

Description

The properties of nematic or nematic-cholesteric liquid-crystalline materials of significantly varying their optical properties, such as light absorption, light scattering, birefringence, reflectivity or colour, under the influence of electric fields are widely utilised for electro-optical display elements. The functioning of display elements of this type is based here, for example, on the phenomena of dynamic scattering, the deformation of aligned phases, the Schadt-Helfrich effect in the twisted cell or the cholesteric-nematic phase transition.

For the technical application of these effects in electronic components, liquid-crystalline dielectrics are required which must meet a large number of demands. The chemical resistance to moisture, air and physical influences, such as heat, radiation in the infrared, visible and ultraviolet regions, and continuous and alternating electric fields, is here of particular importance. Industrially usable liquid-crystalline dielectrics are also required to have a liquid-crystalline mesophase in the temperature range from at least +10°C to +50°C, preferably from 0°C to 60°C, and the lowest possible viscosity at room temperature, which preferably should not exceed 70×10^{-3} Pa.s. Finally, they must not have any characteristic absorption in the region of visible light, that is to say they must be colourless.

A number of liquid-crystalline compounds has already been disclosed, which fulfil the stability demands

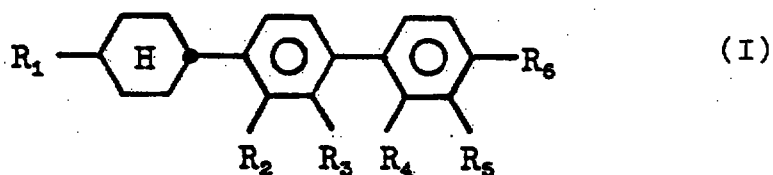
made on dielectrics intended for electronic components, and which are also colourless. These include, in particular, the p,p'-disubstituted phenyl benzoates described in German Offenlegungsschrift 2,139,628 and the p,p'-disubstituted phenylcyclohexane derivatives described in German Offenlegungsschrift 2,636,684. In both the classes of compounds mentioned, and also in other known series of compounds with a liquid-crystalline mesophase, there are no individual compounds which form a liquid-crystalline nematic mesophase in the required temperature range from 10°C to 60°C. As a rule, mixtures of two or more compounds are therefore prepared in order to obtain substances which can be used as liquid-crystalline dielectrics. For this purpose, at least one compound having a low melting point and clear point is usually mixed with another compound having a markedly higher melting point and clear point. This normally gives a mixture, the melting point of which is below that of the lower-melting component, whilst the clear point is between the clear points of the components. Nevertheless, difficulties arise again and again in the preparation of optimum dielectrics, because the components having the high melting points and clear points frequently also impart a high viscosity to the mixtures. As a result, the switching times of the electro-optical display elements, produced with these mixtures, are extended in an undesirable manner. Moreover, problems are frequently caused by the fact that the mutual solubility of the various components, in particular at room temperature or lower temperatures,

is only very limited.

The compounds according to the invention are superior to the compounds of the prior art since they all possess a high clear point, a low viscosity and
5 a broad nematic spectrum.

It is the object of the invention to prepare liquid-crystalline dielectrics which have a nematic phase within the required temperature range and, in liquid crystal cells, make switching times possible, which are sufficiently short at room temperature.
10

It has now been found that the cyclohexylbiphenyl derivatives of the formula (I)



wherein R₁ is alkyl having 1 - 12 C atoms, R₆ is alkyl or
15 alkoxy having 1 - 12 C atoms, CN or fluorine, and R₂, R₃, R₄ and R₅ are hydrogen or fluorine, with the proviso that at least one, but not more than two of the radicals R₂, R₃, R₄, R₅ and R₆ are fluorine, are outstandingly suitable for use as components of liquid-crystalline dielectrics. Addi-
20 tionally, these compounds have an extremely wide range of application:

Depending on the selection of the substituents, the compounds of the formula (I) can either be used as

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base materials representing the predominant part of liquid-crystalline dielectrics, or compounds of the formula (I) can also be added in smaller proportions of, for example, 2 to 45 per cent by weight to liquid-crystalline base materials from other classes of compounds, in order thus to prepare dielectrics having a widened liquid-crystalline mesophase or to influence the magnitude of the dielectric anisotropy of such a dielectric.

