

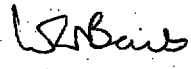
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IN THE MATTER OF an Application
for a European Patent
in the name of Merck Patent Gesell-
schaft mit beschränkter Haftung
granted under No. 0022183 , and
IN THE MATTER OF an Application
for a Singapore Registration Patent.

I, WOLFGANG GERSON BARB, B.Sc., Ph.D., F.P.I., a Fellow
of the Institute of Linguists, of "Spring Wood", Hedgerley
Lane, Gerrards Cross, Buckinghamshire, do solemnly and
sincerely declare that I am conversant with the English
and German languages and am a competent translator thereof,
and that the following is a true and correct translation
of the European Patent
No. 0022183 granted to Merck Patent Gesellschaft mit beschränkter
Haftung

and the Official Certificate attached thereto.

Declared at Europa House,
Marshall Way, Gerrards Cross,
in the County of Buckinghamshire,
this 30th day of March 1983


W. G. Barb

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Cyclohexylbiphenyls, processes for their preparation,
5 dielectrics containing them and an electrooptical
display element

For electrooptical display elements, the proper-
ties of nematic or nematic-cholesteric liquid crystal
materials of changing significantly their optical proper-
10 ties, such as light absorption, light scattering, double
refraction, reflecting power or colour under the influence
of electric fields, are utilised to an increasing
extent. The functioning of such display elements is
based, for example, on the phenomena of dynamic scatter-
15 ing, the deformation of oriented phases, the Schadt-
Helfrich effect in a twisted cell or the cholesteric-
nematic phase transition.

Industrial application of these effects in
electronic components necessitates liquid crystal dielec-
20 trics, which must fulfil a large number of requirements.
Chemical stability towards moisture, air and physical influen-
ces, such as heat, radiation in the infrared, visible
and ultraviolet range and constant and alternating
electrical fields, is particularly important in this
25 context. A liquid crystal mesophase in the tempera-
ture range from at least $+10^{\circ}\text{C}$ to $+50^{\circ}\text{C}$, preferably

from 0°C to 60°C, and as low as possible a viscosity at room temperature, which should preferably be not more than $70 \cdot 10^{-3}$ Pa.s, are also required of liquid crystal dielectrics which can be used industrially. Finally, these dielectrics must exhibit no characteristic absorption in the range of visible light, that is to say they must be colourless.

A number of liquid crystal compounds which fulfil the stability requirements demanded of dielectrics for electronic components and are also colourless are already known. These include, in particular, the p,p'-disubstituted phenyl benzoates described in German Offenlegungsschrift 2,139,628 and the p,p'-disubstituted phenylcyclohexane derivatives described in German Offenlegungsschrift 2,636,684. In both the classes of compounds mentioned, and also in other known series of compounds with a liquid crystal mesophase, there are no individual compounds which form a liquid crystal nematic mesophase in the required temperature range of 10°C to 60°C. Mixtures of two or more compounds are thus as a rule prepared in order to obtain substances which can be used as liquid crystal dielectrics. These are usually obtained by mixing at least one compound with a low melting point and clear point with another compound with a significantly higher melting point and clear point.

A mixture which has a melting point below that of the lower-melting component, whilst the clear point is between the clear points of the components, is usually obtained by this procedure. However, optimum dielec-

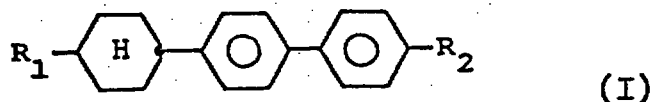
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trics cannot be prepared in this manner, since the components with the high melting points and clear points almost always also impart a high viscosity to the mixtures. The switching times of the electrooptical display elements produced with these mixtures are thus lengthened in an undesirable manner.

The invention is based on the object of preparing liquid crystal dielectrics which have a nematic phase in the required temperature range and permit sufficiently short switching times in liquid crystal cells at room temperature.

Hexahydroterphenyl derivatives with which this object can be achieved for the part range of liquid crystal dielectrics with positive dielectric anisotropy are already known from German Offenlegungsschrift 2,701,591. However, these hexahydroterphenyl derivatives cannot be used for the preparation of liquid crystal dielectrics with negative dielectric anisotropy, which, for example, are required for liquid crystal display elements which operate by the principle of dynamic scattering.

It is has now been found that the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain are outstandingly suitable as components of mixtures for liquid crystal dielectrics.

Surprisingly, the compounds of the formula (I) themselves have liquid crystal mesophases within a broad temperature range, the clear points being as a rule about 150°C or more. Even in view of the structurally related cyano-substituted hexahydroterphenyl derivatives according to German Offenlegungsschrift 2,701,591, such broad mesophases were not to be expected, as, for example, a comparison of the liquid crystal cyanobiphenyl derivatives according to German Offenlegungsschrift 2,356,085 with the p,p'-dialkyl- and -alkyl-alkoxy-biphenyls, which are already known and are not liquid crystal, shows. The dielectric anisotropy of the cyclohexylbiphenyls of the formula (I) is between about -1 and +3, and as a rule is about zero. The temperature range of the mesophase of liquid crystal base materials is significantly widened by adding these compounds; in many cases, surprisingly, the viscosities of liquid crystal materials which in themselves have a relatively low viscosity are also reduced further.

The invention thus relates to the cyclohexylbiphenyls of the formula (I), processes for their preparation and their use as components of liquid crystal dielectrics. The invention furthermore relates to liquid crystal dielectrics with 2 or more components containing at least one cyclohexylbiphenyl derivative of the formula (I) and to electrooptical display elements based on a liquid crystal cell containing such a liquid crystal dielectric.

The substituent R_1 in the compounds of the formula (I) can be straight-chain or branched. If R

is straight-chain, that is to say methyl, ethyl, n-propyl, n-butyl, n-pentyl, n-hexyl, n-heptyl, n-octyl, n-nonyl, n-decyl, n-undecyl or n-dodecyl, the compounds of the formula (I) thereby characterised have, as a rule, particularly high clear points. The compounds of the general formula (I) in which R_1 is an alkyl radical with 1 - 10, in particular with 1 - 8, C atoms are particularly preferred. However, compounds of the general formula (I) with branched substituents R_1 are also occasionally important, since these compounds frequently have better solubility properties in the customary liquid crystal base mixtures. The compounds with a branched substituent R_1 can furthermore be prepared in an optically active form; these substances are of importance as chiral doping substances. Such substituents R_1 , which are not straight-chain, are branched no more than once. Preferred branched substituents are those which contain a methyl or ethyl group in the 2- or 3-position of a relatively long carbon chain, for example 2-methylpropyl, 2-methylbutyl, 3-methylbutyl, 2-methylpentyl or 2-ethylhexyl.

These selection criteria also apply analogously to the substituent R_2 in the compounds of the formula (I) if this substituent is an alkyl group. If R_2 is an alkoxy or alkanoyloxy group, these criteria also apply to the alkyl part of these groups; in addition, however, alkyl parts which are also branched in the 1-position are also of interest in these groups, so that examples of alkoxy groups R_2 which are also important, in addi-

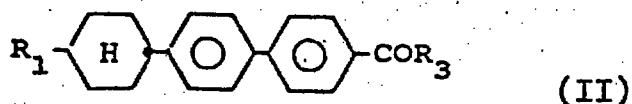
tion to those derived from the abovementioned alkyl groups, are 1-methylpropoxy, 1-methylbutoxy, 1-methylpentyloxy, 1-methylhexyloxy, and 1-methylheptyloxy; isobutyryloxy and isovaleryloxy are of particular interest
5 as branched alkanoyloxy groups.

At most one of the substituents R_1 and R_2 in the compounds according to the invention contains a branched carbon chain.

If R_2 is a perfluorinated alkyl, alkoxy or alkanoyloxy group, groups which are preferred are those which
10 contain no more than 8 C atoms, and in particular those with 1 - 5 C atoms. These groups also contain at most only one chain branching, a trifluoromethyl group in the 2- or 3-position being preferred.

15 In all the compounds according to the invention, the substituents on the cyclohexane ring are arranged in the trans-position; this is indicated in the formulae by the black marking on the right-hand side of the cyclohexane ring.

