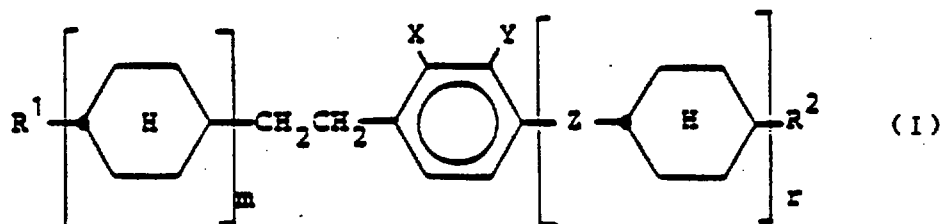


Description

The invention relates to novel nematic compounds which have a negative DC anisotropy and are suitable as components of liquid crystal (LC) mixtures. These are compounds of the formula I



in which $m = 1$ or 2 , $r = \text{zero or } 1$ and $m + r = 1$ or 2 , and R^1 and R^2 are identical or different and are selected from alkyl and alkoxy groups each having 1-12 carbon atoms in a straight or branched chain, which may be chiral, Z is a bridge member selected from a single bond and the groups of the formulae $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$, one of the groups X and Y is selected from fluorine, chlorine, bromine and cyano and the other of the groups X and Y is selected from hydrogen, fluorine, chlorine, bromine and cyano, with the proviso that $m = r = 1$ if X and Y are both cyano.

The invention also relates to nematic LC mixtures which contain the novel compounds as components and have an overall negative DC anisotropy.

Nematic liquid crystal mixtures with negative DC anisotropy (DCA) are required for operating certain displays, for example the so-called guest/host displays (GHD) and homotropic-nematic displays (HND) with a positive image display or positive contrast. Similar compounds are known, for example from J.C. Dubois et al., Mol. Cryst. Liq. Cryst. 42 (1977) 139; German Offenlegungsschriften No. 2,240,864, 2,613,293, 2,835,662 and 2,937,700, Soviet Patent Specification 562,547 and European Patent Application No. 80200464.8.

Structurally similar compounds without lateral substitution ($X = Y = \text{H}$) are known from GB-A-2,123,409 and US-A-4,393,258.

However, no satisfactory nematic LC mixtures,

- 2 -

0133489

which have a sufficiently strong negative DCA (for example 2 or better) in combination with the further properties, necessary for perfect operation of display points, of LC mixtures, such as chemical stability in general, photo-
5 chemical, electrochemical and thermal stability as well as a sufficiently wide range of anisotropy and sufficiently short response times even at low temperatures, for example at most about one second at the lower end of the anisotropy range, are yet obtainable by means of the compounds
10 hitherto known.

It was the object of the invention to provide novel nematic compounds which enable LC mixtures with a markedly negative DCA and the further properties mentioned to be prepared.

15 It has been found that the compounds of the formula I are outstandingly suitable as components of liquid-crystalline phases. In particular, stable liquid-crystalline phases with an overall negative optical anisotropy and a comparatively low viscosity can be prepared by using
20 them.

The compounds of the formula I can be used, like similar compounds, as components of liquid-crystalline phases, such as are required especially for electro-optical displays of the type of guest/host displays or homo-
25 tropic-nematic displays.

Moreover, quite generally, the range of the liquid-crystalline substances, which are suitable for the preparation of nematic mixtures from various application aspects, is considerably widened by the provision of the compounds
30 of the formula I.

The invention thus relates to compounds of the formula I and to the use of the compounds of the formula I as components of liquid-crystalline mixtures. The invention also relates to liquid-crystalline mixtures
35 having a content of at least one compound of the formula I, and to electrooptical display elements which contain such mixtures.

In these novel compounds, the cyclohexyl rings

0133489

are always in the trans-configuration, as indicated by dots in the formula I.

At least one of the groups X and Y is a substituent having a polarizing action from the group comprising
5 fluorine, chlorine, bromine and cyano.

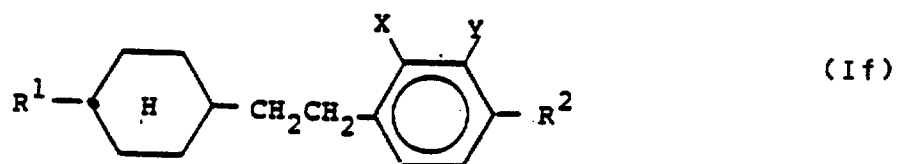
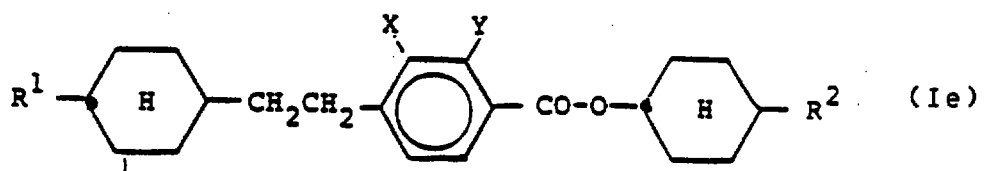
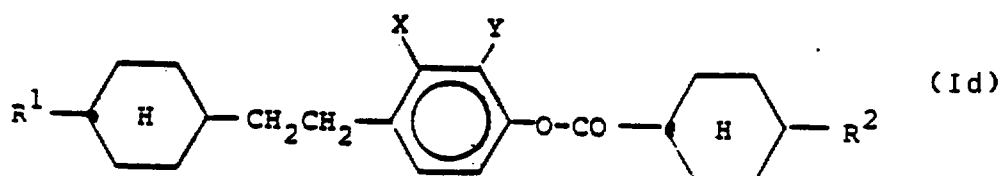
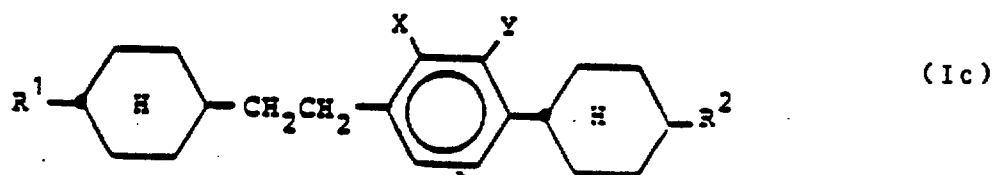
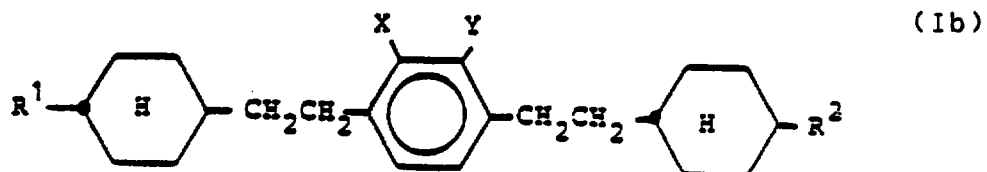
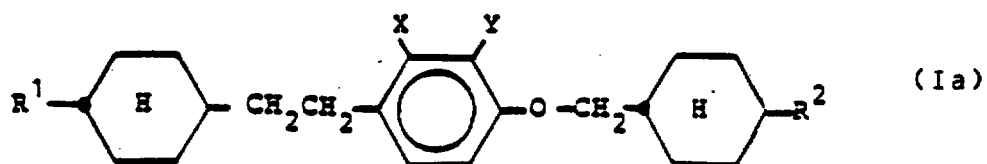
Those compounds of the formula I are particularly preferred in which one of the groups X and Y is fluorine, chlorine or cyano, and especially those in which X is fluorine and Y is hydrogen.

10 If $r = 1$, the bridge member Z, present in that case, can be a single bond or a grouping selected from the groups of the formulae $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$. Preferably, Z is $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$ or $-\text{O}-\text{CO}-$.

