca - 4 - ene in the amount of 475 g. is obtained. This colorless oil has a molecular weight of 222, a boiling point of 72°C at 0.2 mm Hg, and an n_D^{20} of 1.5021.

EXAMPLE III

The bicyclo C-12 of Example I is hydrogenated according to the method of Example II over a 4-hour period to completely hydrogenate it. After filtration to remove the catalyst and removal of the ethanol as in Example II, fractionation yields 480 g. of 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0]tridecane, a colorless oil having a boiling point of 72°C at 0.2 mm Hg and an n_D^{20} of 1.4975. NMR spectroscopy shows no unsaturation, and mass spectrometry shows a molecular weight of 224.

EXAMPLE IV

Cyclized Bicyclo C-12

A mixture of 960 g. of 85% phosphoric acid and 480 g. of benzene is introduced into

a flask fitted with a stirrer, reflux condenser, thermometer, and dropping funnel. This mixture is brought to a temperature of about 34°C is then maintained at 32–35°C while 957 g. of the bicyclo C-12 prepared in Example I is added over a 1–2 hour time.

After six hours of continuous agitation at 32–35°C, the reaction mass is added to an equal volume of water. The organic layer is decanted and washed until it is neutral to litmus with a saturated aqueous solution of sodium bicarbonate and then distilled on a 24-inch Podbielniak column.

Approximately 750 g. of a constant boiling mixture of the cyclized material, as determined by gas-liquid chromatographic analysis, is obtained. This material has a pleasant woody, camphoraceous odor, a boiling point of 95–100°C at 0.4 mm Hg, an n_D^{20} of 1.5040–1.5101, the infrared absorption spectrum shown in Fig. 1, and the NMR spectrum shown in Fig. 2.

EXAMPLE V

1,5,9-Trimethylcyclododeca-4,8-dien-1-ol

A mixture of 19 g. of lithium aluminum hydride and 500 ml. of tetrahydrofuran is introduced into a reaction flask fitted with a stirrer, reflux condenser, and dropping funnel after the flask is purged with dry nitrogen.

A mixture of 51 g. of 1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] - trideca - 4,8 - diene and 100 ml. of tetrahydrofuran is added to the flask from the dropping funnel during a 2-hour period while the mixture is maintained at a gentle reflux. The heating is then continued for an additional six hours to maintain the mixture at reflux.

The reaction mixture is then cooled to room temperature and 32 g. of water is slowly added. Thirty ml. of 52% acetic acid is then added to the water and reaction mixture, and the mixture is extracted with an equal volume of diethylether.

The diethylether is distilled off to obtain 15 g. of 1,5,9 - trimethylcyclododeca - 4,8 - dien - 1 - ol as a clear liquid with a boiling point of 113–118°C at 0.1 mm Hg and an n_D^{20} of 1.5134–1.5143. Nuclear magnetic resonance data show that the material is a tertiary alcohol.

EXAMPLE VI

1,5,9-Trimethylcyclododeca-5,9-dien-2-one

A mixture of 612 g. of 1,5,9 - trimethyl - cyclododeca - 1,5,9 - triene and 1800 ml of methylene chloride are introduced into a flask fitted with a stirrer, thermometer, reflux condenser, and dropping funnel. The mixture is brought to a temperature of about 0°C, and 605 g. of 50% peracetic acid is added during a 3-hour period while the mixture is maintained at 0–5°C with stirring. The agitation

is continued for three hours after completion of the peracetic acid addition.

The reaction mass is then washed with an equal volume of a 5% aqueous ferrous ammonium sulfate solution to destroy any unreacted peracetic acid. The organic layer is then washed to neutrality by test with litmus and the solvent is removed by vacuum distillation. The final product is distilled by means of a 3-foot tantakum wire column.

This produces 106 g. of 1,5,9 - trimethyl - cyclododeca - 5,9 - dien - 2 - one as a water-white liquid having a boiling point of 128–131°C at 2.6 mm Hg and an n_D^{20} of 1.5050–1.5057.