20 The compounds according to the invention are prepared in the customary manner for such substances. Thus, the compounds of the formula (I) wherein R_2 is an alkyl group are obtained by reducing the carbonyl group in a compound of the formula (II)

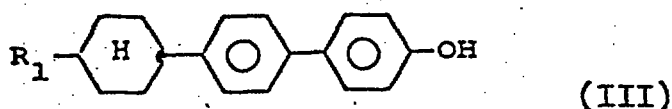


wherein R_3 is H or alkyl with 1 - 11 C atoms, to the methylene group. This reduction is carried out in a manner which is known per se, for example by catalytic

hydrogenation or with hydrazine hydrate and an alkali metal hydroxide or alcoholate in a high-boiling solvent, such as diethylene glycol or dimethylsulfoxide, with zinc and hydrogen chloride in diethyl ether, or with
5 zinc amalgam in aqueous hydrochloric acid. After a working up operation which is customary per se, the compounds of the formula (I) thus obtained are purified by fractional distillation under reduced pressure or by recrystallisation from a suitable solvent, for example
10 ethanol or ethyl acetate.

The compounds of the formula (I) in which R_2 is an alkoxy group are prepared by converting a ketone of the formula (II) wherein R_3 is preferably methyl to a phenol of the formula (III)

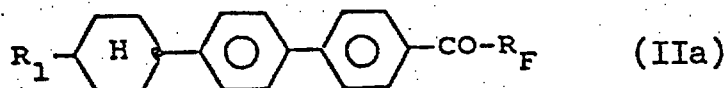
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by treatment with an oxidising agent and subsequent hydrolysis, and then reacting this phenol with an O-alkylating agent. The oxidising agent used for converting the ketone (II) into the phenol (III) is, for example,
20 performic acid or another peracid. The reaction with an O-alkylating agent, for example an alkyl iodide or alkyl bromide, is as a rule carried out in the presence of a base, such as sodium hydroxide or sodium carbonate, in a polar solvent, for example acetone.

25

The compounds of the formula (I) in which R_2 is a perfluoroalkyl group are prepared by reacting a ketone of the formula (IIa)



wherein R_F is a perfluoroalkyl radical with 1 - 11 C atoms, with sulfur tetrafluoride. The ketones (IIa) are obtained by reacting the corresponding 4-(4-alkyl-
5 cyclohexyl)-biphenyl with a perfluorocarboxylic acid halide in the presence of a Friedel-Crafts catalyst.

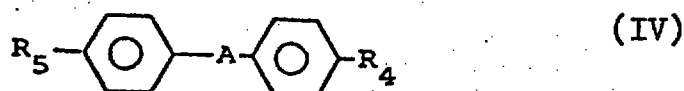
The compounds of the formula (I) in which R_2 is a perfluoroalkoxy group are prepared by esterifying a phenol (III) with a perfluorocarboxylic acid under
10 conditions which are customary per se and reacting the resulting ester with sulfur tetrafluoride in the presence of a fluorine-containing Lewis acid, for example hydrogen fluoride, boron trifluoride or titanium tetrafluoride.

The compounds of the formula (I) in which R_2 is an
15 optionally perfluorinated alkanoyloxy group are prepared by reacting a phenol (III) with a carboxylic acid or perfluorocarboxylic acid or a reactive derivative of such an acid, for example an acid halide, preferably an acid chloride, or an acid anhydride, advantageously in the pres-
20 ence of a base, such as, for example, pyridine or triethylamine.

The cyclohexylbiphenyls of the formula (I) are used as components of liquid crystal dielectrics for the purpose of widening the temperature range of the liquid
25 crystal mesophase, and in particular of raising the clear point. Compared with the benzoyloxybenzoic acid phenyl ester derivatives according to German Offen-

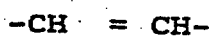
legungsschrift 2,139,628 or the biphenylcarboxylic acid phenyl ester derivatives or benzoic acid biphenyl ester derivatives according to German Offenlegungsschrift 2,450,088, which were hitherto used for this purpose, 5 the compounds according to the invention provide the considerable advantage that they increase the viscosity of the liquid crystal base dielectrics less, or even reduce it. Because of the low values of their dielectric anisotropy, they are preferably used as components 10 of liquid crystal dielectrics with negative dielectric anisotropy.

The liquid crystal dielectrics according to the invention consist of two or more components, and amongst these at least one of the formula (I). The other 15 components are preferably nematic or nematogenic substances from the classes of azobenzenes, azoxybenzenes, biphenyls, Schiff's bases, in particular benzylidene derivatives, phenyl benzoates, phenylcyclohexanes, optionally halogenated stilbenes, diphenylacetylene 20 derivatives, diphenyl nitrones and substituted cinnamic acids. The most important compounds which are possible as other components of this type can be characterised by the formula (IV):

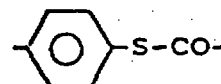
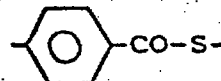
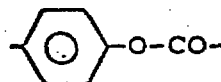
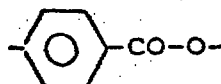
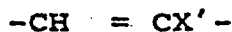


25 wherein

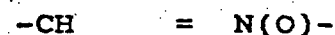
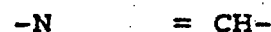
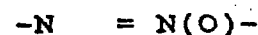
A is



(71)



5



or a C-C single bond.

- 10 Other possible components of the dielectrics according to the invention are those compounds of the formula (IV) in which one or more phenyl rings are replaced by a corresponding number of trans-cyclohexyl rings; X' is halogen, preferably Cl, or -CN. R₅ and R₄ are identical or different and can be alkyl, alkoxy, alkanoyl, alkanoyloxy or alkoxycarbonyloxy radicals with up to 18, preferably up to 8, C atoms. In most of these compounds, R₅ and R₄ are preferably different, one of the radicals usually being an alkyl or alkoxy group. However, a large number of other variants of the substituents envisaged are also customary. Many such substances are commercially available.

The dielectrics according to the invention as a rule contain at least 30, preferably 50 - 99 and in

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particular 60 -98, parts by weight of the compounds of the formulae (I) and, if appropriate, (IV). One or more compounds of the formula (I) preferably make up at least 5 parts by weight, and in most cases even 10 or 5 more parts by weight, of this amount. The invention also comprises those liquid crystal dielectrics to which, for example, only less than 5 parts by weight, for example 0.1 to 3 parts by weight, of one or more compounds of the formula (I) have been added for doping 10 purposes.

The dielectrics according to the invention are prepared in a manner which is customary per se. As a rule, the desired amount of one or more compounds of the formula (I) is dissolved in the other components, preferably 15 ably at elevated temperature. The completeness of the dissolving operation can be observed particularly easily if a temperature above the clear point of the base material is chosen here.

However, it is also possible to mix solutions of 20 components of the formulae (I) and (IV) in a suitable organic solvent, for example acetone, chloroform or methanol, and after thorough mixing, to remove the solvent again, for example by distillation under reduced pressure. In this procedure, of course, care must be taken that no 25 impurities or undesired doping substances are incorporated through the solvent.

The liquid crystal dielectrics according to the invention can be modified by suitable additives so that they can be used in all types of liquid crystal display

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elements hitherto disclosed. Such additives are known to the expert and are described in detail in the relevant literature. For example, it is possible to add substances to alter the dielectric anisotropy, the viscosity, the conductivity and/or the orientation of the nematic phases. Such substances are described, for example, in German Offenlegungsschriften 2,209,127, 2,240,864, 2,321,632, 2,338,281 and 2,450,088.

The following examples are intended to illustrate the invention. In the examples, m. denotes the melting point and c. denotes the clear point of a liquid crystal substance in degrees Centigrade; boiling points are designated by b.p. Unless otherwise indicated, data relating to parts or percentages are parts by weight or percentages by weight.

Example 1

(a) 306 g of 4-(4-n-pentylcyclohexyl)-biphenyl are dissolved in a suspension of 150 g of anhydrous aluminium chloride in 2,000 ml of methylene chloride at 10°, whilst stirring, and a solution of 79 g of acetyl chloride in 250 ml of methylene chloride is added dropwise to the solution in the course of 2 hours, whilst stirring. The reaction mixture is stirred for a further 16 hours and poured into a solution of 300 ml of concentrated hydrochloric acid in 2.5 l of ice-water. The organic phase is separated off, washed with water and sodium bicarbonate solution, dried over calcium chloride and evaporated. The p-(4-n-pentylcyclohexyl)-p'-acetyl-biphenyl which remains is recrystallised from ethanol;

m. 125° , yield: 315 g.