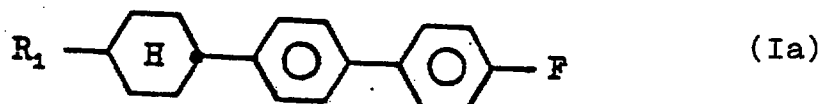
By a suitable selection of the substituents R_1 to R_6 , the compounds of the formula (I) can be used either for the preparation of dielectrics having a pronounced positive dielectric anisotropy, for use in display elements based on the twisted nematic cell or on the cholesteric-nematic phase transition, or it is also possible to prepare dielectrics having a dielectric anisotropy which only slightly differs from zero or is even negative, the latter dielectrics being used in display elements based on dynamic scattering or on the deformation of aligned phases (DAP effect).

In the pure state, the compounds of the formula (I) are colourless, and they form nematic mesophases of low viscosity in a temperature range which is astonishingly wide and is favourable for electro-optical application.

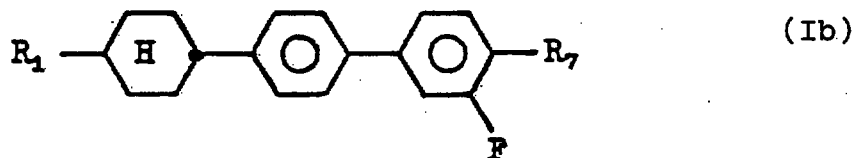
The invention thus relates to the cyclohexylbiphenyl derivatives of the formula (I) and to their use as components of liquid-crystalline dielectrics. Moreover, the invention relates to liquid-crystalline dielectrics containing at least one cyclohexylbiphenyl derivative of the formula (I), and to electro-optical display elements

based on a liquid crystal cell, which contain a liquid-crystalline dielectric of this type.

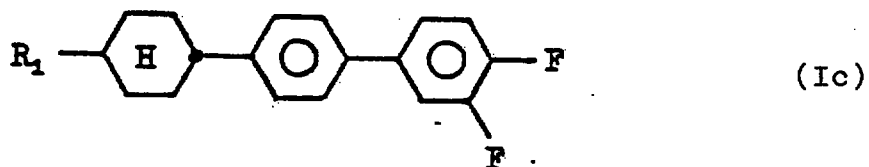
The cyclohexylbiphenyl derivatives according to the invention comprise, in particular, the 4-(trans-4-alkylcyclohexyl)-4'-fluorobiphenyls of the formula (Ia),



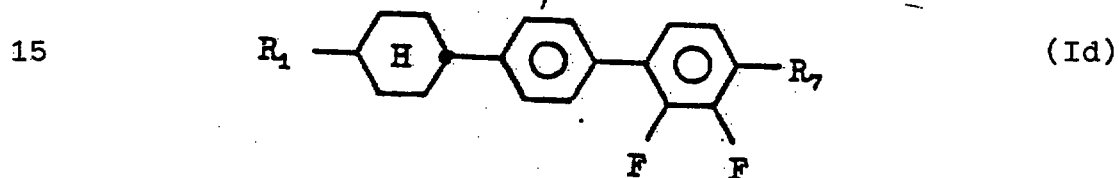
the 4-(trans-4-alkylcyclohexyl)-3'-fluoro-4'-(R₇)-biphenyls of the formula (Ib),



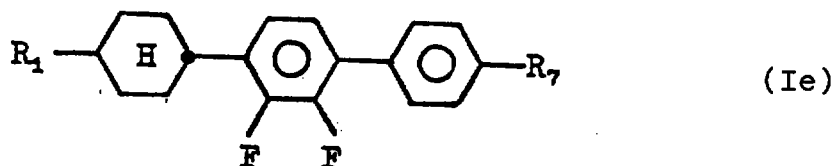
10 the 4-(trans-4-alkylcyclohexyl)-3',4'-difluorobiphenyls of the formula (Ic),



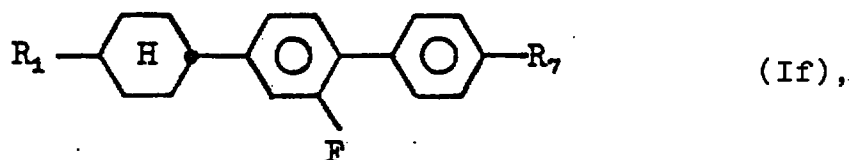
the 4-(trans-4-alkylcyclohexyl)-2',3'-difluoro-4'-(R₇)-biphenyls of the formula (Id),