EXAMPLE VII

Cyclized Cyclo C-12

Into a one liter reaction flask equipped with a stirrer, thermometer, reflux condenser and heating mantle is placed 250 g. benzene, 250 g. polyphosphoric acid, and 250 g. trimethylcyclododecatriene. The mass is stirred and refluxed for eight hours. The reaction mass thereupon separates into two phases: an organic phase and an aqueous acid phase. The organic phase is decanted, and the aqueous acid phase is washed with one volume of benzene.

The benzene layer is washed with three volumes of saturated sodium chloride solution and dried over magnesium sulfate and filtered. The benzene is recovered and the product is distilled. The resulting product is a mixture of isomers having a boiling range of 106°–128°C at 1.0–1.5 mm Hg and an n_D^{20} range of 1.5045–1.5104. The infrared spectrum of this material is as shown in Fig. 3.

EXAMPLE VIII

Epoxy Cyclized Cyclo C-12

Into a 3 liter reaction flask equipped with a stirrer, a thermometer, reflux condenser and dropping funnel are placed 1000 ml methylene chloride (CH_2Cl_2), 180 g. anhydrous sodium acetate, and 238 g. cyclized cyclo C-12 produced in Example VII. The reaction mass is cooled to 0°C and stirred for a period of three hours during which time 248 g. of 40% peracetic acid is added drop-wise.

When the addition of the peracetic acid is completed, stirring is continued for a period of three hours at a temperature range of 0°C up to 5°C. The reaction mass is then left to stand overnight. After a period of approximately twelve hours the reaction mass is tested for peroxide content. One liter of water is added to the reaction mass, and the mass is then stirred and transferred to a separatory funnel.

The organic layer is separated and washed with one volume of aqueous sodium chloride,

two volumes of 10% ferric ammonium sulfate $[\text{FeNH}_4(\text{SO}_4)_2]$, two times two volumes of saturated sodium bicarbonate, and two volumes of saturated sodium chloride. The reaction mass is then dried over magnesium sulfate and filtered, and the solvent is recovered at 50°C at 10 mm Hg. The crude weight of the epoxidized product is 256 g.

The product is then distilled to obtain epoxy cyclized cyclo C-12 as a liquid having a boiling range of 120°—134°C at 1.6—1.3 mm Hg and an n_D^{20} range of 1.4948—1.4922. The IR spectrum is shown in Fig. 4. The material has an intense pleasant woody, camphoraceous odor.

EXAMPLE IX

Perfume Composition

A perfume composition is prepared by admixing the following ingredients in the indicated proportions:

Ingredient	Parts
Bergamot oil	150
Orange oil (Florida)	75
Lemon oil (California), C.P.	15
"IMGA" (Gamma methyl ionone)	20
Cyclized bicyclo C-12 prepared in Example IV	50
Eugenol, U.S.P.	10
"Lyrat" (hydroxymethylpentyl cyclohexenecarboxaldehyde)	30
Styralyl acetate	5
Ylang extra	4
Petitgrain SA	25
Patchouli dark	5
Camomile Oil, bulked	1

EXAMPLE X

A second perfume composition is prepared by admixing the following ingredients in the indicated proportions:

Ingredient	Parts
Perfume composition prepared in Example IX	390
Alcohol of bicyclo C-12 prepared in Example V	50

Each of these two perfume base compositions is then admixed with aqueous ethanol, chilled, and filtered to produce a finished cologne. The two colognes so prepared have a citrus aroma leaning toward a woody, amber, camphoraceous fragrance note.

These base compositions can also be used to scent soap or other toilet goods such as lotion or aerosol sprays. The other derivatives prepared according to this invention are similarly used, as further illustrated in the following Example.