R^1 and R^2 are identical or different wing groups
15 selected from C_1 - C_{12} -alkyl and C_1 - C_{12} -alkoxy groups having a straight or branched chain, which may be chiral, of the alkyl moiety, such as, for example, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl or dodecyl as the alkyl moiety, including the
20 corresponding chiral isomeric alkyl moieties such as, for example, 1-methylpropyl, 1-methylbutyl, 2-methylbutyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 1- or 2- or 3- or 4-methylhexyl, 1- or 2- or 3- or 4- or 5-methylheptyl and further alkyl-alkyl groups formed in accordance
25 with this principle and having an asymmetric carbon atom. Alkyl moieties having 2-8 carbon atoms, in particular 3-8 carbon atoms, are frequently preferred.

R^1 is preferably straight-chain alkyl having 2-8 carbon atoms. In the case of $r = 0$, R^2 is preferably
30 straight-chain alkoxy having 2-8 carbon atoms and, in the case of $r = 1$, it is preferably straight-chain alkyl having 2-8 carbon atoms.

Preferred groups of compounds according to the invention, of the formula I, are of the following formulae
35 Ia, Ib, Ic, Id, Ie and If, in which R^1 , R^2 , X and Y have the meanings given above for the formula I:

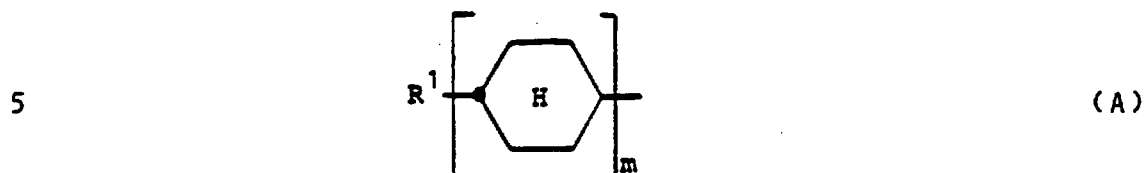


Those compounds of the formula If are preferred in which R² is alkoxy and R¹ is alkyl.

The novel compounds I can be prepared by various processes. A first general process is based on the

0133489

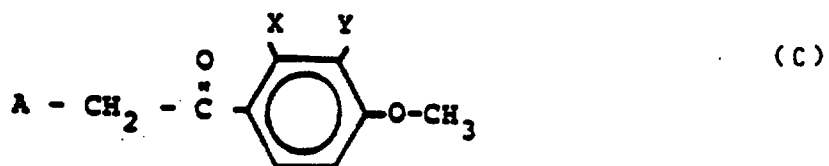
condensation of a corresponding carboxylic acid derivative of the formula $A-CH_2COOH$, preferably in the form of the corresponding acid halide, in which A represents the left-hand part of the molecule of the compound I, that is to say



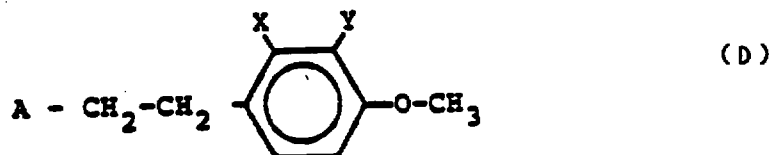
with a corresponding anisole derivative of the formula B



to form the corresponding ketone of the formula C



10 which is then reduced for replacing the ketocarbonyl oxygen by two hydrogen atoms, a compound of the formula D

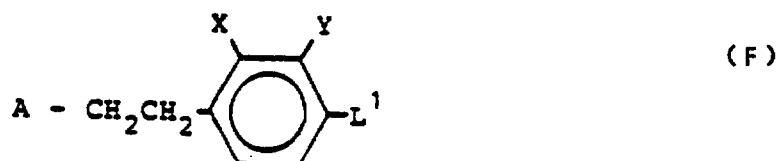


being formed.

For modifying R^2 or/and (if $r = 1$) for introducing the structure E

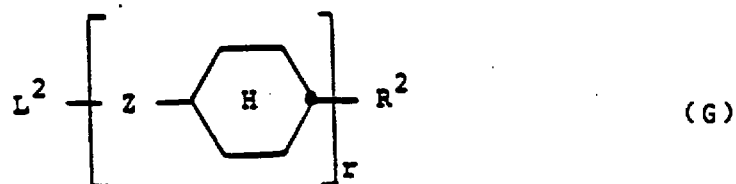


the compound D can be converted to a compound F



0133489

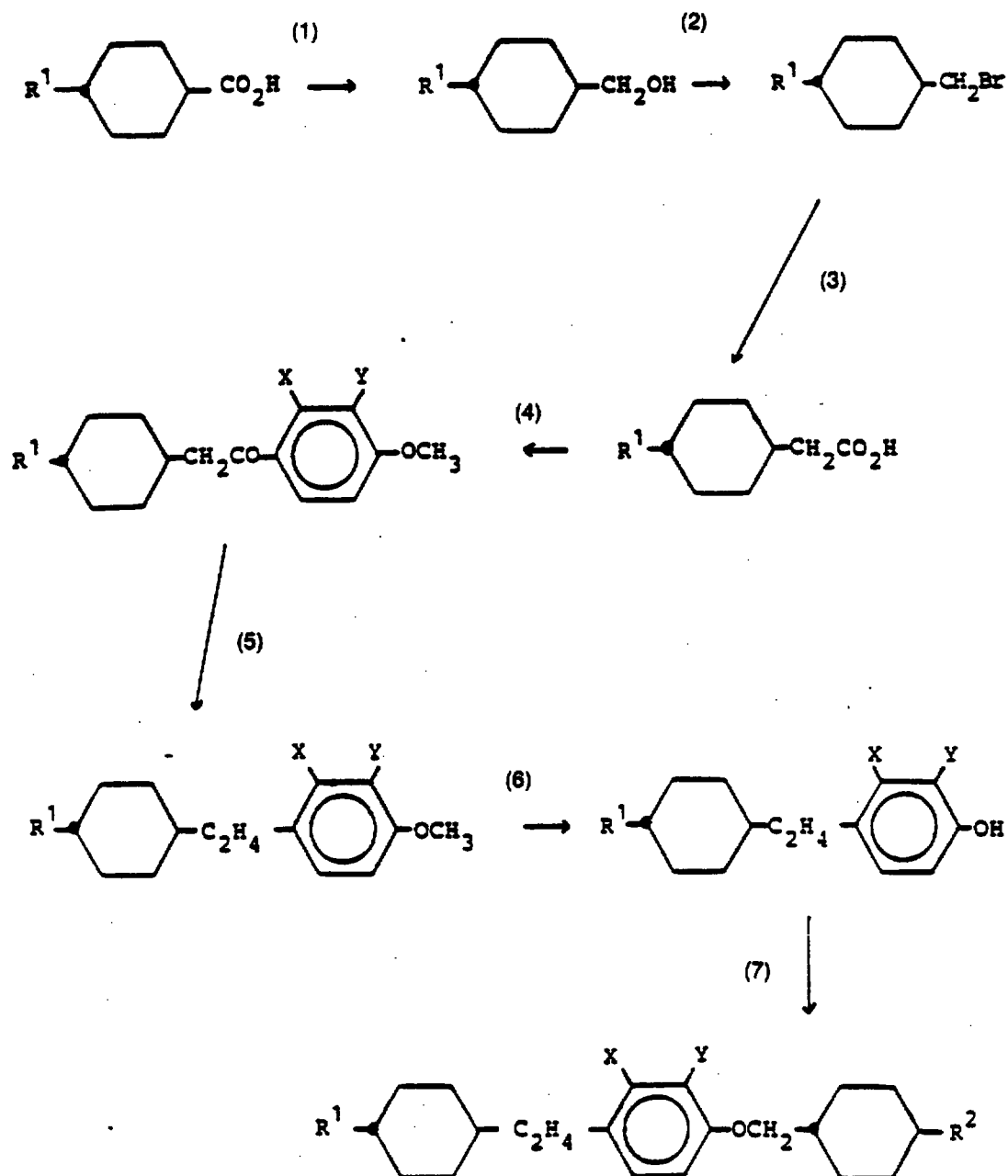
in which L^1 is a first reactive group, such as hydroxyl, COOH or halogen, and the compound F can then be reacted with a compound of the formula G



5 in which L^2 is a second reactive group, in order to form the target compound I or a pre-compound which can be converted into the latter.