15 the 2,3-difluoro-4-(trans-4-alkylcyclohexyl)-4'-(R₇)-biphenyls of the formula (Ie)



and the 2-fluoro-4-(trans-4-alkylcyclohexyl)-4'-(R₇)-biphenyls of the formula (If)



5 R₇ in these part formulae being alkyl or alkoxy having 1 - 12 C atoms or CN, and R₁ having the meaning indicated under the formula (I). The trans-position of the substituents in the 1-position and 4-position of the cyclohexane ring is marked in the formula illustrations by a
10 thickened black dot on the right-hand side of the ring. Those compounds of the formula (I) which are not comprised by the part formulae (Ia) to (If) admittedly have the same advantageous properties as those of the groups singled out, but they are more difficult to prepare and
15 therefore less economical; the compounds of the part formulae (Ia) to (If) are therefore preferred.

Amongst the compounds of the formula (I), those of the part formulae (Ia) to (Ic) have a positive dielectric anisotropy; by contrast, the compounds of the part
20 formulae (Id) to (If) have a negative dielectric anisotropy, or values of around zero, if R₇ is alkyl or alkoxy, and they have a diminished positive dielectric anisotropy, if R₇ is CN.

In the compounds of the formula (I), the alkyl
25 radical R₁ and the alkyl or alkoxy radical R₆ can be

straight-chain or branched. If the radical is straight-chain, that is to say it is 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 characterised

5 in this way have, as a rule, higher clear points than the compounds with branched wing groups R_1 and/or R_6 . For this reason, usually at most one of the wing groups R_1 and R_6 contains a branched carbon chain. Compounds of the formula (I) with a branched wing group R_1 or R_6 are

10 occasionally important due to a higher solubility in the conventional liquid-crystalline base materials, but in particular they are important as chiral doping substances, if they possess optical activity because of the chain branching. Such branched wing groups do not contain

15 more than one chain branching. Those branched hydrocarbon radicals are preferred in which a methyl or ethyl group is present in the 1-position, 2-position or 3-position of a longer carbon chain, for example 2-methylpropyl, 2-methylbutyl, 3-methylbutyl, 2-methylpentyl, 3-

20 methylpentyl, 2-ethylhexyl or 1-methylhexyl. If R_6 is alkyl or alkoxy, the wing groups R_1 and R_6 together can contain up to 24 carbon atoms. Within the scope of the present invention, those are preferred amongst these in which R_1 and R_6 together contain 3 to 14, in particular

25 4 up to 12, carbon atoms.

The compounds according to the invention are prepared by a method which is conventional for substances of this type. Thus, the 4-(trans-4-alkylcyclohexyl)-4'-fluorobiphenyls of the formula (Ia) are obtained by

nitration the known 4-(trans-4-alkylcyclohexyl)-biphenyls, unsubstituted in the 4'-position, to give the corresponding 4'-nitro compounds which are reduced to the 4'-amino compounds and converted, in a manner which is in itself known, according to Schiemann-Balz into the 4'-fluoro compounds. For the preparation of the 3',4'-difluoro compounds of the formula (Ic), a 4-(trans-4-alkylcyclohexyl)-4'-aminobiphenyl is first acetylated and then nitrated to the 3'-nitro-4'-acetamidobiphenyl derivative which is then converted by reduction and hydrolysis into the 3',4'-diaminobiphenyl derivative. The 3',4'-difluorobiphenyl derivative is then obtained, in turn, from the latter by diazotisation, reacting with fluoborate and thermal decomposition.

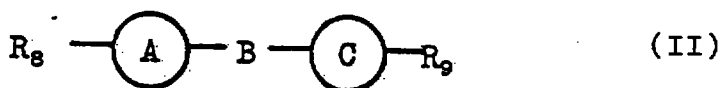
15 The compounds of the formula (I), wherein R_6 is an alkyl or alkoxy group and one or two of the radicals R_2 to R_5 are fluorine, are prepared analogously from the correspondingly substituted mononitro or dinitro compounds. These starting materials are obtained by

20 nitration of the 4-(trans-4-alkylcyclohexyl)-4'-(alkyl- or -alkoxy)-biphenyls. The distribution of isomers in the resulting mixture of nitration products can here be influenced in the direction of the main desired products by a suitable selection of the nitration conditions which