EXAMPLE XI

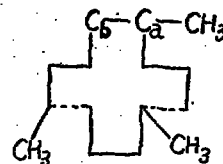
The following perfume composition is prepared:

Ingredient	Amount (grams)	
Cassia absolute	60	
Methyl ionone	60	
Jasmin extra	80	
Neroli oil, bigerade	60	65
Patchouli oil	60	
Vanillin	60	
Violet	60	
Epoxy cyclized cyclo C-12 produced in Example VIII	60	70
Lemon oil	80	
Rose Geranium oil	120	
Lavender oil, French	120	
Sweet orange oil	80	
Musk extract, 3 percent	50	75
Civet extract, 3 percent	50	
	1,000	

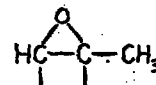
The foregoing blend is evaluated and found to have a high degree of richness and persistence in its novel woody-amber-like quality.

WHAT WE CLAIM IS:—

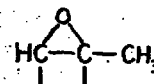
1. 1,5,9 - Cyclododeca derivatives of the formula:



wherein $\text{C}_b-\text{C}_a-\text{CH}_3$ is



$\text{H}_2\text{C}-\text{C}(\text{OH})-\text{CH}_3$ or $\text{C}(\text{O})=\text{C}(\text{H})-\text{CH}_3$ and the dashed lines represent single or double bonds; and the cyclized derivatives when $\text{C}_b-\text{C}_a-\text{CH}_3$ is



or $\text{HC}=\text{C}-\text{CH}_3$; and the epoxy products of said cyclized derivatives when $\text{C}_b-\text{C}_a-\text{CH}_3$ is $\text{HC}=\text{C}-\text{CH}_3$, and mixtures of the compounds.

two volumes of 10% ferric ammonium sulfate $[\text{FeNH}_4(\text{SO}_4)_2]$, two times two volumes of saturated sodium bicarbonate, and two volumes of saturated sodium chloride. The reaction mass is then dried over magnesium sulfate and filtered, and the solvent is recovered at 50°C at 10 mm Hg. The crude weight of the epoxidized product is 256 g.

- 5 The product is then distilled to obtain epoxy cyclized cyclo C-12 as a liquid having a boiling range of 120°—134°C at 1.6—1.3 mm Hg and an n_D^{20} range of 1.4948—1.4922. The IR spectrum is shown in Fig. 4. The material has an intense pleasant woody, camphoraceous odor.

EXAMPLE IX Perfume Composition

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Ingredient	Parts
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Lemon oil (California), C.P.	15
25 "IMGA" (Gamma methyl ionone)	20
Cyclized bicyclo C-12 prepared in Example IV	50
Eugenol, U.S.P.	10
30 "Lyrall" (hydroxymethylpentyl cyclohexenecarboxaldehyde)	30
Styralyl acetate	5
Ylang extra	4
Petitgrain SA	25
Patchouli dark	5
35 Camomile Oil, bulked	1

EXAMPLE X

A second perfume composition is prepared by admixing the following ingredients in the indicated proportions:

Ingredient	Parts
40 Perfume composition prepared in Example IX	390
Alcohol of bicyclo C-12 prepared in Example V	50

- 45 Each of these two perfume base compositions is then admixed with aqueous ethanol, chilled, and filtered to produce a finished cologne. The two colognes so prepared have a citrus aroma leaning toward a woody, amber, camphoraceous fragrance note.

- 50 These base compositions can also be used to scent soap or other toilet goods such as lotion or aerosol sprays. The other derivatives prepared according to this invention are similarly used, as further illustrated in the following Example.

EXAMPLE XI

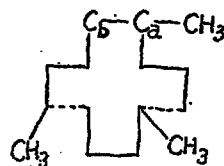
The following perfume composition is prepared:

Ingredient	Amount (grams)	
Cassia absolute	60	60
Methyl ionone	60	
Jasmin extra	80	
Neroli oil, bigerade	60	65
Patchouli oil	60	
Vanillin	60	
Violet	60	
Epoxy cyclized cyclo C-12 produced in Example VIII	60	70
Lemon oil	80	
Rose Geranium oil	120	
Lavender oil, French	120	
Sweet orange oil	80	
Musk extract, 3 percent	50	75
Civet extract, 3 percent	50	
	1,000	