Alternatively, the compounds I can also be prepared from appropriate pre-compounds of analogous structure, but without transversely polarizing substituents, by halogenation or transhalogenation and, if appropriate, nitrilation (replacement of halogen by cyano).

A specific example of the synthesis of preferred compounds I is illustrated by reference to the reaction equations which follow:



- (1) Reduction, for example with $LiAlH_4$,
- (2) bromination, for example with elemental bromine in acetonitrile,
- (3) CO₂ Grignard,
- 5 (4) Conversion into acid halide and reaction with 2-Y-3-X-anisole,
- (5) reduction,

0133489

- (6) demethylation, for example with boron tribromide, and
(7) condensation with (trans-4-R²-cyclohexyl)-methyl bromide.

5 The starting materials required for the various syntheses of the compounds I are either known or can be prepared by methods known per se.

The compounds of the formula I are colourless in the pure state and form liquid-crystalline mesophases in
10 a temperature range favourably located for the electro-optical use. They are very stable chemically, thermally and to light.

The compounds of the formula I have a wide range of application. Depending on the selection of the substituents, these compounds can be used as base materials, of
15 which liquid-crystalline dielectrics are predominantly composed; however, compounds of the formula I can also be added to liquid-crystalline base materials from other classes of compounds, for example in order to reduce the
20 dielectric and/or optical anisotropy of such a dielectric. The compounds of the formula I are also suitable as intermediates for the preparation of other substances, which can be used as constituents of liquid-crystalline dielectrics.

25 To prepare LC mixtures according to the invention, at least one specific compound I in each case is used as a component, if appropriate together with other specific compounds I or/and mixed with compounds known for the preparation of LC mixtures with a clearly negative DCA for
30 use in GHD or HND systems. The compound I, of which there is at least one, here amounts as a rule to at least 5 mol % and at most 30 mol % of the LC mixture. If several compounds I are used, these can represent a predominant proportion, for example 50-90 mol %, of the mixture in the
35 case of appropriate selection.

LC mixtures which consist virtually only of compounds I are also included in the invention.

The examples which follow are intended to

0133489

illustrate the invention without restricting it. M. = melting point, C. = clear point. Percentage data above and below mean % by weight; all the temperatures are given in degrees celsius. "Usual working-up" means: water is added, the mixture is extracted with methylene chloride, the phases are separated, the organic phase is dried and evaporated, and the product is purified by crystallisation and/or chromatography. The phase transition temperatures quoted relate to degrees celsius and are in each case given between the corresponding symbols of the phases "C" (crystalline), "N" (nematic), "I" (isotropic), "S_A" (A-smectic).

Example 1

(a) Preparation of trans-4-pentylcyclohexylacetyl chloride

For conversion into the acid chloride, trans-4-pentylcyclohexylacetic acid (12.0 g, 0.0566 mol) was reacted for about 1 hour on an oil bath at 80°C with thionyl chloride (50 ml). The solution obtained was evaporated under reduced pressure, treated with absolute toluene (50 ml) and once more evaporated under reduced pressure.

(b) Preparation of 2-fluoro-4-methoxy- α -(trans-4-pentylcyclohexyl)-acetophenone

The acid chloride obtained according to section (a) was taken up in absolute dichloromethane (50 ml), without further purification, and added dropwise under virtually anhydrous conditions to a solution of 3-fluoroanisole (7.1 g, 0.0566 mol), aluminium chloride (8.3 g, 0.0623 mol) and absolute dichloromethane (100 ml). The mixture thus formed was stirred for 12 hours and then poured onto ice water which contained 50 ml of concentrated hydrochloric acid. The organic phase was separated off, and the aqueous phase was again extracted with dichloromethane (2 x 100 ml). The combined organic phases were then washed with water, sodium bicarbonate and water, and dried over magnesium sulfate. The crude product obtained after evaporation of the dichloromethane

0133489

under reduced pressure was purified by recrystallisation from hexane at 0°C. This gave 11.5 g (64% yield) of pure 2-fluoro-4-methoxy- α -(trans-4-pentylcyclohexyl)-acetophenone, M. 71 to 72°C.

5 (c) Preparation of 2-(trans-4-pentylcyclohexyl)-1-(2-fluoro-4-methoxyphenyl)-ethane

A mixture of the 2-fluoro-4-methoxy- α -(trans-4-pentylcyclohexyl)-acetophenone (10.0 g, 0.0313 mol) obtained according to section (b), aluminium lithium hydride (2.1 g, 0.0560 mol), aluminium chloride (15.0 g, 0.1125 mol), absolute ether (70 ml) and absolute chloroform (70 ml) was heated to gentle reflux for 5.5 hours under virtually anhydrous conditions.

The reaction solution was then cooled and subsequently treated with water-containing ether, water and concentrated hydrochloric acid. The aqueous phase was separated off and extracted twice more with ether (2 x 100 ml). The combined organic phases were then washed with water, sodium bicarbonate and water, dried over magnesium sulfate and then concentrated. The crude product was distilled in a bulb tube at 150°C/about 4×10^{-2} mm Hg. This product (9.0 g, 94% yield) can be used for the following reaction without further purification.

25 (d) Preparation of 3-fluoro-4-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-phenol

A solution of the 2-(trans-4-pentylcyclohexyl)-1-(2-fluoro-4-methoxyphenyl)-ethane (9.0 g, 0.0294 mol) obtained according to section (c) in absolute dichloromethane (100 ml) was added dropwise to a solution of boron tribromide (11.0 g, 0.0441 mol) and absolute dichloromethane (100 ml) under virtually anhydrous conditions at 0°C. The mixture thus formed was stirred for 1 hour and then poured onto ice water. The organic phase was separated off, and the aqueous phase was extracted again with dichloromethane (2 x 50 ml). The combined organic phases were washed with water and dried over magnesium sulfate. The crude product obtained after evaporation was recrystallised from hexane at 0°C. 8.5 g (98%

yield) of pure target product were obtained.

(e) Preparation of 1-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-2-fluorobenzene

5 A mixture of the 3-fluoro-4-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-phenol (2.0 g, 0.00068 mol) obtained according to section (d), (trans-4-propylcyclohexyl)-methyl bromide (2.0 g, 0.00089 mol), anhydrous potassium carbonate (3.8 g, 0.0274 mol) and absolute di-
10 methylformamide (100 ml) was heated for 24 hours under reflux.

 The reaction mixture was worked up as in section (d). The crude product was purified by column chromatography on silica gel with toluene as the eluant. After
15 evaporation of the toluene, the product was recrystallised several times from ethanol, until the phase transition temperatures were constant; the corresponding values are as follows: C 61.5 ° N 110 ° I.

Examples 2 to 7

20 According to the process indicated in Example 1, and using the corresponding (trans-4-alkylcyclohexyl)-methyl bromides, the following compounds I according to the invention were prepared:

(Example)

25 (2) 1-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-4-(trans-4-pentylcyclohexyl)-methoxy-2-fluorobenzene;

C 72 ° S_A 73 ° N 113 ° I;

(3) 1-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-4-(trans-4-heptylcyclohexyl)-methoxy-2-fluorobenzene; C 88 ° S_A

30 94 ° N 110 ° I;

(4) 1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-2-fluorobenzene; C 64 ° N
108 ° I;

(5) 1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-(trans-4-pentylcyclohexyl)-methoxy-2-fluorobenzene; C 54.5 ° N
35 110.5 ° I;

(6) 1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-(trans-4-heptylcyclohexyl)-methoxy-2-fluorobenzene; C 72.5 ° S_A

0133489

76.5 ° N 107.5 ° I;

(7) 1-[2-(trans-4-heptylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-2-fluorobenzene; C 45 ° N 108 ° I.