(b) 175 g of p-(4-n-pentylcyclohexyl)-p'-acetylbiphenyl are dissolved in 1.5 l of tetrahydrofuran and are hydrogenated in the presence of 10 g of palladium-on-charcoal (5 % of Pd) at room temperature and under normal pressure for 80 hours. The catalyst is then filtered off, the filtrate is evaporated and the p-(4-n-pentylcyclohexyl)-p'-ethylbiphenyl which remains is recrystallised from ethanol; m. 34° , c. 164° , yield: 149 g.

10 The following compounds are prepared analogously:

- p-(4-methylcyclohexyl)-p'-methylbiphenyl,
p-(4-ethylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-methylbiphenyl,
15 p-(4-n-pentylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-methylbiphenyl,
20 p-(4-n-decylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-undecylcyclohexyl)-p'-methylbiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-methylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-methylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-methylbiphenyl,
25 p-[4-(3-methylbutyl)-cyclohexyl]-p'-methylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-methylbiphenyl.
p-(4-Methylcyclohexyl)-p'-ethylbiphenyl,
p-(4-ethylcyclohexyl)-p'-ethylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-ethylbiphenyl,

(73)

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- p-(4-n-butylcyclohexyl)-p'-ethylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-ethylbiphenyl, m. 44° , c. 156° ;
p-(4-n-heptylcyclohexyl)-p'-ethylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-ethylbiphenyl,
5 p-(4-n-nonylcyclohexyl)-p'-ethylbiphenyl,
p-(4-n-decylcyclohexyl)-p'-ethylbiphenyl,
p-(4-n-undecylcyclohexyl)-p'-ethylbiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-ethylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-ethylbiphenyl,
10 p-[4-(2-methylbutyl)-cyclohexyl]-p'-ethylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-ethylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-ethylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-propylbiphenyl,
15 p-(4-n-propylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-propylbiphenyl, m. 14° ,
c. 158° ;
p-(4-n-hexylcyclohexyl)-p'-n-propylbiphenyl,
20 p-(4-n-heptylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-propylbiphenyl,
p-(4-n-undecylcyclohexyl)-p'-n-propylbiphenyl,
25 p-(4-n-dodecylcyclohexyl)-p'-n-propylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-propylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-propylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-propylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-propylbiphenyl.

- p-(4-Methylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-butylbiphenyl,
5 p-(4-n-pentylcyclohexyl)-p'-n-butylbiphenyl, m. 20°, c. 170.5°;
p-(4-n-hexylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-butylbiphenyl,
10 p-(4-n-decylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-undecylcyclohexyl)-p'-n-butylbiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-n-butylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-butylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-butylbiphenyl,
15 p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-butylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-butylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-pentylbiphenyl,
20 p-(4-n-butylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-pentylbiphenyl, m. 13°,
c. 170°;
p-(4-n-hexylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-pentylbiphenyl,
25 p-(4-n-octylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-undecylcyclohexyl)-p'-n-pentylbiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-n-pentylbiphenyl,

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- p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-pentylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-pentylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-pentylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-pentylbiphenyl.
- 5 p-(4-Methylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-hexylbiphenyl.
p-(4-n-pentylcyclohexyl)-p'-n-hexylbiphenyl,
- 10 p-(4-n-hexylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-hexylbiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-hexylbiphenyl,
- 15 p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-hexylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-hexylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-hexylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-hexylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-heptylbiphenyl,
- 20 p-(4-ethylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-heptylbiphenyl,
- 25 p-(4-n-heptylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-heptylbiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-heptylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-heptylbiphenyl,

- p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-heptylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-heptylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-heptylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-octylbiphenyl,
5 p-(4-ethylcyclohexyl)-p'-n-octylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-octylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-octylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-octylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-octylbiphenyl,
10 p-(4-n-heptylcyclohexyl)-p'-n-octylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-octylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-octylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-octylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-octylbiphenyl and
15 p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-octylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-nonylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-nonylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-nonylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-nonylbiphenyl,
20 p-(4-n-pentylcyclohexyl)-p'-n-nonylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-nonylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-nonylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-nonylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-nonylbiphenyl,
25 p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-nonylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-nonylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-decylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-decylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-decylbiphenyl,

- p-(4-n-butylcyclohexyl)-p'-n-decylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-decylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-decylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-decylbiphenyl,
5 p-(4-n-octylcyclohexyl)-p'-n-decylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-decylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-decylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-decylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-decylbiphenyl.
- 10 p-(4-Methylcyclohexyl)-p'-n-undecylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-undecylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-undecylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-undecylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-undecylbiphenyl,
15 p-(4-n-hexylcyclohexyl)-p'-n-undecylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-undecylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-undecylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-undecylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-undecylbiphenyl,
20 p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-undecylbiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-undecylbiphenyl.
p-(4-Methylcyclohexyl)-p'-n-dodecylbiphenyl,
p-(4-ethylcyclohexyl)-p'-n-dodecylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-dodecylbiphenyl,
25 p-(4-n-butylcyclohexyl)-p'-n-dodecylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-dodecylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-dodecylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-dodecylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-dodecylbiphenyl,

- p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-dodecylbiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-dodecylbiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-dodecylbiphenyl
and
- 5 p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-dodecylbiphenyl.
p-(4-Methylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-ethylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-n-propylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-n-butylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
10 p-(4-n-pentylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
m. 50°, c. 88°;
p-(4-n-hexylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-n-heptylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-n-octylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
15 p-(4-n-nonylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-n-decylcyclohexyl)-p'-(2-methylbutyl)-biphenyl,
p-(4-n-undecylcyclohexyl)-p'-(2-methylbutyl)-biphenyl and
p-(4-n-dodecylcyclohexyl)-p'-(2-methylbutyl)-biphenyl.
p-(4-Methylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
20 p-(4-ethylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-propylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-butylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-pentylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-hexylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
25 p-(4-n-heptylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-octylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-nonylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-decylcyclohexyl)-p'-(2-methylpentyl)-biphenyl,
p-(4-n-undecylcyclohexyl)-p'-(2-methylpentyl)-biphenyl

and

p-(4-n-dodecylcyclohexyl)-p'-(2-methylpentyl)-biphenyl.

p-(4-Methylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-ethylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

5 p-(4-n-propylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-butylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-pentylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-hexylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-heptylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

10 p-(4-n-octylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-nonylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-decylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl,

p-(4-n-undecylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl and

p-(4-n-dodecylcyclohexyl)-p'-(2-ethylhexyl)-biphenyl.

15 Example 2

A mixture of 20 ml of 33% hydrogen peroxide and 50 ml of 98% formic acid is added to a suspension of 35 g of p-(4-n-pentylcyclohexyl)-p'-acetylbiphenyl in 200 ml of 98% formic acid and the reaction mixture is
20 stirred at room temperature for 72 hours. It is poured onto 1,000 g of ice and extracted twice with 500 ml of methylene chloride each time. The p-(4-n-pentylcyclohexyl)-p'-acetoxibiphenyl which remains after evaporating off the solvent is recrystallised from ethanol;
25 m. 77°, c. 215°.

The following compounds are prepared analogously:

p-(4-methylcyclohexyl)-p'-acetoxibiphenyl,

p-(4-ethylcyclohexyl)-p'-acetoxibiphenyl,

p-(4-n-propylcyclohexyl)-p'-acetoxibiphenyl,

- p-(4-n-butylcyclohexyl)-p'-acetoxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-acetoxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-acetoxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-acetoxybiphenyl,
5 p-(4-n-nonylcyclohexyl)-p'-acetoxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-acetoxybiphenyl,
p-(4-n-undecylcyclohexyl)-p'-acetoxybiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-acetoxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-acetoxybiphenyl,
10 p-[4-(2-methylbutyl)-cyclohexyl]-p'-acetoxybiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-acetoxybiphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-acetoxybiphenyl.