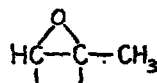
The foregoing blend is evaluated and found to have a high degree of richness and persistence in its novel woody-amber-like quality. 80

WHAT WE CLAIM IS:—

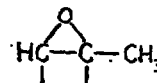
1. 1,5,9 - Cyclododeca derivatives of the formula:



wherein $\text{C}_5-\text{C}_a-\text{CH}_3$ is



40 $\text{H}_2-\text{C}-\text{C}-\text{CH}_3$ or $\text{C}-\text{C}-\text{CH}_3$ and the dashed lines represent single or double bonds; and the cyclized derivatives when $\text{C}_5-\text{C}_a-\text{CH}_3$ is



or $\text{HC}=\text{C}-\text{CH}_3$; and the epoxy products of said cyclized derivatives when $\text{C}_5-\text{C}_a-\text{CH}_3$ is $\text{HC}=\text{C}-\text{CH}_3$, and mixtures of the compounds. 90





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2. 1,5,9 - Trimethyl - 13 - oxabicyclo -
[10.1.0]trideca - 4,8 - diene.
3. 1,5,9 - Trimethyl - 13 - oxabicyclo -
[10.1.0]tridec - 4 - ene.
- 5 4. 1,5,9 - Trimethyl - 13 - oxabicyclo -
[10.1.0]tridecane.
5. Cyclized 1,5,9 - trimethyl - 13 - oxa -
bicyclo[10.1.0]trideca - 4,8 - diene having a
boiling point of 95—100°C. at 0.4 mm Hg,
an n_D^{20} of 1.5040—1.5101, the infrared
absorption spectrum shown in Fig. 1, and the
NMR spectrum shown in Fig. 2.
- 10 6. Cyclized 1,5,9 - trimethylcyclododeca -
triene - 1,5,9 having a boiling range of 106°
to 128°C. at 1.0—1.5 mm Hg and the infra -
red absorption spectrum shown in Fig. 3.
- 15 7. Epoxy cyclized 1,5,9 - trimethylcyclo -
dodecatriene - 1,5,9 having a boiling range
of 120° to 134°C. at 1.6—1.3 mm Hg and the
infrared absorption spectrum shown in Fig. 4.
- 20 8. 1,5,9 - Trimethylcyclododeca - 5,9 -
dien - 2 - one.
9. 1,5,9 - Trimethylcyclododeca - 4,8 -
dien - 1 - ol.
- 25 10. A perfume composition containing an
effective amount of a substance selected from
the group consisting of 1,5,9 - trimethyl -
13 - oxabicyclo[10.1.0]trideca - 4,8 - diene;
1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] -
tridec - 4 - ene; 1,5,9 - trimethyl - 13 - oxa -
bicyclo[10.1.0]tridecane; cyclized 1,5,9 -
trimethyl - 13 - oxabicyclo[10.1.0]trideca -
4,8 - diene having a boiling point of 95—
100°C. at 0.4 mm Hg, an n_D^{20} of 1.5040—
1.5101, the infrared absorption spectrum
shown in Fig. 1, and the NMR spectrum
shown in Fig. 2; cyclized 1,5,9 - trimethyl -
cyclododecatriene - 1,5,9 having a boiling
range of 106° to 128°C. at 1.0—1.5 mm
Hg and the infrared absorption spectrum
shown in Fig. 3; epoxy cyclized 1,5,9 -
trimethylcyclododecatriene - 1,5,9 having a
boiling range of 120° to 134°C. at 1.6—1.3
mm Hg and the infrared absorption spectrum
shown in Fig. 4; 1,5,9 - trimethylcyclo -
dodeca - 5,9 - dien - 2 - one; and 1,5,9 -
trimethyl cyclododeca - 4,8 - dien - 1 - ol or
mixtures of any of these to impart a woody -
amber fragrance note to the composition.
- 50 11. A method for preparing 1,5,9 - cyclo -
dodeca derivatives of formula I in claim 1,
which comprises
- 55 (a) reacting 1,5,9 - trimethylcyclododeca -
triene - 1,5,9 with an organic per -
carboxylic acid under anhydrous con -
ditions in the presence of an alkaline
reagent to form 1,5,9 - trimethyl - 13 -
oxabicyclo[10.1.0]trideca - 4,8 - diene
or with an organic percarboxylic acid in