5

Example 8

From 1-(4-trans-heptylcyclohexyl)-2-(3-fluoro-4-hydroxyphenyl)-ethane [M. 70 - 71°; obtainable analogously to Example 1] and (trans-4-propylcyclohexyl)-methyl bromide, 1-[2-(trans-4-heptylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-3-fluorobenzene is obtained analogously to Example 1; C 50.5 ° S_A 90 ° N 110 ° I.

Example 9

From 1-(4-trans-heptylcyclohexyl)-2-(3-bromo-4-hydroxyphenyl)-ethane [M. 50 - 51°; obtainable by bromination of 1-(4-trans-heptylcyclohexyl)-2-(4-hydroxyphenyl)-ethane in dichloromethane], 1-[2-trans-4-heptylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-3-bromobenzene is obtained analogously to Example 8; C 44 ° N 85.5 ° I.

20

Example 10

From 1-(4-trans-4-heptylcyclohexyl)-2-(3-chloro-4-hydroxyphenyl)-ethane [M. 56 - 57°, obtainable analogously to Example 1] and (trans-4-propylcyclohexyl)-methyl bromide, 1-[2-(trans-4-heptylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-3-chlorobenzene is obtained analogously to Example 1; C 46 ° N 96 ° I.

25

Example 11

From 1-(4-trans-4-heptylcyclohexyl)-2-(3-cyano-4-hydroxyphenyl)-ethane and (trans-4-propylcyclohexyl)-methyl bromide, 1-[2-(trans-4-heptylcyclohexyl)-1-ethyl]-4-(trans-4-propylcyclohexyl)-methoxy-3-cyanobenzene is obtained analogously to Example 1; C 57 ° S_A 90 ° I.

30

Example 12

A mixture of 1.0 g of 1-(4-trans-pentylcyclohexyl)-2-(2-fluoro-4-hydroxyphenyl)-ethane (Example 1), 0.8 g of 1-bromobutane, 1.9 g of potassium carbonate and 30 ml of butanone is boiled overnight. The reaction mixture is added to 250 ml of water, and this is extracted

35

0133489

with three times 50 ml of chloroform. The combined organic phases are washed with twice 500 ml of water and dried over MgSO_4 . Usual working-up gives 1-(4-trans-pentylcyclohexyl)-2-(2-fluoro-4-butoxyphenyl)-ethane;

5 C 24 * N 26 * I.

Examples 13 to 25

Following the procedure indicated in Example 12, the following compounds (I) according to the invention were prepared, using the corresponding 1-(4-trans-alkylcyclohexyl)-2-(2-fluoro-4-hydroxyphenyl)-ethanes or the corresponding 1-(4-trans-alkylcyclohexyl)-2-(3-fluoro-4-hydroxyphenyl)-ethanes and the corresponding 1-bromoalkanes:

(Example)

- 15 (13) 1-(4-trans-propylcyclohexyl)-2-(2-fluoro-4-ethoxyphenyl)-ethane; M. 22° ; C. 14° (monotropic);
(14) 1-(4-trans-propylcyclohexyl)-2-(2-fluoro-4-butoxyphenyl)-ethane; M. 21° ; C. 12° (monotropic);
(15) 1-(4-trans-propylcyclohexyl)-2-(2-fluoro-4-hexyloxyphenyl)-ethane; M. 28° ; C. 22° (monotropic);
20 (16) 1-(4-trans-pentylcyclohexyl)-2-(2-fluoro-4-ethoxyphenyl)-ethane; M. 32° ; C. 28° (monotropic);
(17) 1-(4-trans-pentylcyclohexyl)-2-(2-fluoro-4-propoxyphenyl)-ethane; M. 22.5° ; C. 10° (monotropic);
25 (18) 1-(4-trans-pentylcyclohexyl)-2-(2-fluoro-4-pentyloxyphenyl)-ethane; M. 26° ; C. 12° (monotropic);
(19) 1-(4-trans-pentylcyclohexyl)-2-(2-fluoro-4-hexyloxyphenyl)-ethane; M. 23.5° ; C. 29.5° ;
(20) 1-(4-trans-heptylcyclohexyl)-2-(2-fluoro-4-ethoxyphenyl)-ethane; M. 46° ; C. 35° (monotropic);
30 (21) 1-(4-trans-heptylcyclohexyl)-2-(2-fluoro-4-butoxyphenyl)-ethane; M. 31° ; C. 34° ;
(22) 1-(4-trans-heptylcyclohexyl)-2-(2-fluoro-4-hexyloxyphenyl)-ethane; M. 29.5° ; C. 35° ;
35 (23) 1-(4-trans-heptylcyclohexyl)-2-(3-fluoro-4-methoxyphenyl)-ethane; M. 32° ; C. 29° (monotropic);
(24) 1-(4-trans-heptylcyclohexyl)-2-(3-fluoro-4-ethoxyphenyl)-ethane; M. 53° ; C. 34° (monotropic);

0133489

(25) 1-(4-trans-heptylcyclohexyl)-2-(3-fluoro-4-hexyloxy-phenyl)-ethane; M. 45°; 35° (monotropic).

Example 26

A mixture of 0.65 g of trans-4-pentylcyclohexane-carboxylic acid chloride and 10 ml of toluene is added to a mixture of 0.9 g of 1-(trans-4-pentylcyclohexyl)-2-(2-fluoro-4-hydroxyphenyl)-ethane (Example 1), 2 ml of pyridine and 10 ml of toluene, and the whole is stirred overnight. The reaction mixture is poured into cold, dilute hydrochloric acid and worked up in the usual way. This gives 3-fluoro-4-[2-(trans-4-pentylcyclohexyl)-ethyl]-phenyl trans-4-pentylcyclohexane-carboxylate; M. 72.5°, C. 147°.

Examples 27 to 31

Following the procedure indicated in Example 26, the following compounds (I) according to the invention are prepared:

- (27) 3-fluoro-4-[2-(trans-4-propylcyclohexyl)-ethyl]-phenyl trans-4-propylcyclohexane-carboxylate; M. 72°; C. 140°;
- (28) 3-fluoro-4-[2-(trans-4-propylcyclohexyl)-ethyl]-phenyl trans-4-pentylcyclohexane-carboxylate; M. 68°; C. 146.5°;
- (29) 3-fluoro-4-[2-(trans-4-propylcyclohexyl)-ethyl]-phenyl trans-4-heptylcyclohexane-carboxylate; C. 84° · S_A 91° · N 140° · I;
- (30) 3-fluoro-4-[2-(trans-4-pentylcyclohexyl)-ethyl]-phenyl trans-4-propylcyclohexane-carboxylate; M. 65°; C. 141°;
- (31) 3-fluoro-4-[2-(trans-4-pentylcyclohexyl)-ethyl]-phenyl trans-4-heptylcyclohexane-carboxylate; C. 100° · S_A 111° · N 142° · I.