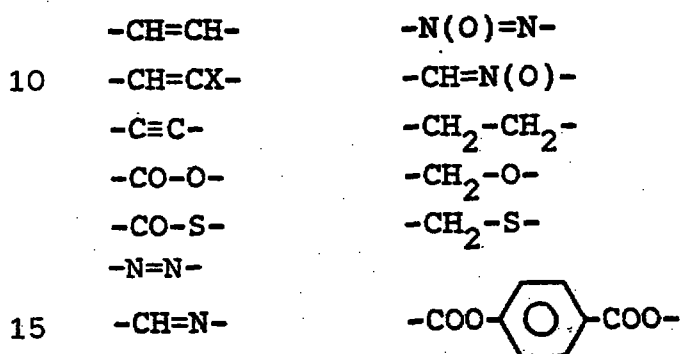
25 are in themselves known from the literature, for example the nature and concentration of the nitrating agent, the solvent, the temperature, the duration of the reaction and/or the catalyst. The desired products can then be separated in the conventional manner from the resulting

mixtures of isomers, for example by chromatographic methods. The reduction of the nitro compounds to the amino compounds is carried out by standard methods, for example by catalytic hydrogenation, by treatment with aqueous dithionite or with tin-II chloride and hydrochloric acid. The Schiemann-Balz synthesis is likewise carried out in a manner which is in itself known, for example according to one of the process variants described in "Organic Reactions", Volume 5 (1949), pages 193 - 228.

10 The dielectrics according to the invention consist of 2 to 15, preferably 3 to 12, components which include at least one fluorine-containing cyclohexylbiphenyl derivative of the formula (I). The other constituents are selected from amongst the nematic or nematogenic substances from the classes of azoxybenzenes, benzylidene-
15 anilines, biphenyls, terphenyls, phenyl benzoates or cyclohexyl benzoates, cyclohexanecarboxylic acid phenyl or cyclohexyl esters, phenylcyclohexanes, cyclohexylbiphenyls, cyclohexylcyclohexanes, cyclohexylnaphthalenes,
20 1,4-bis-cyclohexylbenzenes, 4,4'-bis-cyclohexylbiphenyls, phenyl- or cyclohexyl-pyrimidines, phenyl- or cyclohexyl-dioxanes, optionally halogenated stilbenes, benzyl phenyl ethers, tolanes and substituted cinnamic acids. The most important compounds which can be used as constituents
25 of liquid-crystalline dielectrics of this type can be characterised by the formula (II).



wherein A and C each are a carbocyclic or heterocyclic ring system selected from the group comprising 1,4-disubstituted benzene rings and cyclohexane rings, 4,4'-disubstituted biphenyl, phenylcyclohexane and cyclohexyl-
 5 cyclohexane systems, 2,5-disubstituted pyrimidine rings and 1,3-dioxane rings, 2,6-disubstituted naphthalene, dihydro- and tetrahydro-naphthalene, quinazoline and tetrahydroquinazoline, B is



or a C-C single bond, X is halogen, preferably chlorine, or -CN, and R₈ and R₉ are alkyl, alkoxy, alkanoyloxy or alkoxy-carbonyloxy having up to 18, preferably up to 8, carbon atoms, or one of these radicals can also be -CN,
 20 -NC, -NO₂, -CF₃, F, Cl or Br. In most of these compounds, R₈ and R₉ are different from one another, one of these radicals being an alkyl group or alkoxy group in most cases. Other variants of the envisaged substituents, however, are also common. Many such substances, or mixtures
 25 thereof, are commercially available.

The dielectrics according to the invention contain, as a rule, at least 30, preferably 50 - 99, in particular 60 - 98, parts by weight of the compounds of the formula (I) and (II). Of this, preferably at least

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5 parts by weight, and in most cases even 10 or more parts by weight, account for one or more compounds of the formula (I). The invention also comprises those liquid-crystalline dielectrics to which 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 example for doping purposes. On the other hand, the compounds according to the formula (I) can account for up to 50 per cent by weight of the dielectrics according to the invention. Preferably, the liquid-crystalline dielectrics according to the invention contain 10 to 30 per cent by weight of one or more compounds of the formula (I).

The preparation of the dielectrics according to the invention is carried out in a manner conventional per se. As a rule, the desired quantity of the components used in a smaller quantity is dissolved in the component representing the main constituent, advantageously at elevated temperature. If a temperature above the clear point of the main constituent is chosen for this, the completeness of the solution process can be observed with ease.

It is also possible, however, to mix solutions of the components of the formula (I) and (II) 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. Of course, it is necessary in this procedure to take care that no impurities or undesired doping substances are

introduced by the solvent.