Example 3

- a) 46 g of p-(4-n-pentylcyclohexyl)-p'-acetoxy-
15 biphenyl are suspended in 250 ml of water and 85 ml of
ethanol with 20 g of sodium hydroxide. The suspension
is heated to the boiling point under reflux for 2 hours
and is then acidified with hydrochloric acid. The
p-(4-n-pentylcyclohexyl)-p'-hydroxybiphenyl which has
20 precipitated is filtered off and washed with water until
neutral; m. 202°.

- b) A solution of 3.4 g of valeryl chloride in 20 ml
of toluene is added dropwise to 9.0 g of p-(4-n-pentyl-
cyclohexyl)-p'-hydroxybiphenyl in the course of 10 minutes
25 at such a rate that the temperature does not exceed 30°.
2.5 g of pyridine are then added and the mixture is
stirred at 20° for 12 hours. The reaction mixture is
then poured into 500 ml of water and the organic phase
is separated off, washed with water until neutral and

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evaporated. The p-(4-n-pentylcyclohexyl)-p'-n-pentanoyloxybiphenyl which remains is recrystallised from ethanol; m. 69°, c. 199°.

The following compounds are prepared analogously:

- 5 p-(4-methylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-propionyloxybiphenyl,
- 10 p-(4-n-hexylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-propionyloxybiphenyl,
- 15 p-(4-n-undecylcyclohexyl)-p'-propionyloxybiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-propionyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-propionyloxy-
biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-propionyloxy-
- 20 biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-propionyloxy-
biphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-propionyloxy-
biphenyl.
- 25 p-(4-Methylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-butyryloxybiphenyl,

- p-(4-n-hexylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-butyryloxybiphenyl,
5 p-(4-n-decylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-undecylcyclohexyl)-p'-butyryloxybiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-butyryloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-butyryloxybiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-butyryloxybiphenyl,
10 p-[4-(3-methylbutyl)-cyclohexyl]-p'-butyryloxybiphenyl
and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-butyryloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
15 p-(4-n-propylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
20 p-(4-n-nonylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-undecylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-n-pentanoyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-pentanoyloxy-
25 biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-pentanoyloxy-
biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-pentanoyloxy-
biphenyl and

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- p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-pentanoyloxybiphenyl.
- p-(4-Methylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-ethylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- 5 p-(4-n-propylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-butylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-pentylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-hexylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-heptylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- 10 p-(4-n-octylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-nonylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-decylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-undecylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- p-(4-n-dodecylcyclohexyl)-p'-n-hexanoyloxybiphenyl,
- 15 p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-hexanoyloxybiphenyl,
- p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-hexanoyloxybiphenyl,
- p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-hexanoyloxybiphenyl and
- 20 p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-hexanoyloxybiphenyl.
- p-(4-Methylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
- p-(4-ethylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
- 25 p-(4-n-propylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
- p-(4-n-butylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
- p-(4-n-pentylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
- p-(4-n-hexylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
- p-(4-n-heptylcyclohexyl)-p'-n-heptanoyloxybiphenyl,

- p-(4-n-octylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-heptanoyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-heptanoyloxy-
5 biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-heptanoyloxy-
biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-heptanoyloxy-
biphenyl and
10 p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-heptanoyloxy-
biphenyl.
p-(4-Methylcyclohexyl)-p'-n-octanoyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-octanoyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-octanoyloxybiphenyl,
15 p-(4-n-butylcyclohexyl)-p'-n-octanoyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-octanoyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-octanoyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-octanoyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-octanoyloxybiphenyl,
20 p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-octanoyloxy-
biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-octanoyloxy-
biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-octanoyloxy-
25 biphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-octanoyloxy-
biphenyl.
p-(4-Methylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-ethylcyclohexyl)-p'-trifluoroacetoxybiphenyl,

- p-(4-n-propylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
5 p-(4-n-heptylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-(4-n-undecylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
10 p-(4-n-dodecylcyclohexyl)-p'-trifluoroacetoxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-trifluoroacetoxy-
biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-trifluoroacetoxy-
biphenyl,
15 p-[4-(3-methylbutyl)-cyclohexyl]-p'-trifluoroacetoxy-
biphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-trifluoroacetoxy-
biphenyl.
p-(4-Methylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,
20 p-(4-ethylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-heptafluorobutyryloxy-
biphenyl,
p-(4-n-butylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-heptafluorobutyryloxy-
25 biphenyl,
p-(4-n-hexylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-heptafluorobutyryloxy-
biphenyl,
p-(4-n-octylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,

- p-(4-n-nonylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-heptafluorobutyryl-
oxybiphenyl,
5 p-[4-(2-methylbutyl)-cyclohexyl]-p'-heptafluorobutyryloxy-
biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-heptafluorobutyryloxy-
biphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-heptafluorobutyryloxy-
10 biphenyl.

Example 4

A solution of 32 g of p-(4-pentylcyclohexyl)-
p'-hydroxybiphenyl in 250 ml of acetone is heated to the
boiling point under reflux with 31 g of n-pentyl bromide
15 in the presence of 70 g of anhydrous potassium carbonate
for 24 hours. After cooling, the reaction mixture is
filtered, the filter is evaporated and the p-(4-n-pentyl-
cyclohexyl)-p'-n-pentyloxybiphenyl which remains is
recrystallised from ethanol; m. 42° , c. 183° , yield: 37 g.

20 The following compounds are prepared analogously:

- p-(4-methylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-ethylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-propylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-butylcyclohexyl)-p'-methoxy-biphenyl,
25 p-(4-n-pentylcyclohexyl)-p'-methoxy-biphenyl, m. 80° ,
c. 165° ;
p-(4-n-hexylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-heptylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-octylcyclohexyl)-p'-methoxy-biphenyl,

- p-(4-n-nonylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-decylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-undecylcyclohexyl)-p'-methoxy-biphenyl,
p-(4-n-dodecylcyclohexyl)-p'-methoxy-biphenyl,
5 p-[4-(2-methylpropyl)-cyclohexyl]-p'-methoxy-biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-methoxy-biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-methoxy-biphenyl and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-methoxy-biphenyl.
p-(4-Methylcyclohexyl)-p'-ethoxy-biphenyl,
10 p-(4-ethylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-propylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-butylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-pentylcyclohexyl)-p'-ethoxy-biphenyl, m. 89° ,
c. 148° ;
15 p-(4-n-hexylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-heptylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-octylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-nonylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-decylcyclohexyl)-p'-ethoxy-biphenyl,
20 p-(4-n-undecylcyclohexyl)-p'-ethoxy-biphenyl,
p-(4-n-dodecylcyclohexyl)-p'-ethoxy-biphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-ethoxy-biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-ethoxy-biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-ethoxy-biphenyl and
25 p-[4-(2-ethylhexyl)-cyclohexyl]-p'-ethoxy-biphenyl.
p-(4-Methylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-propyloxybiphenyl,

- p-(4-n-pentylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-propyloxybiphenyl,
5 p-(4-n-nonylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-undecylcyclohexyl)-p'-n-propyloxybiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-n-propyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-propyloxy-
10 biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-propyloxybiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-propyloxybiphenyl
and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-propyloxybiphenyl.
15 p-(4-Methylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-butyloxybiphenyl,
20 p-(4-n-hexylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-butyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-butyloxybiphenyl,
25 p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-butyloxybiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-butyloxybiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-butyloxybiphenyl
and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-butyloxybiphenyl.