The following are further examples of compounds of the formula (I):

- 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(3-fluoro-4-pentyl-phenyl)-ethane;
- 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(2-fluoro-4-pentyl-phenyl)-ethane;
- 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(3-fluoro-4-butoxy-phenyl)-ethane;
- 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(2-fluoro-4-butoxy-phenyl)-ethane;

- 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(3-cyano-4-pentyl-phenyl)-ethane;
2-(trans-4-pentyl-4'-bicyclohexyl)-1-(2-cyano-4-pentyl-phenyl)-ethane;
- 5 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(3-cyano-4-ethoxy-phenyl)-ethane;
2-(trans-4-pentyl-4'-bicyclohexyl)-1-(3-cyano-4-butoxy-phenyl)-ethane;
2-(trans-4-pentyl-4'-bicyclohexyl)-1-(3-cyano-4-hexyloxy-phenyl)-ethane;
- 10 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(2-cyano-4-ethoxy-phenyl)-ethane;
2-(trans-4-pentyl-4'-bicyclohexyl)-1-(2-cyano-4-butoxy-phenyl)-ethane;
- 15 2-(trans-4-pentyl-4'-bicyclohexyl)-1-(2-cyano-4-hexyloxy-phenyl)-ethane;
2-fluoro-1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
3-fluoro-1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
- 20 2-fluoro-1,4-di-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
2,3-difluoro-1,4-di-[2-(trans-4-propylcyclohexyl)-1-ethyl]-benzene;
- 25 2,3-difluoro-1,4-di-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
2,3-difluoro-1,4-di-[2-(trans-4-heptylcyclohexyl)-1-ethyl]-benzene;
- 2-cyano-1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
- 30 3-cyano-1-[2-(trans-4-propylcyclohexyl)-1-ethyl]-4-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
2-cyano-1,4-di-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;
- 35 2,3-dicyano-1,4-di-[2-(trans-4-propylcyclohexyl)-1-ethyl]-benzene;
2,3-dicyano-1,4-di-[2-(trans-4-pentylcyclohexyl)-1-ethyl]-benzene;

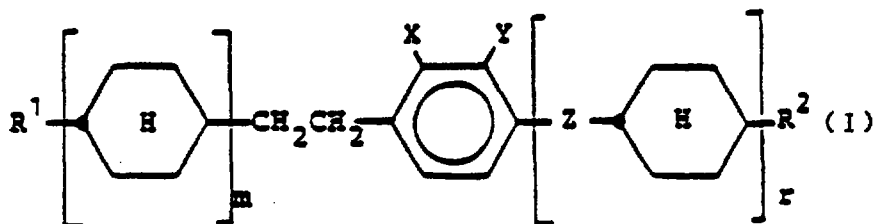
0133489

2,3-dicyano-1,4-di-[2-(trans-4-heptylcyclohexyl)-1-ethyl]-
benzene.



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

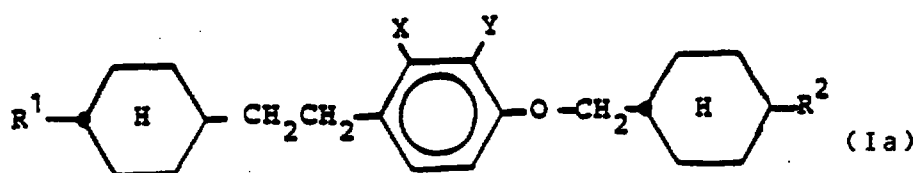
1. Nematic compounds with a negative DC anisotropy characterized by the formula I



in which $m = 1$ or 2 , $r = \text{zero or } 1$ and $m + r = 1$ or 2 , and R^1 and R^2 are identical or different and are selected from alkyl and alkoxy groups each having 1 - 12 carbon atoms in a straight or branched chain, which may be chiral, z is a bridge member selected from a single bond and the groups of the formulae $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$, one of the groups X and Y is selected from fluorine, chlorine, bromine and cyano and the other of the groups X and Y is selected from hydrogen, fluorine, chlorine, bromine and cyano, with the proviso that $m = r = 1$ if X and Y are both cyano.

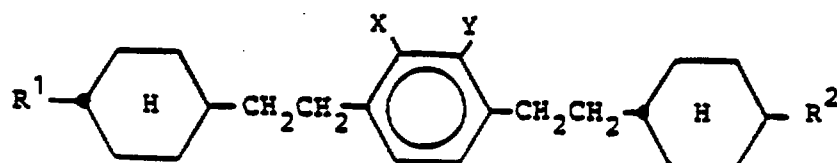
2. Compound according to Claim 1, characterized in that $m + r = 2$.

3. Compound according to Claim 1, characterized by the formula Ia



in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

4. Compound according to Claim 1, characterized by the formula Ib

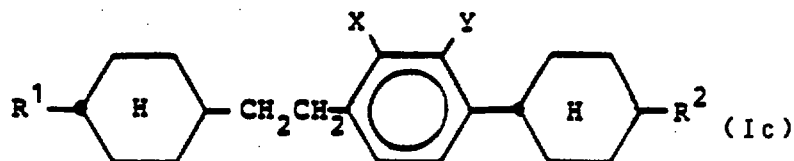




0133489

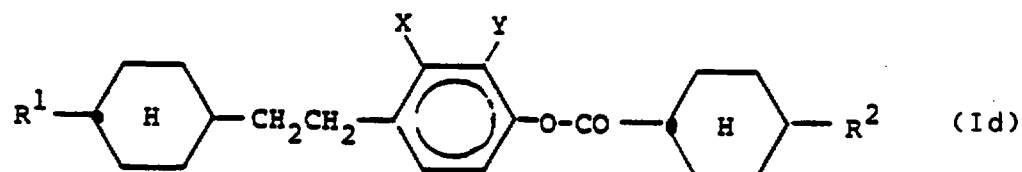
in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

5. Compound according to Claim 1, characterized by the formula Ic



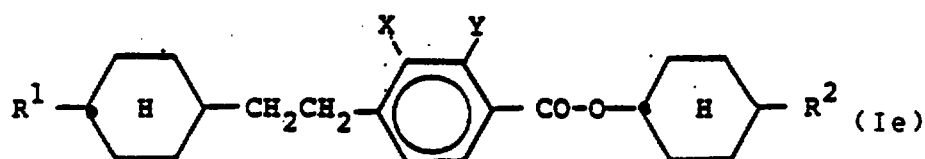
in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

6. Compound according to Claim 1, characterized by the formula Id



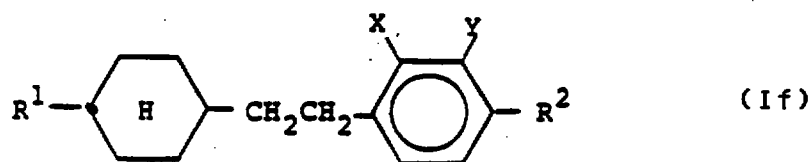
in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

7. Compound according to Claim 1, characterized by the formula Ie



in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

8. Compound according to Claim 1, characterized by the formula If



in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

9. Liquid crystal mixture, characterized in that it contains at least one compound of the formula I according to Claim 1, as a component.



0133489

10. Mixture according to Claim 9, characterized in that it contains at least one compound of the formula I in which $m + r = 2$.

11. Mixture according to Claim 9, characterized in that it contains at least one compound of the formulae Ia, Ib, Ic, Id, Ie or If according to Claims 3, 4, 5, 6, 7 or 8.

12. Use of the compounds of the formula I according to Claim 1, as components of liquid crystal mixtures.

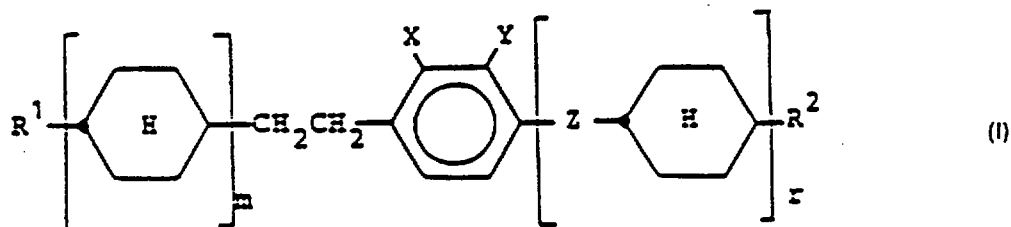
13. Electro-optical display element, characterized in that it contains a mixture according to one of Claims 9, 10 or 11.



As printed.