The liquid-crystalline dielectrics according to the invention can be modified by suitable additives in such a way that they can be used in all hitherto disclosed types of liquid crystal display elements. Additives of this type are known to those skilled in the art and are extensively described in the relevant literature. For example, it is possible to add dichroic dyestuffs or substances which are intended to modify the dielectric anisotropy, the viscosity, the conductivity and/or the orientation of the nematic phases. Substances of this type are described, for example, in German Offenlegungsschriften 2,209,127, 2,240,864, 2,321,632, 2,338,281, 2,450,088, 2,637,430, 2,853,728 and 2,902,177.

The examples which follow are intended to explain the invention without restricting it. In the examples, m.p. denotes the melting point, and c.p. denotes the clear point, of a liquid-crystalline substance in degrees centigrade; boiling points are marked b.p. Unless otherwise stated, parts or percentage data denote parts by weight or per cent by weight.

Example 1

(a) 15.3 g of 4-(trans-4-n-pentylcyclohexyl)-biphenyl are introduced in portions into a warm mixture, at 40°, of 5 ml of 65% nitric acid and 6 ml of 96% sulfuric acid. After the end of the addition, the reaction mixture is stirred for 1 further hour at 60° and is poured onto 150 g of ice. After thawing, the 4-(trans-4-n-pentylcyclohexyl)-4'-nitrobiphenyl which has crystallised out is

filtered off and recrystallised from ethanol; m.p. 115°, c.p. 176°.

(b) Under normal pressure and at room temperature, hydrogen is passed for one hour into a suspension of 3 g of palladium-on-carbon (10% of Pd) in a solution of 10 g of 4-(trans-4-n-pentylcyclohexyl)-4'-nitrobiphenyl in 100 ml of tetrahydrofuran. The catalyst is then filtered off and the filtrate is evaporated. The remaining 4-(trans-4-n-pentylcyclohexyl)-4'-aminobiphenyl is recrystallised from petroleum ether (boiling range 40 - 60°); m.p. 132°, c.p. 215°.

(c) 7.8 g of 4-(trans-4-n-pentylcyclohexyl)-4'-aminobiphenyl are suspended in 5 ml of 36% aqueous hydrochloric acid.

After the addition of 5 ml of dioxane, the solution of 1.9 g of sodium nitrite in 7.5 ml of water is added dropwise at 0°. Immediately afterwards, and likewise at 0°, a solution of 6 g of sodium tetrafluoroborate in 10 ml of water is added dropwise. The precipitate which forms is filtered off ½ hour after the end of the addition of the fluorine compound, washed with ice water and dried in vacuo at room temperature. The dried powder is heated to 120°. When the evolution of BF₃ has ceased, the residue is dissolved in ethanol. 3.5 g of 4-(trans-4-n-pentylcyclohexyl)-4'-fluorobiphenyl of m.p. 99° and c.p. 154° crystallise from the solution.

The following are prepared analogously:

4-(trans-4-methylcyclohexyl)-4'-fluorobiphenyl,

4-(trans-4-ethylcyclohexyl)-4'-fluorobiphenyl,

- 4-(trans-4-n-propylcyclohexyl)-4'-fluorobiphenyl,
4-(trans-4-n-butylcyclohexyl)-4'-fluorobiphenyl,
4-(trans-4-n-hexylcyclohexyl)-4'-fluorobiphenyl,
4-(trans-4-n-heptylcyclohexyl)-4'-fluorobiphenyl,
5 4-(trans-4-n-decylcyclohexyl)-4'-fluorobiphenyl,
4-(trans-4-n-dodecylcyclohexyl)-4'-fluorobiphenyl and
4-[trans-4-(2-methylbutyl)-cyclohexyl]-4'-fluorobiphenyl.

Example 2

- (a) 16.7 g of 4-(trans-4-n-pentylcyclohexyl)-4'-
10 ethylbiphenyl are nitrated in the manner described in
Example 1(a). The mixture of isomeric nitration pro-
ducts is poured into ice water, filtered off and then dis-
solved in toluene and is then separated by high-pressure
liquid chromatography on a preparative scale. This
15 gives 8.7 g of 4-(trans-4-n-pentylcyclohexyl)-2'-nitro-
4'-ethylbiphenyl and 5.5 g of 4-(trans-4-n-pentylcyclo-
hexyl)-2-nitro-4'-ethylbiphenyl.
- (b) The nitro compounds prepared according to
Example 2(a) are reduced, analogously to Example 1(b),
20 to the corresponding amino compounds and the latter are
converted analogously to Example 1(c) into 4-(trans-4-n-pentylcyclo-
hexyl)-2'-fluoro-4'-ethylbiphenyl of m.p. 27° , c.p. 104° and 4-(trans-
4-n-pentylcyclohexyl)-2-fluoro-4'-ethylbiphenyl of m.p. 26° and c.p. 107° .