- p-(4-Methylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-pentyloxybiphenyl,
5 p-(4-n-hexylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-pentyloxybiphenyl,
10 p-(4-n-undecylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-(4-n-dodecylcyclohexyl)-p'-n-pentyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-pentyloxybiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-pentyloxybiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-pentyloxybiphenyl
15 and
p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-pentyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-hexyloxybiphenyl,
20 p-(4-n-butylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-hexyloxybiphenyl,
25 p-(4-n-nonylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-(4-n-decylcyclohexyl)-p'-n-hexyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-hexyloxybiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-hexyloxybiphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-hexyloxybiphenyl

and

p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-hexyloxybiphenyl.

p-(4-Methylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-ethylcyclohexyl)-p'-n-heptyloxybiphenyl,

5 p-(4-n-propylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-n-butylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-n-pentylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-n-hexylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-n-heptylcyclohexyl)-p'-n-heptyloxybiphenyl,

10 p-(4-n-octylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-n-nonylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-(4-n-decylcyclohexyl)-p'-n-heptyloxybiphenyl,

p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-heptyloxybiphenyl,

p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-heptyloxybiphenyl,

15 p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-heptyloxybiphenyl

and

p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-heptyloxybiphenyl.

p-(4-Methylcyclohexyl)-p'-n-octyloxybiphenyl,

p-(4-ethylcyclohexyl)-p'-n-octyloxybiphenyl,

20 p-(4-n-propylcyclohexyl)-p'-n-octyloxybiphenyl,

p-(4-n-butylcyclohexyl)-p'-n-octyloxybiphenyl,

p-(4-n-pentylcyclohexyl)-p'-n-octyloxybiphenyl,

p-(4-n-hexylcyclohexyl)-p'-n-octyloxybiphenyl,

p-(4-n-heptylcyclohexyl)-p'-n-octyloxybiphenyl,

25 p-(4-n-octylcyclohexyl)-p'-n-octyloxybiphenyl,

p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-octyloxybiphenyl,

p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-octyloxybiphenyl,

p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-octyloxybiphenyl

and

- p-[4-(2-ethylhexyl)-cyclohexyl]-p'-n-octyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-n-nonyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-nonyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-nonyloxybiphenyl,
5 p-(4-n-butylcyclohexyl)-p'-n-nonyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-nonyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-nonyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-nonyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-nonyloxybiphenyl,
10 p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-nonyloxybiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-nonyloxybiphenyl
and
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-nonyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-n-decyloxybiphenyl,
15 p-(4-ethylcyclohexyl)-p'-n-decyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-decyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-decyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-decyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-decyloxybiphenyl,
20 p-(4-n-heptylcyclohexyl)-p'-n-decyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-n-decyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-decyloxybiphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-decyloxybiphenyl
and
25 p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-decyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-n-undecyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-n-undecyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-undecyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-undecyloxybiphenyl,

- p-(4-n-pentylcyclohexyl)-p'-n-undecyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-undecyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-n-undecyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-undecyloxy-
5 biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-undecyloxybiphenyl
and
p-[4-(3-methylbutyl)-cyclohexyl]-p'-n-undecyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-n-dodecyloxybiphenyl,
10 p-(4-ethylcyclohexyl)-p'-n-dodecyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-n-dodecyloxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-n-dodecyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-n-dodecyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-n-dodecyloxybiphenyl,
15 p-(4-n-heptylcyclohexyl)-p'-n-dodecyloxybiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-n-dodecyloxy-
biphenyl and
p-[4-(2-methylbutyl)-cyclohexyl]-p'-n-dodecyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
20 p-(4-ethylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-propylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-butylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-pentylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-hexylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
25 p-(4-n-heptylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-octylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-nonylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-decylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,
p-(4-n-undecylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl

and

p-(4-n-dodecylcyclohexyl)-p'-(2-methylbutyloxy)-biphenyl,

p-(4-Methylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

p-(4-ethylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

5 p-(4-n-propylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

p-(4-n-butylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

p-(4-n-pentylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

p-(4-n-hexylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

p-(4-n-heptylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

10 p-(4-n-octylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl,

p-(4-n-nonylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl

and

p-(4-n-decylcyclohexyl)-p'-(2-methylheptyloxy)-biphenyl.

Example 5

15 A solution of 32 g of p-(4-n-pentylcyclohexyl)-p'-hydroxybiphenyl in 200 ml of toluene is heated to the boiling point under reflux with 42 g of heptafluorobutyric anhydride and 2 drops of concentrated sulfuric acid for 7 hours. The cooled reaction mixture is
20 washed with 150 ml of aqueous sodium bicarbonate solution, dried over sodium sulfate and evaporated. The p-(4-n-pentylcyclohexyl)-p'-heptafluorobutyryloxybiphenyl which remains is heated at 170° in a pressure vessel in the presence of 25 g of anhydrous hydrofluoric
25 acid and 108 g of sulfur tetrafluoride for 8 hours.

The volatile constituents of the reaction mixture are then removed by bubbling out with nitrogen, the residue is taken up in a suspension of 50 g of sodium fluoride in 250 ml of tetrahydrofuran and, after stirring for

- 35 -

2 hours, the resulting suspension is filtered. The filtrate is evaporated and the p-(4-n-pentylcyclohexyl)-p'-perfluorobutyloxybiphenyl which remains is recrystallised from ethanol.

5 The following compounds are prepared analogously:

- p-(4-methylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-perfluoroethoxybiphenyl,
10 p-(4-n-pentylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-perfluoroethoxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-perfluoroethoxybiphenyl and
15 p-(4-n-decylcyclohexyl)-p'-perfluoroethoxybiphenyl.
p-(4-Methylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-n-butylcyclohexyl)-p'-perfluoropropoxybiphenyl,
20 p-(4-n-pentylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-perfluoropropoxybiphenyl,
p-(4-n-nonylcyclohexyl)-p'-perfluoropropoxybiphenyl
25 and
p-(4-n-decylcyclohexyl)-p'-perfluoropropoxybiphenyl.
p-(4-Methylcyclohexyl)-p'-perfluorobutyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluorobutyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluorobutyloxybiphenyl,

- 36 -

- p-(4-n-butylcyclohexyl)-p'-perfluorobutyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluorobutyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-perfluorobutyloxybiphenyl,
p-(4-n-octylcyclohexyl)-p'-perfluorobutyloxybiphenyl,
5 p-(4-n-nonylcyclohexyl)-p'-perfluorobutyloxybiphenyl and
p-(4-n-decylcyclohexyl)-p'-perfluorobutyloxybiphenyl.
p-(4-Methylcyclohexyl)-p'-perfluoropentyloxybiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoropentyloxybiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluoropentyloxybiphenyl,
10 p-(4-n-butylcyclohexyl)-p'-perfluoropentyloxybiphenyl,
p-(4-n-pentylcyclohexyl)-p'-perfluoropentyloxybiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluoropentyloxybiphenyl,
p-(4-n-heptylcyclohexyl)-p'-perfluoropentyloxybiphenyl
and
15 p-(4-n-octylcyclohexyl)-p'-perfluoropentyloxybiphenyl.

Example 6

- p-(4-n-Pentylcyclohexyl)-p'-trifluoroacetyl-
biphenyl is prepared from 4-(4-n-pentylcyclohexyl)-
biphenyl and trifluoroacetyl chloride in the presence
20 of aluminium chloride, analogously to Example 1(a).
40 g of the compound obtained are heated at 100° in a
pressure vessel with 50 g of sulfur tetrafluoride for
8 hours. After cooling, the excess sulfur tetrafluoride
and volatile reaction products are removed by bubbling
25 nitrogen in, and the p-(4-n-pentylcyclohexyl)-p'-per-
fluoroethylbiphenyl which remains is recrystallised from
ethanol.

The following compounds are prepared analogously:
p-(4-methylcyclohexyl)-p'-trifluoromethylbiphenyl,

- p-(4-ethylcyclohexyl)-p'-trifluoromethylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-trifluoromethylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-trifluoromethylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-trifluoromethylbiphenyl,
5 p-(4-n-hexylcyclohexyl)-p'-trifluoromethylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-trifluoromethylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-trifluoromethylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-trifluoromethylbiphenyl and
p-(4-n-decylcyclohexyl)-p'-trifluoromethylbiphenyl.
- 10 p-(4-Methylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluoroethylbiphenyl,
15 p-(4-n-heptylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-n-nonylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-(4-n-decylcyclohexyl)-p'-perfluoroethylbiphenyl,
p-[4-(2-methylpropyl)-cyclohexyl]-p'-perfluoroethyl-
20 biphenyl,
p-[4-(2-methylbutyl)-cyclohexyl]-p'-perfluoroethyl-
biphenyl,
p-[4-(3-methylbutyl)-cyclohexyl]-p'-perfluoroethyl-
biphenyl and
25 p-[4-(2-ethylhexyl)-cyclohexyl]-p'-perfluoroethylbiphenyl.
p-(4-Methylcyclohexyl)-p'-perfluoropropylbiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoropropylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluoropropylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-perfluoropropylbiphenyl,