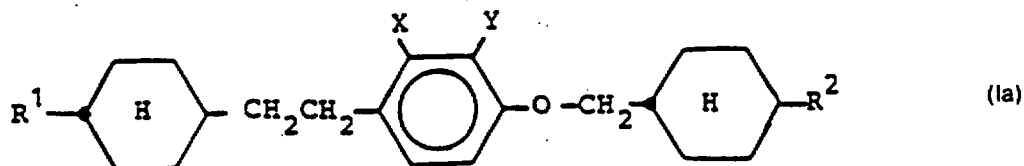
Claims (for the Contracting States : CH, DE, FR, GB, IT, LI, NL)

1. Nematic compounds with a negative anisotropy of the dielectric constant, characterised by the formula (I)



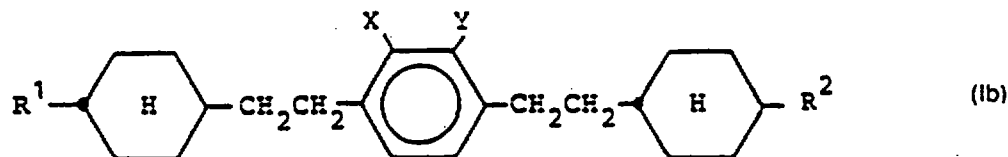
in which $m = 1$ or 2 , r is zero or 1 and $m + r = 1$ or 2 , and R^1 and R^2 are identical or different and are selected from alkyl and alkoxy groups each having 1-12 carbon atoms in a straight or branched chain, which may be chiral, Z is a bridge member selected from a single bond and the groups of the formulae $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$, one of the groups X and Y is selected from fluorine, chlorine, bromine and cyano and the other of the groups X and Y is selected from hydrogen, fluorine, chlorine, bromine and cyano, with the proviso that $m = r = 1$ if X and Y are both cyano.

2. Compound according to Claim 1, characterised in that $m + r = 2$.
3. Compound according to Claim 1, characterised by the formula Ia



in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

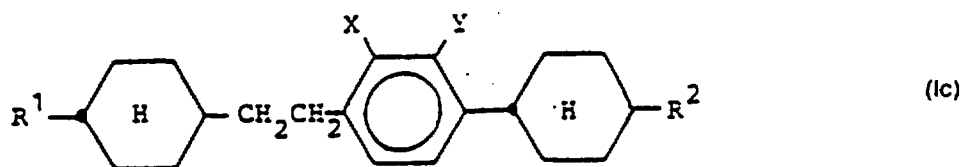
4. Compound according to Claim 1, characterised by the formula Ib



in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

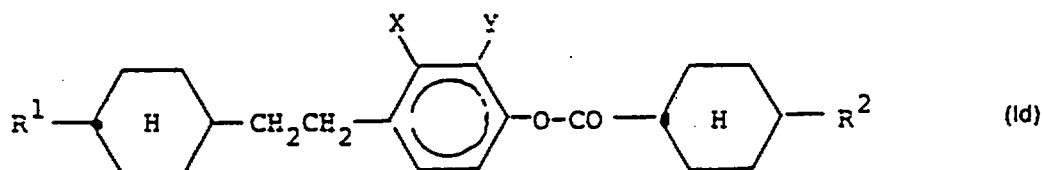


5. Compound according to Claim 1, characterised by the formula Ic



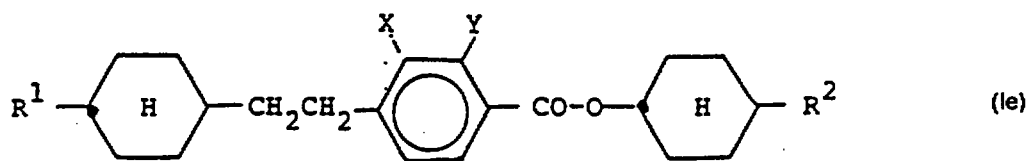
in which R¹, R², X and Y have the meanings given in Claim 1.

6. Compound according to Claim 1, characterised by the formula Id



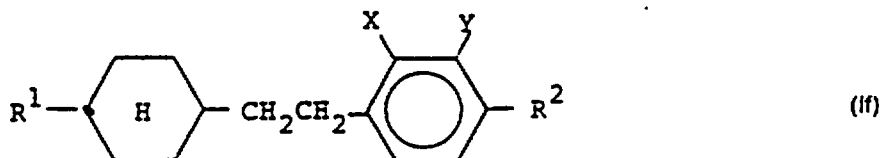
in which R¹, R², X and Y have the meanings given in Claim 1.

7. Compound according to Claim 1, characterised by the formula Ie



in which R¹, R², X and Y have the meanings given in Claim 1.

8. Compound according to Claim 1, characterised by the formula If



in which R¹, R², X and Y have the meanings given in Claim 1.

9. Liquid crystal mixture, characterised in that it contains at least one compound of the formula (I) according to Claim 1, as a component.

10. Mixture according to Claim 9, characterised in that it contains at least one compound of the formula (I) in which m + r = 2.

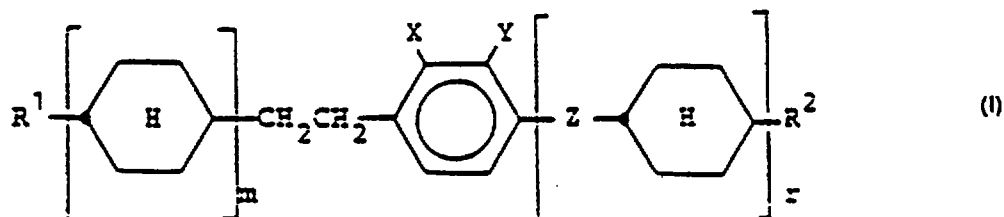
11. Mixture according to Claim 9, characterised in that it contains at least one compound of the formulae Ia, Ib, Ic, Id, Ie, or If according to Claims 3, 4, 5, 6, 7 or 8.

12. Use of the compounds of the formula (I) according to Claim 1, as components of liquid crystal mixtures.

13. Electro-optical display element, characterised in that it contains a mixture according to one of Claims 9, 10 or 11.

Claims (for the Contracting State AT)

1. Liquid crystal mixture, characterised in that it contains at least one nematic compound with a negative anisotropy of the dielectric constant, characterised by the formula (I)

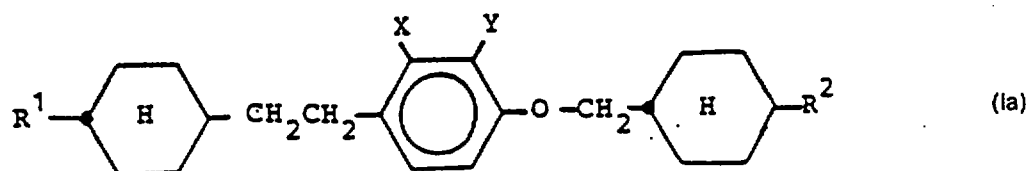




in which $m = 1$ or 2 , r is zero or 1 and $m + r = 1$ or 2 , and R^1 and R^2 are identical or different and are selected from alkyl and alkoxy groups each having 1-12 carbon atoms in a straight or branched chain, which may be chiral, Z is a bridge member selected from a single bond and the groups of the formulae $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{O}-\text{CO}-$ or $-\text{CO}-\text{O}-$, one of the groups X and Y is selected from fluorine, chlorine, bromine and cyano and the other of the groups X and Y is selected from hydrogen, fluorine, chlorine, bromine and cyano, with the proviso that $m = r = 1$ if X and Y are both cyano.

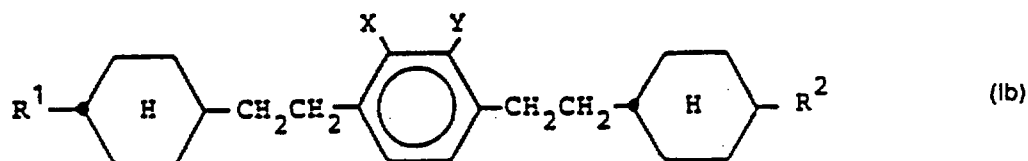
2. Liquid crystal mixture according to Claim 1, characterised in that $m + r = 2$.