the absence of an alkaline reagent to
form 1,5,9 - trimethylcyclododeca -
5,9 - dien - 2 - one, and/or
- 60 (b) cyclizing the 1,5,9 - trimethyl - 13 -
oxabicyclo[10.1.0]trideca - 4,8 - diene
or 1,5,9 - trimethylcyclododecatriene -
1,5,9 with a proton donor cyclizing
agent,
and, if desired, doing one or more of the
following:
- 70 (c) catalytically reducing the products in
steps (a) and (b) to reduce one or more
unsaturation linkages or to produce mix -
tures of these,
- (d) reducing the 1,5,9 - trimethyl - 13 -
oxabicyclo[10.1.0]trideca - 4,8 - diene
with an alkali metal hydride to form
1,5,9 - trimethylcyclododeca - 4,8 -
dien - 1 - ol,
- 75 (e) epoxidizing the cyclized products
formed from the triene in step (b) with
a percarboxylic acid in the presence of
an alkaline reagent.
12. A process for the preparation of 1,5,9 -
trimethyl - 13 - oxabicyclo[10.1.0]trideca -
4,8 - diene and derivatives thereof which
comprises reacting 1,5,9 - trimethylcyclo -
dodeca - 1,5,9 - triene with an organic per -
carboxylic acid under substantially anhydrous
conditions in the presence of an alkaline re -
agent to epoxidize the dodecatriene.
- 85 13. The process according to claim 12,
wherein the reaction is carried out in the
presence of an inert organic vehicle.
14. The process according to claim 12 or
13, wherein the temperature is maintained
in the range of from -15°C. to 30°C.
- 90 15. The process according to any one of
claims 12 to 14, wherein the temperature is
maintained in the range of from 0°C. to
5°C.
16. The process according to any one of
claims 12 to 15, wherein the acid is peracetic
acid.
17. The process according to any one of
claims 12 to 16, wherein the oxabicyclotri -
decadiene formed is treated with hydrogen
in the presence of a hydrogenation catalyst to
form 1,5,9 - trimethyl - 13 - oxabicyclo -
[10.1.0]tridec - 4 - ene and/or 1,5,9 -
trimethyl - 13 - oxabicyclo[10.1.0]tridecane.
- 110 18. The process according to any one of
claims 12 to 16, wherein the oxabicyclotri -
decadiene is reduced with lithium aluminum
hydride to form 1,5,9 - trimethylcyclododeca -
4,8 - dienol - 1.
- 115 19. A process which comprises treating
1,5,9 - trimethylcyclododecatriene - 1,5,9 or
1,5,9 - trimethyl - 13 - oxabicyclo[10.1.0] -
trideca - 4,8 - diene with a proton donor to
cyclize the material.
- 120 20. The process according to claim 19,
wherein, when 1,5,9 - trimethylcyclododeca -
triene - 1,5,9 is used, the cyclized product
is treated with an epoxidation agent which
is a percarboxylic acid in the presence of
an alkaline reagent or hydrogen peroxide in
the presence of a catalyst to epoxidize the
cyclized material.
- 125 21. A process for the production of 1,5,9 -
- 130

trimethylcyclododeca - 4,8 - dien - 2 - one
which comprises reacting 1,5,9 - trimethyl -
cyclododeca - 1,5,9 - triene with a per-
carboxylic acid under substantially anhydrous
conditions.

5 22. A method for preparing the compounds
as defined in claim 1 substantially as des-
cribed.

23. The compounds as defined in claim 1
whenever prepared by the procedures sub-
stantially as described.

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Agents for the Applicants.

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