- p-(4-n-pentylcyclohexyl)-p'-perfluoropropylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluoropropylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-perfluoropropylbiphenyl,
p-(4-n-octylcyclohexyl)-p'-perfluoropropylbiphenyl,
5 p-(4-n-nonylcyclohexyl)-p'-perfluoropropylbiphenyl and
p-(4-n-decylcyclohexyl)-p'-perfluoropropylbiphenyl.
p-(4-Methylcyclohexyl)-p'-perfluorobutylbiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluorobutylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluorobutylbiphenyl,
10 p-(4-n-butylcyclohexyl)-p'-perfluorobutylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-perfluorobutylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluorobutylbiphenyl,
p-(4-n-heptylcyclohexyl)-p'-perfluorobutylbiphenyl and
p-(4-n-octylcyclohexyl)-p'-perfluorobutylbiphenyl.
15 p-(4-Methylcyclohexyl)-p'-perfluoropentylbiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoropentylbiphenyl,
p-(4-n-propylcyclohexyl)-p'-perfluoropentylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-perfluoropentylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-perfluoropentylbiphenyl,
20 p-(4-n-hexylcyclohexyl)-p'-perfluoropentylbiphenyl
p-(4-n-heptylcyclohexyl)-p'-perfluoropentylbiphenyl and
p-(4-n-octylcyclohexyl)-p'-perfluoropentylbiphenyl.
p-(4-Methylcyclohexyl)-p'-perfluoroisobutylbiphenyl,
p-(4-ethylcyclohexyl)-p'-perfluoroisobutylbiphenyl,
25 p-(4-n-propylcyclohexyl)-p'-perfluoroisobutylbiphenyl,
p-(4-n-butylcyclohexyl)-p'-perfluoroisobutylbiphenyl,
p-(4-n-pentylcyclohexyl)-p'-perfluoroisobutylbiphenyl,
p-(4-n-hexylcyclohexyl)-p'-perfluoroisobutylbiphenyl
p-(4-n-heptylcyclohexyl)-p'-perfluoroisobutylbiphenyl and

p-(4-n-octylcyclohexyl)-p'-perfluoroisobutylbiphenyl.

The following examples relate to dielectrics according to the invention.

Example 7

- 5 The dielectric consisting of 67 % of 4-n-butyl-4'-methoxyazoxybenzene and 33 % of 4-ethyl-4'-methoxyazoxybenzene has a nematic phase in the temperature range from -5° to $+73^{\circ}$ and a viscosity of $31 \cdot 10^{-3}$ Pa.s at 20° .

- 10 A dielectric consisting of 95 % of this two-component mixture and 5 % of p-(4-n-pentylcyclohexyl)-p'-ethoxybiphenyl has a nematic phase in the temperature range from -10° to $+79^{\circ}$ and a viscosity of $28 \cdot 10^{-3}$ Pa.s at 20° .

Example 8

- 15 The dielectric consisting of 67 % of anisic acid 4-n-pentylphenyl ester and 33 % of 4-n-hexyloxybenzoic acid 4'-n-pentylphenyl ester has a nematic phase in the temperature range from $+15^{\circ}$ to $+48^{\circ}$ and a viscosity of $58 \cdot 10^{-3}$ Pa.s at 20° .

- 20 A dielectric consisting of 80 % of this two-component mixture and 20 % of p-(4-n-pentylcyclohexyl)-p'-ethylbiphenyl has a nematic phase in the temperature range from 0° to $+71^{\circ}$ and a viscosity of $49 \cdot 10^{-3}$ Pa.s at 20° .

Example 9

- 25 A dielectric consisting of 77 % of the two-component mixture according to Example 7 and 23 % of p-(4-n-pentylcyclohexyl)-p'-ethylbiphenyl has a nematic phase in the temperature range from -15° to $+95^{\circ}$ and a viscosity of $30 \cdot 10^{-3}$ Pa.s at 20° .

Example 10

A dielectric consisting of 80 % of the two-component mixture according to Example 8 and 20 % of p-(4-n-hexylcyclohexyl)-p'-ethylbiphenyl has a nematic 5 phase in the temperature range from 6° to 68° and a viscosity of $52 \cdot 10^{-3}$ Pa.s at 20°.

Example 11

The dielectric consisting of 29 % of 4-(4-n-propylcyclohexyl)-benzonitrile, 41 % of 4-(4-n-pentyl-10 cyclohexyl)-benzonitrile and 30 % of 4-(4-n-heptylcyclohexyl)-benzonitrile has a nematic phase in the temperature range from -3° to +52° and a viscosity of 24 cSt at 20°.

A dielectric consisting of 74 % of this ternary 15 mixture and 26 % of p-(4-n-pentylcyclohexyl)-p'-ethylbiphenyl has a nematic phase in the temperature range from -10° to +74° and a viscosity of 23 cSt at 20°.

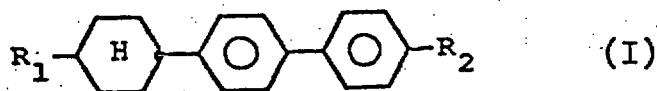
Example 12

The liquid crystal compound p-n-pentyl-p'-cyano- 20 biphenyl has a nematic phase in the temperature range from 22.5° to 35° and a viscosity of 29.5 cSt at 20° (supercooled state).

A mixture of 90 % of p-n-pentyl-p'-cyclobiphenyl and 10 % of p-(4-n-pentylcyclohexyl)-p'-n-butylbiphenyl 25 has a nematic phase in the temperature range from 18.5° to 49.2° and a viscosity of 29 cSt at 20°.

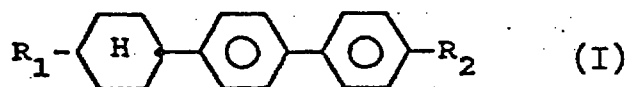
Patent Claims for the contracting states CH, LI, DE, FR, GB, IT and NL

1. Cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 contain a branched carbon chain.

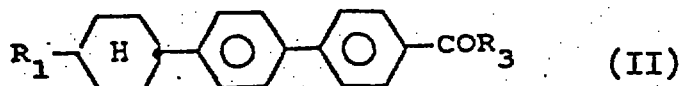
2. Process for the preparation of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain, characterised in that

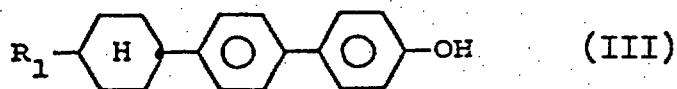
(a) for the preparation of a compound of the formula (I)

wherein R_2 denotes an alkyl group, the carbonyl group in a compound of the formula (II)



wherein R_3 is H or alkyl with 1 - 11 C atoms and R_1 has the abovementioned meaning, is reduced to the methylene group, or

(b) to prepare a compound of the formula (I) wherein R_2 is an alkoxy group, a compound of the formula (II) is converted into a phenol of the formula (III)



wherein R_1 has the abovementioned meaning, by treatment with an oxidising agent and, if appropriate, subsequent hydrolysis, and this phenol is reacted with an O-alkylating agent, or

(c) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkyl group, a 4-(4-alkylcyclohexyl)-biphenyl is reacted with a perfluorocarboxylic acid halide in the presence of a Lewis acid and the carbonyl group in the fluoroalkyl ketone thus obtained is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or

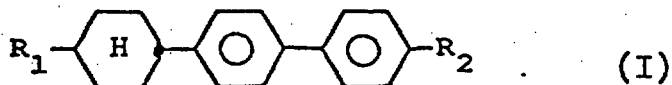
(d) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkoxy group, a phenol of the formula (III) is esterified by reaction with a perfluorocarboxylic acid derivative and the ester-carbonyl group in the resulting perfluorocarboxylic acid phenyl ester derivative is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or

(e) to prepare a compound of the formula (I) wherein R_2 is an optionally perfluorinated alkanoyloxy group, a phenol of the formula (III) is esterified in a manner which is in itself customary, by reaction with an optionally perfluorinated alkanecarboxylic acid or a reactive

- 3 -

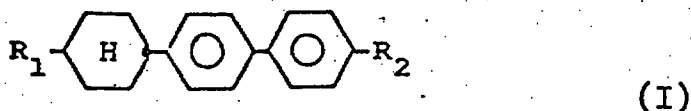
derivative of such an acid.