3. Liquid crystal mixture according to Claim 1, characterised in that it contains at least one compound of the formula Ia.



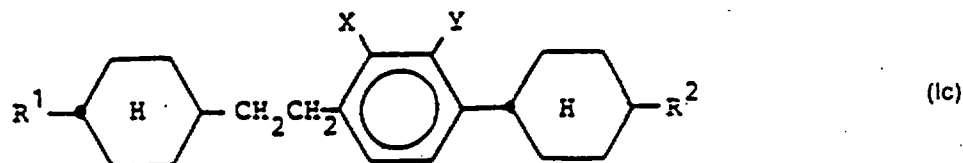
in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

4. Liquid crystal mixture according to Claim 1, characterised in that it contains at least one compound of the formula Ib



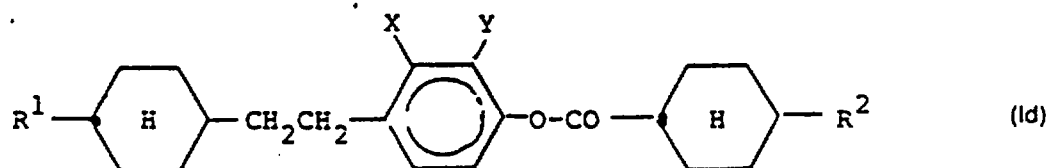
in which R^1 , R^2 , X and Y have the meanings give in Claim 1.

5. Liquid crystal mixture according to Claim 1, characterised in that it contains at least one compound of the formula Ic



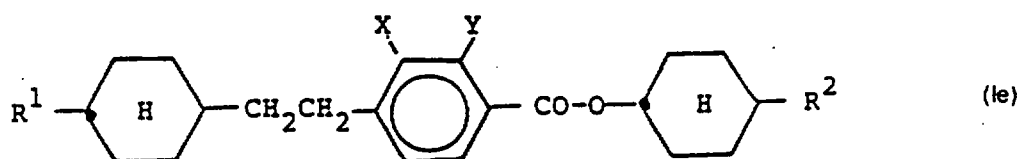
in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

6. Liquid crystal mixture according to Claim 1, characterised in that it contains at least one compound of the formula Id



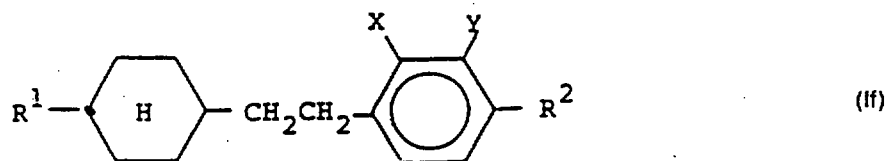
in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

7. Liquid crystal mixture according to Claim 1, characterised in that it contains at least one compound of the formula Ie



in which R^1 , R^2 , X and Y have the meanings given in Claim 1.

8. Liquid crystal mixture according to Claim 1, characterised in that it contains at least one compound of the formula If



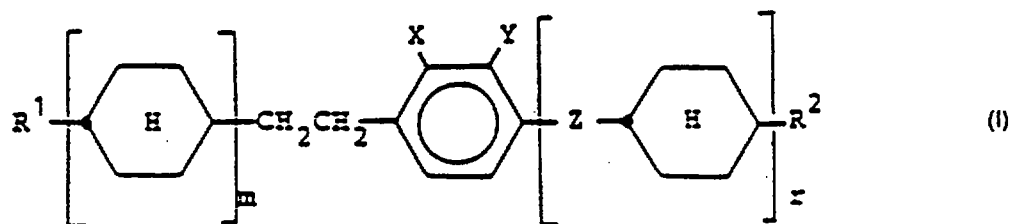
in which R¹, R², X and Y have the meanings given in Claim 1.

9. Use of the compounds of the formula (I) according to Claim 1, as components of liquid crystal mixtures.

10. Electro-optical display element, characterised in that it contains a mixture according to one of Claims 1 to 8.

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

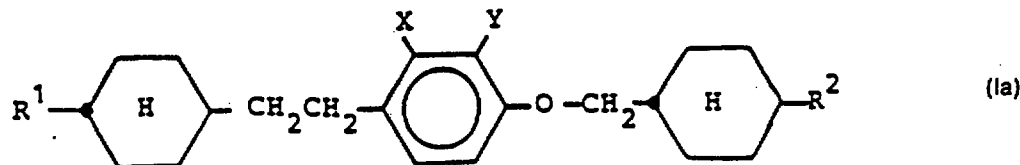
1. Composés nématiques à anisotropie diélectrique négative, caractérisés par la formule I



dans laquelle m = 1 ou 2, r = 0 ou 1 et m + r = 1 ou 2 et R¹ et R², ayant des significations identiques ou différentes, sont choisis parmi les groupes alkyle et alcoxy contenant chacun 1 à 12 atomes de carbone en chaîne droite ou ramifiée et le cas échéant chirale, Z représente un pont choisi parmi les liaisons simples et les groupes de formules $-\text{CH}_2\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{O}-\text{CO}-$ ou $-\text{CO}-\text{O}-$, l'un des substituants X et Y est choisi parmi le fluor, le chlore, le brome et le cyano et l'autre parmi l'hydrogène, le fluor, le chlore, le brome et le cyano, avec la condition supplémentaire que m = r = 1 lorsque les deux symboles X et Y représentent des groupes cyano.

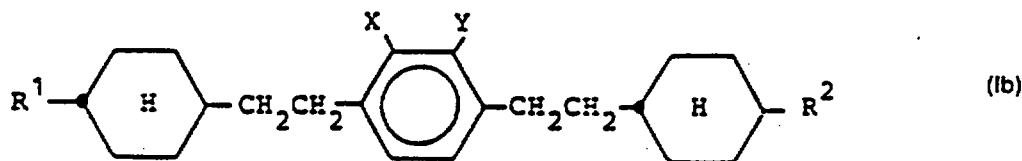
2. Composé selon la revendication 1, caractérisé en ce que m + r = 2.

3. Composé selon la revendication 1, caractérisé par la formule Ia



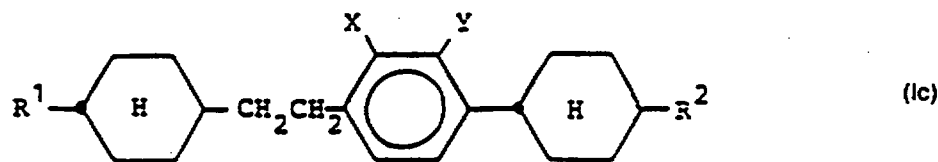
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

4. Composé selon la revendication 1, caractérisé par la formule Ib



dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

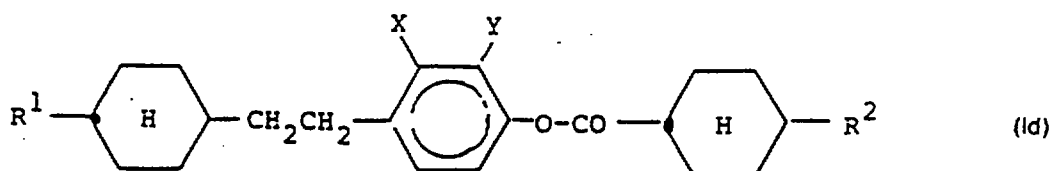
5. Composé selon la revendication 1, caractérisé par la formule Ic.