The following are prepared analogously:

- 25 4-(trans-4-ethylcyclohexyl)-2'-fluoro-4'-n-butylbiphenyl,
4-(trans-4-n-propylcyclohexyl)-2'-fluoro-4'-n-propyl-
biphenyl,
4-(trans-4-n-propylcyclohexyl)-2'-fluoro-4'-n-octylbi-
phenyl,

- 4-(trans-4-n-butylcyclohexyl)-2'-fluoro-4'-n-butylbiphenyl,
4-(trans-4-n-pentylcyclohexyl)-2'-fluoro-4'-n-propylbiphenyl,
5 4-(trans-4-n-pentylcyclohexyl)-2'-fluoro-4'-n-pentylbiphenyl,
4-(trans-4-n-heptylcyclohexyl)-2'-fluoro-4'-n-butylbiphenyl, smetic-nematic transition 52° , c.p. 105° ,
4-(trans-4-n-octylcyclohexyl)-2'-fluoro-4'-methylbiphenyl,
10 4-(trans-4-ethylcyclohexyl)-2-fluoro-4'-n-butylbiphenyl,
4-(trans-4-n-propylcyclohexyl)-2-fluoro-4'-n-propylbiphenyl,
4-(trans-4-n-propylcyclohexyl)-2-fluoro-4'-n-octylbiphenyl,
15 4-(trans-4-n-butylcyclohexyl)-2-fluoro-4'-n-butylbiphenyl,
4-(trans-4-n-pentylcyclohexyl)-2-fluoro-4'-n-propylbiphenyl,
4-(trans-4-n-pentylcyclohexyl)-2-fluoro-4'-n-pentylbiphenyl,
20 4-(trans-4-n-heptylcyclohexyl)-2-fluoro-4'-n-butylbiphenyl,
4-(trans-4-n-octylcyclohexyl)-2-fluoro-4'-methylbiphenyl and
4-(trans-4-n-pentylcyclohexyl)-2,2'-difluoro-4'-ethylbiphenyl, m.p. -2° ,
c.p. 80° .

25 The following examples relate to liquid-crystalline dielectrics according to the invention:

Example A

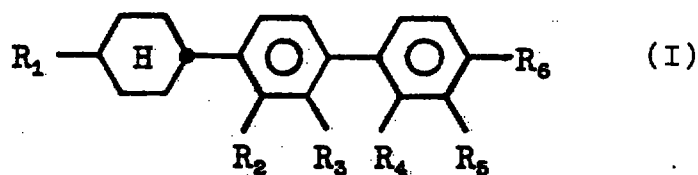
The liquid-crystalline dielectric composed of 24% of 4-(trans-4-n-propylcyclohexyl)-benzonitrile,

36% of 4-(trans-4-n-pentylcyclohexyl)-benzonitrile,
25% of 4-(trans-4-n-heptylcyclohexyl)-benzonitrile and
15% of 4-(trans-4-n-pentylcyclohexyl)-biphenyl-4'-carbo-
nitrile

- 5 has a nematic range from -6° to $+70^{\circ}$ and a viscosity of 28×10^{-3} Pa.s at 20° and 97×10^{-3} Pa.s at 0° . If the last-mentioned component in this mixture is replaced by the same quantity by weight of 4-(trans-4-n-pentylcyclohexyl)-4'-fluorobiphenyl, the temperature range of the
- 10 nematic phase changes slightly to a range from -10° to $+65^{\circ}$; the viscosity values, which have a significant influence on the switching times, in the dielectric according to the invention, thus prepared, are 24×10^{-3} Pa.s at 20° and only 68×10^{-3} Pa.s at 0° .