3. Use of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain, as components of liquid crystal dielectrics.

4. Liquid crystal dielectric with 2 or more components, characterised in that it contains at least one cyclohexylbiphenyl of the formula (I)

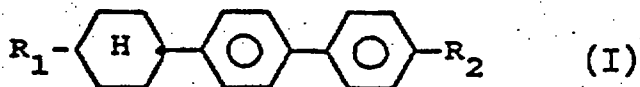


wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain.

5. Electrooptical display element based on a liquid crystal cell, characterised in that it contains a liquid crystal dielectric according to Claim 4.

Claims for the contracting state AT

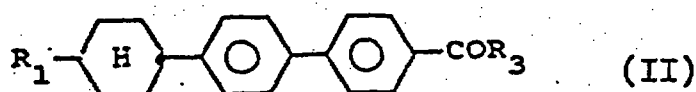
1. Process for the preparation of the cyclohexylbiphenyls of the formula (I)



- 4 -

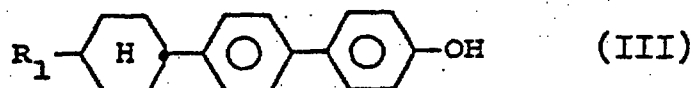
wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain, characterised in that

(a) for the preparation of a compound of the formula (I) wherein R_2 denotes an alkyl group, the carbonyl group in a compound of the formula (II)



wherein R_3 is H or alkyl with 1 - 11 C atoms and R_1 has the abovementioned meaning, is reduced to the methylene group, or

(b) to prepare a compound of the formula (I) wherein R_2 is an alkoxy group, a compound of the formula (II) is converted into a phenol of the formula (III)



wherein R_1 has the abovementioned meaning, by treatment with an oxidising agent and, if appropriate, subsequent hydrolysis, and this phenol is reacted with an O-alkylating agent, or

(c) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkyl group, a 4-(4-alkylcyclohexyl)-biphenyl is reacted with a perfluorocarboxylic acid halide in the presence of a Lewis acid and the carbonyl group in the fluoroalkyl ketone thus obtained is converted into a difluoromethylene group by reaction with sulfur tetra-

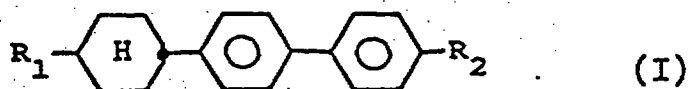
- 5 -

fluoride, or

(d) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkoxy group, a phenol of the formula (III) is esterified by reaction with a perfluorocarboxylic acid derivative and the ester-carbonyl group in the resulting perfluorocarboxylic acid phenyl ester derivative is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or

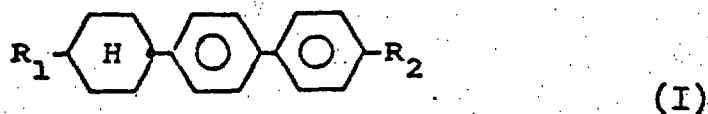
(e) to prepare a compound of the formula (I) wherein R_2 is an optionally perfluorinated alkanoyloxy group, a phenol of the formula (III) is esterified in a manner which is in itself customary, by reaction with an optionally perfluorinated alkanecarboxylic acid or a reactive derivative of such an acid.

2. Use of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain, as components of liquid crystal dielectrics.

3. Liquid crystal dielectric with 2 or more components, characterised in that it contains at least one cyclohexylbiphenyl of the formula (I)



- 6 -

wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, at most one of the substituents R_1 and R_2 containing a branched carbon chain.

4. Electrooptical display element based on a liquid crystal cell, characterised in that it contains a liquid crystal dielectric according to Claim 3.

Claims for the contracting state AT

(Translation of German text)

Claims for the Contracting states: CH, LI, DE, FR, GB, IT, NL (As printed)

1. Cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain.

2. Process for the preparation of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 - 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 - 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain, characterised in that

- (a) for the preparation of a compound of the formula (I) wherein R_2 denotes an alkyl group, the carbonyl group in a compound of the formula (II)



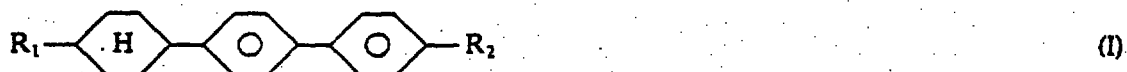
wherein R_3 is H or alkyl with 1 - 11 C atoms and R_1 has the abovementioned meaning, is reduced to the methylene group, or

- (b) to prepare a compound of the formula (I) wherein R_2 is an alkoxy group, a compound of the formula (II) is converted into a phenol of the formula (III)



- wherein R_1 has the abovementioned meaning, by treatment with an oxidising agent and, if appropriate, subsequent hydrolysis, and this phenol is reacted with an O-alkylating agent, or
- (c) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkyl group, a 4-(4-alkylcyclohexyl)-bi-phenyl is reacted with a perfluorocarboxylic acid halide in the presence of a Lewis acid and the carbonyl group in the fluoroalkyl ketone thus obtained is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or
 - (d) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkoxy group, a phenol of the formula (III) is esterified by reaction with a perfluorocarboxylic acid derivative and the ester-carbonyl group in the resulting perfluorocarboxylic acid phenyl ester derivative is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or
 - (e) to prepare a compound of the formula (I) wherein R_2 is an optionally perfluorinated alkanoyloxy group, a phenol of the formula (III) is esterified in a manner which is in itself customary, by reaction with an optionally perfluorinated alkanecarboxylic acid or a reactive derivative of such an acid.

3. Use of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 – 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 – 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain, as components of liquid crystal dielectrics.

4. Liquid crystal dielectric, characterised in that it contains at least one cyclohexylbiphenyl of the formula (I)

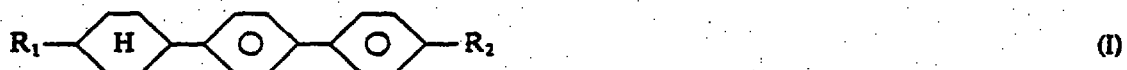


wherein R_1 is an alkyl group with 1 – 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 – 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain.

5. Electrooptical display element based on a liquid crystal cell, characterised in that it contains a liquid crystal dielectric according to claim 4.

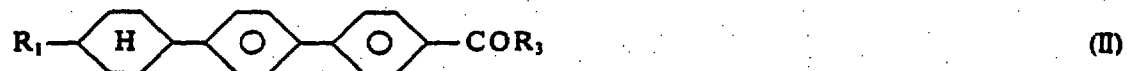
Claims for the Contracting state AT (As printed)

1. Process for the preparation of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 – 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 – 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain, characterised in that

- (a) for the preparation of a compound of the formula (I) wherein R_2 denotes an alkyl group, the carbonyl group in a compound of the formula (II)



wherein R_3 is H or alkyl with 1 – 11 C atoms and R_1 has the abovementioned meaning, is reduced to the methylene group, or

- (b) to prepare a compound of the formula (I) wherein R_2 is an alkoxy group, a compound of the formula (II) is converted into a phenol of the formula (III)



- wherein R_1 has the abovementioned meaning, by treatment with an oxidising agent and, if appropriate, subsequent hydrolysis, and this phenol is reacted with an O-alkylating agent, or
- (c) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkyl group, a 4-(4-alkylcyclohexyl)-biphenyl is reacted with a perfluorocarboxylic acid halide in the presence of a Lewis acid and the carbonyl group in the fluoroalkyl ketone thus obtained is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or
 - (d) to prepare a compound of the formula (I) wherein R_2 is a perfluoroalkoxy group, a phenol of the formula (III) is esterified by reaction with a perfluorocarboxylic acid derivative and the ester-carbonyl group in the resulting perfluorocarboxylic acid phenyl ester derivative is converted into a difluoromethylene group by reaction with sulfur tetrafluoride, or
 - (e) to prepare a compound of the formula (I) wherein R_2 is an optionally perfluorinated alkanoyloxy group, a phenol of the formula (III) is esterified in a manner which is in itself customary, by reaction with an optionally perfluorinated alkanecarboxylic acid or a reactive derivative of such an acid.

2. Use of the cyclohexylbiphenyls of the formula (I)



wherein R_1 is an alkyl group with 1 – 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 – 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain, as components of liquid crystal dielectrics.