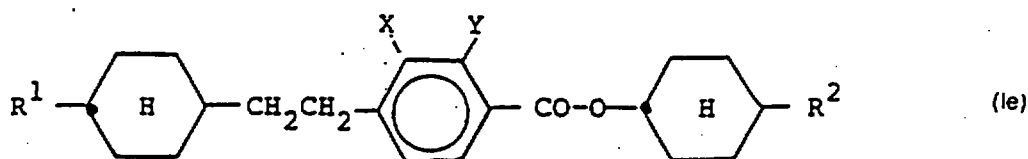
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

6. Composé selon la revendication 1, caractérisé par la formule Id



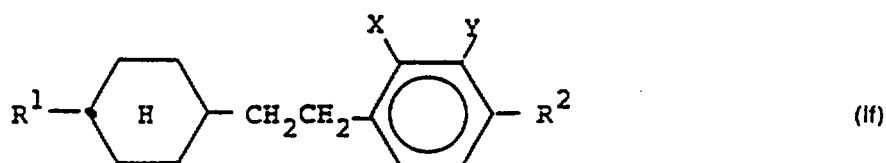
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

7. Composé selon la revendication 1, caractérisé par la formule le



dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

8. Composé selon la revendication 1, caractérisé par la formule lf



dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

9. Mélange à cristaux liquides, caractérisé en ce qu'il contient au moins un composé de formule I selon la revendication 1 en tant que composant.

10. Mélange selon la revendication 9, caractérisé en ce qu'il contient au moins un composé de formule I dans laquelle m + r = 2.

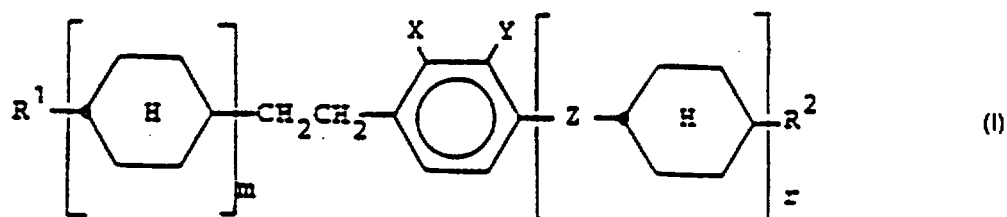
11. Mélange selon la revendication 9, caractérisé en ce qu'il contient au moins un composé de formule Ia, Ib, Ic, Id, le, ou lf selon les revendications 3, 4, 5, 6, 7 ou 8.

12. Utilisation des composés de formule I selon la revendication 1 en tant que composants de mélanges à cristaux liquides.

13. Élément d'affichage électro-optique, caractérisé en ce qu'il contient un mélange selon l'une des revendications 9, 10 ou 11.

Revendications (pour l'Etat contractant AT)

1. Mélange à cristaux liquides, caractérisé en ce qu'il contient au moins un composé nématique à anisotropie diélectrique négative caractérisé par la formule I

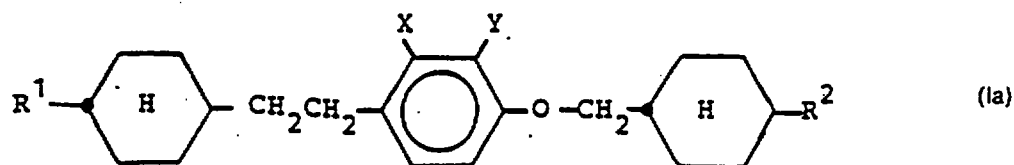


dans laquelle m = 1 ou 2, r = 0 ou 1 et m + r = 1 ou 2 et R¹ et R², ayant des significations identiques ou différentes, sont choisis parmi les groupes alkyle et alcoxy contenant chacun 1 à 12 atomes de carbone en chaîne droite ou ramifiée et le cas échéant chirale, Z représente un pont choisi parmi les liaisons simples et les groupes de formule -CH₂CH₂-, -OCH₂-, -O-CO- ou -CO-O-, l'un des substituants X et Y est choisi parmi le fluor, le chlore, le brome et le cyano et l'autre parmi l'hydrogène, le fluor, le chlore, le brome et le cyano, avec la condition supplémentaire que m = r = 1 lorsque les deux symboles X et Y représentent des groupes cyano.

2. Mélange à cristaux liquides selon la revendication 1, caractérisé en ce que m + r = 2.

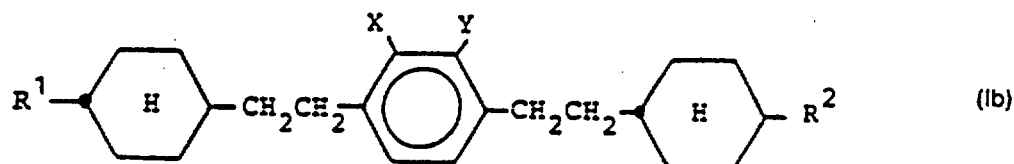


3. Mélange à cristaux liquide selon la revendication 1, caractérisé en ce qu'il contient au moins un composé de formule la



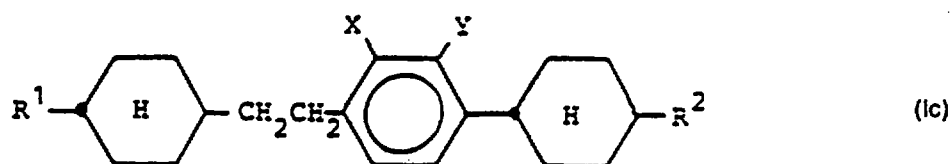
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

4. Mélange à cristaux liquides selon la revendication 1, caractérisé en ce qu'il contient au moins un composé de formule lb



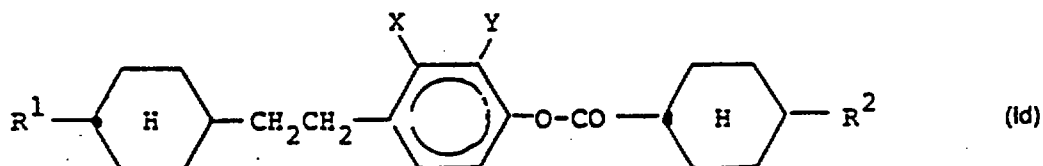
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

5. Mélange à cristaux liquides selon la revendication 1, caractérisé en ce qu'il contient au moins un composé de formule lc



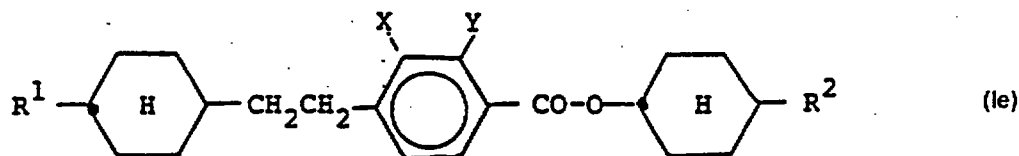
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

6. Mélange à cristaux liquides selon la revendication 1, caractérisé en ce qu'il contient au moins un composé de formule ld



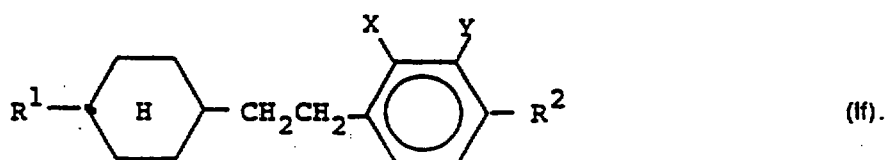
dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

7. Mélange à cristaux liquides selon la revendication 1, caractérisé en ce qu'il contient au moins un composé de formule le



dans laquelle R¹, R², X et Y ont les significations indiquées dans la revendication 1.

8. Mélange à cristaux liquides selon la revendication 1, caractérisé en ce qu'il contient au moins un composé de formule lf





0 133 489

dans laquelle R^1 , R^2 , X et Y ont les significations indiquées dans la revendication 1.

9. Utilisation des composés de formule I selon la revendication 1 en tant que composants de mélanges à cristaux liquides.

10. Élément d'affichage électro-optique, caractérisé en ce qu'il contient un mélange selon l'une des 5 revendications 1 à 8.