Patent Claims (For the contracting states : CH, DE, FR, GB, IT, LI, NL)

1. Fluorine-containing cyclohexylbiphenyl derivatives of the formula (I)



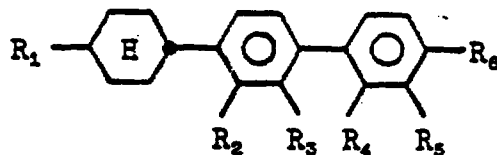
wherein R_1 is alkyl having 1 - 12 C atoms, R_6 is alkyl or alkoxy having 1 - 12 C atoms, CN or fluorine, and R_2 , R_3 , R_4 and R_5 are hydrogen or fluorine, with the proviso that at least one, but not more than two of the radicals R_2 , R_3 , R_4 , R_5 and R_6 are fluorine.

2. Use of the cyclohexylbiphenyl derivatives of the formula (I) according to Claim 1 as components of liquid-crystalline dielectrics.
3. Liquid-crystalline dielectric with two or more liquid-crystalline components, characterised in that at least one component is a cyclohexylbiphenyl derivative of the formula (I) according to Claim 1.
4. Electro-optical display element based on a liquid crystal cell, characterised in that it contains a liquid-crystalline dielectric according to Claim 3.



Ansprüche (für den Vertragsstaat AT) (As printed)

1. Verwendung fluorhaltiger Cyclohexylbiphenylderivate der Formel (I),



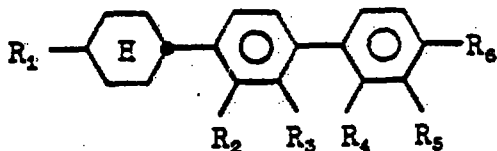
worin

R₁ Alkyl mit 1-12 C-Atomen,

R₆ Alkyl oder Alkoxy mit 1-12 C-Atomen, CN oder Fluor, und

R₂, R₃, R₄ und R₅ Wasserstoff oder Fluor bedeuten, mit der Maßgabe, daß mindestens einer, jedoch nicht mehr als zwei der Reste R₂, R₃, R₄, R₅ und R₆ Fluor bedeuten, als Komponenten flüssigkristalliner Dielektrika.

2. Flüssigkristallines Dielektrikum mit zwei oder mehr flüssigkristallinen Komponenten, dadurch gekennzeichnet, daß mindestens eine Komponente ein Cyclohexylbiphenylderivat der Formel (I),



worin

R₁ Alkyl mit 1-12 C-Atomen,

R₆ Alkyl oder Alkoxy mit 1-12 C-Atomen, CN oder Fluor, und

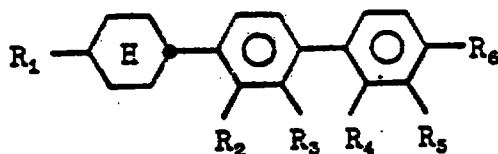
R₂, R₃, R₄ und R₅ Wasserstoff oder Fluor bedeuten, mit der Maßgabe, daß mindestens einer, jedoch nicht mehr als zwei der Reste R₂, R₃, R₄, R₅ und R₆ Fluor bedeuten, ist.

3. Elektrooptisches Anzeigeelement auf der Basis einer Flüssigkristallzelle, dadurch gekennzeichnet, daß es ein flüssigkristallines Dielektrikum nach Anspruch 2 ist.



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

1. Cyclohexylbiphenyl derivatives of the formula (I)



wherein

R₁ is alkyl having 1-12 C atoms,

R₆ is alkyl or alkoxy having 1-12 C atoms, CN or fluorine, and

R₂, R₃, R₄ and R₅ are hydrogen or fluorine, with the proviso that at least one, but not more than two of the radicals R₂, R₃, R₄, R₅ and R₆ are fluorine.

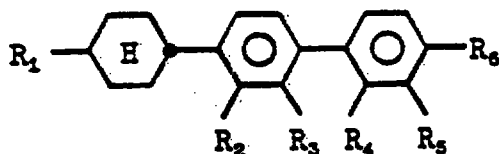
2. Use of the cyclohexylbiphenyl derivatives of the formula (I) according to Claim 1 as components of liquid-crystalline dielectrics.

3. Liquid-crystalline dielectric with two or more liquid-crystalline components, characterised in that at least one component is a cyclohexylbiphenyl derivative of the formula (I) according to Claim 1.