3. Liquid crystal dielectric, characterised in that it contains at least one cyclohexylbiphenyl of the formula (I)



wherein R_1 is an alkyl group with 1 – 12 C atoms and R_2 is an optionally perfluorinated alkyl, alkoxy or alkanoyloxy group with 1 – 12 C atoms, wherein, however, at most one of the substituents R_1 and R_2 contains a branched carbon chain.

4. Electrooptical display element based on a liquid crystal cell, characterised in that it contains a liquid crystal dielectric according to claim 4.

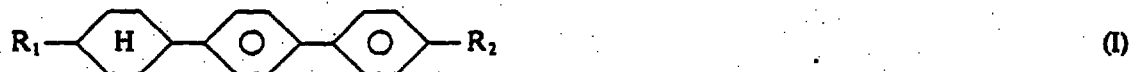
Revendications pour les Etats contractants: CH, LI, DE, FR, GB, IT, NL (As printed)

1. Cyclohexylbiphényles de formule (I)



où R_1 représente un groupe alcoyle en C_1 à C_{12} et R_2 un groupe alcoyle, alcoxy ou alcanoyloxy en C_1 à C_{12} éventuellement perfluoré, où cependant au plus l'un des substituants R_1 et R_2 contient une chaîne hydrocarbonée ramifiée.

2. Procédé de préparation des cyclohexylbiphényles de formule (I)



où R_1 représente un groupe alcoyle en C_1 à C_{12} et R_2 un groupe alcoyle, alcoxy ou alcanoyloxy en C_1 à C_{12} éventuellement perfluoré, où cependant au plus l'un des substituants R_1 et R_2 contient une chaîne hydrocarbonée ramifiée, caractérisé en ce que

- (a) Pour préparer un composé de formule (I) où R_2 représente un groupe alcoyle, on réduit le groupe carbonyle en groupe méthylène dans un composé de formule (II)



(II)

- où R₃ représente H ou un alcoyle en C₁ à C₁₁, et où R₁ possède la signification donnée ci-dessus, ou
- (b) Pour préparer un composé de formule (I) où R₂ représente un groupe alcoxy, on transforme un composé de formule (II) par traitement avec un agent oxydant suivi éventuellement par une hydrolyse en un phénol de formule (III)



(III)

- où R₁ possède la signification donnée ci-dessus, et en ce qu'on fait réagir celui-ci avec un agent O-alcoylant, ou
- (c) Pour préparer un composé de formule (I) où R₂ représente un groupe perfluoroalcoyle, on fait réagir un 4-(4-alcoylcyclohexyl)-biphényle avec un halogénure d'acide perfluorocarboxylique en présence d'un acide de Lewis et on transforme dans la fluoroalcoylcétone ainsi obtenue le groupe carbonyle par réaction avec du tétrafluorure de soufre en un groupe difluorométhylène, ou
- (d) Pour préparer un composé de formule (I) où R₂ représente un groupe perfluoroalcoxy, on estérifie un phénol de formule (III) par réaction avec un dérivé d'acide perfluorocarboxylique et dans le dérivé de phénylester d'acide perfluorocarboxylique obtenu, on transforme le groupe estercarbonyle par réaction avec du tétrafluorure de soufre en un groupe difluorométhylène, ou
- (e) Pour préparer un composé de formule (I) où R₂ représente un groupe alcanoyloxy éventuellement perfluoré, on estérifie de manière habituelle un phénol de formule (III) par réaction avec un acide alcanecarboxylique éventuellement perfluoré ou un dérivé réactif d'un tel acide.

3. Application des cyclohexylbiphényles de formule (I)



(I)

où

R₁ représente un groupe alcoyle en C₁ à C₁₂ etR₂ un groupe alcoyle, alcoxy ou alcanoyloxy en C₁ à C₁₂ éventuellement perfluoré,

où cependant au plus l'un des substituants R₁ et R₂ contient une chaîne carbonée ramifiée, comme composants de diélectriques à cristaux liquides.

4. Diélectrique à cristaux liquides constitué de deux ou plusieurs composants, caractérisé en ce qu'il contient au moins un cyclohexylbiphényle de formule (I)



(I)

où

R₁ représente un groupe alcoyle en C₁ à C₁₂ etR₂ un groupe alcoyle, alcoxy ou alcanoyloxy en C₁ à C₁₂ éventuellement perfluoré,

où cependant au plus l'un des substituants R₁ et R₂ contient une chaîne carbonée ramifiée.

5. Élément indicateur électro-optique à base d'une cellule à cristaux liquides, caractérisé en ce qu'il contient un diélectrique à cristaux liquides selon la revendication 4.

Revendications pour l'Etat contractant: AT (As printed)

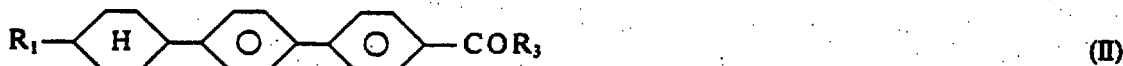
1. Procédé de préparation des cyclohexylbiphényles de formule (I)



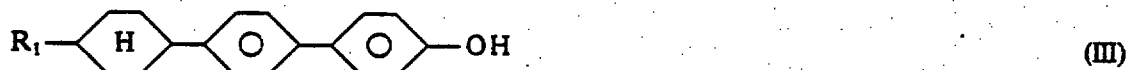
(I)

où R_1 représente un groupe alcoyle en C_1 à C_{12} et R_2 un groupe alcoyle, alcoxy ou alcanoyloxy en C_1 à C_{12} éventuellement perfluoré, où cependant au plus l'un des substituants R_1 et R_2 contient une chaîne hydrocarbonée ramifiée, caractérisé en ce que

- (a) Pour préparer un composé de formule (I) où R_2 représente un groupe alcoyle, on réduit le groupe carbonyle en groupe méthylène dans un composé de formule (II)



- où R_3 représente H ou un alcoyle en C_1 à C_{11} et où R_1 possède la signification donnée ci-dessus, ou
(b) Pour préparer un composé de formule (I) où R_2 représente un groupe alcoxy, on transforme un composé de formule (II) par traitement avec un agent oxydant suivi éventuellement par une hydrolyse en un phénol de formule (III)



où R_1 possède la signification donnée ci-dessus, et en ce qu'on fait réagir celui-ci avec un agent O-alcoylant, ou

- (c) Pour préparer un composé de formule (I) où R_2 représente un groupe perfluoroalcoyle, on fait réagir un 4-(4-alcoylcyclohexyl)-biphényle avec un halogénure d'acide perfluorocarboxylique en présence d'un acide de Lewis et on transforme dans la fluoroalcoylcétone ainsi obtenue le groupe carbonyle par réaction avec du tétrafluorure de soufre en un groupe difluorométhylène, ou
(d) Pour préparer un composé de formule (I) où R_2 représente un groupe perfluoroalcoxy, on estérifie un phénol de formule (III) par réaction avec un dérivé d'acide perfluorocarboxylique et dans le dérivé de phényl ester d'acide perfluorocarboxylique obtenu, on transforme le groupe estercarbone par réaction avec du tétrafluorure de soufre en un groupe difluorométhylène, ou
(e) Pour préparer un composé de formule (I) où R_2 représente un groupe alcanoyloxy éventuellement perfluoré, on estérifie de manière habituelle un phénol de formule (III) par réaction avec un acide alcanecarboxylique éventuellement perfluoré ou un dérivé réactif d'un tel acide.

2. Application des cyclohexylbiphényles de formule (I)



où

R_1 représente un groupe alcoyle en C_1 à C_{12} et

R_2 un groupe alcoyle, alcoxy ou alcanoyloxy en C_1 à C_{12} éventuellement perfluoré,

où cependant au plus l'un des substituants R_1 et R_2 contient une chaîne carbonée ramifiée, comme composants de diélectriques à cristaux liquides.

3. Diélectrique à cristaux liquides constitué de deux ou plusieurs composants, caractérisé en ce qu'il contient au moins un cyclohexylbiphényle de formule (I)



où

R_1 représente un groupe alcoyle en C_1 à C_{12} et

R_2 un groupe alcoyle, alcoxy ou alcanoyloxy en C_1 à C_{12} éventuellement perfluoré,

où cependant au plus l'un des substituants R_1 et R_2 contient une chaîne carbonée ramifiée.

4. Élément indicateur électro-optique à base d'une cellule à cristaux liquides, caractérisé en ce qu'il contient un diélectrique à cristaux liquides selon la revendication 3.