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

Claims (for the Contracting State AT) (As printed)

1. Use of the Cyclohexylbiphenyl derivatives of the formula (I)



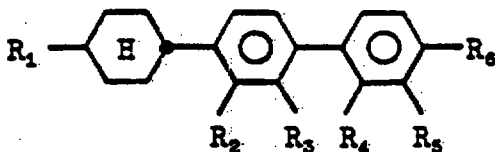
wherein

R₁ is alkyl having 1-12 C atoms,

R₆ is alkyl or alkoxy having 1-12 C atoms, CN or fluorine, and

R₂, R₃, R₄ and R₅ are hydrogen or fluorine, with the proviso that at least one, but not more than two of the radicals R₂, R₃, R₄, R₅ and R₆ are fluorine, as components of liquid-crystalline dielectrics.

2. Liquid-crystalline dielectric containing two or more liquid-crystalline components, characterised in that at least one component is a cyclohexylbiphenyl derivative of the formula (I)



wherein

R₁ is alkyl having 1-12 C atoms,

R₆ is alkyl or alkoxy having 1-12 C atoms, CN or fluorine, and

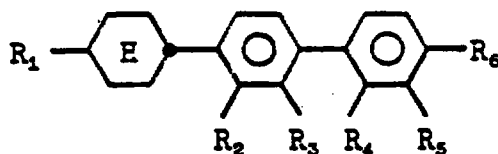
R₂, R₃, R₄ and R₅ are hydrogen or fluorine, with the proviso that at least one, but not more than two of the radicals R₂, R₃, R₄, R₅ and R₆ are fluorine.

3. Electro-optical display element based on a liquid crystal cell, characterised in that it contains a liquid-crystalline dielectric according to Claim 2.



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

1. Dérivés fluorés du cyclohexyl-biphényle, de formule I



(I)

dans laquelle

R₁ représente un groupe alkyle en C 1-C 12,

R₆ représente un groupe alkyle ou alcoxy en C 1-C 12, un groupe CN ou le fluor, et

R₂, R₃, R₄ et R₅ représentent l'hydrogène ou le fluor, étant spécifié qu'au moins un et pas plus de deux des symboles R₂, R₃, R₄, R₅ et R₆ représentent le fluor.

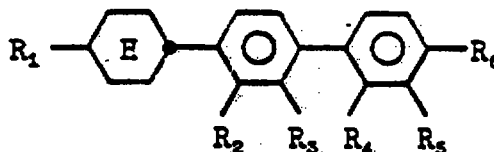
2. Utilisation des dérivés du cyclohexylbiphényle de formule I selon la revendication 1, en tant que composants de diélectriques à cristaux liquides.

3. Diélectriques à cristaux liquides à deux ou plusieurs composants à cristaux liquides, caractérisé en ce qu'au moins un composant est un dérivé du cyclohexyl-biphényle de formule I selon la revendication 1.

4. Eléments indicateurs électro-optiques à base d'une cellule à cristaux liquides, caractérisés en ce qu'ils contiennent un diélectrique à cristaux liquides selon la revendication 3.

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

1. Utilisation de dérivés fluorés du cyclohexyl-biphényle de formule I



(I)

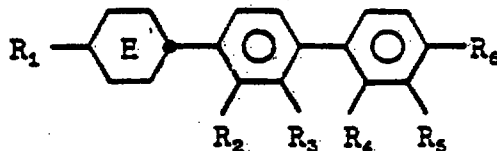
dans laquelle

R₁ représente un groupe alkyle en C 1-C 12,

R₆ représente un groupe alkyle ou alcoxy en C 1-C 12, un groupe CN ou le fluor, et

R₂, R₃, R₄ et R₅ représentent l'hydrogène ou le fluor, étant spécifié qu'au moins un mais pas plus de deux des symboles R₂, R₃, R₄, R₅ et R₆ représentent le fluor.

2. Diélectrique à cristaux liquides contenant deux ou plusieurs composants à cristaux liquides, caractérisé en ce qu'au moins un composant est un dérivé du cyclohexyl-biphényle de formule I



(I)

dans laquelle

R₁ représente un groupe alkyle en C 1-C 12,

R₆ représente un groupe alkyle ou alcoxy en C 1-C 12, un groupe CN ou le fluor, et

R₂, R₃, R₄ et R₅ représentent l'hydrogène ou le fluor, étant spécifié qu'au moins un mais pas plus de deux des symboles R₂, R₃, R₄, R₅ et R₆ représentent le fluor.

3. Elément indicateur électro-optique à base d'une cellule à cristaux liquides, caractérisé en ce qu'il consiste en un diélectrique à cristaux liquides selon la revendication 2.

