

Description

The invention relates to substituted phenyl trifluoromethyl ethers of the formula I



5 in which

10 R^1 is H or alkyl having 1-18 C atoms in which one or more CH_2 groups may also be replaced by -E-, -O-, -S- and/or -CO-, where two heteroatoms are not linked directly to one another, or perfluoroalkyl having 1-18 C atoms in which one or more CF_2 groups may also be replaced by - CH_2 -, -E-, -O-, -S- and/or -CO-, where two heteroatoms are not linked directly to one another,

15 E is $CH=CH$, $CH=CH$, $C\equiv C$, CHY , $CX-CH$ or $CH-CX$,


X is Y, CH_3 or H,

Y is CN, NCS, NCO or halogen,

20 A^1 and A^2 , independently of one another, are each 1,4-cyclohexylene, in which one or two non-adjacent CH_2 groups may also be replaced by -O- and/or S atoms, 1,4-cyclohexenylene, 1,4-bicyclo-(2.2.2)octylene, piperidine-1,4-diyl or 1,4-phenylene, in which one or more CH groups may be replaced by N, which is unsubstituted or monosubstituted or polysubstituted by halogen atoms and/or CN and/or CH_3 groups,

25 Z^1 is -O-CO-, - CH_2O -, - OCH_2 -, - CH_2CH_2 -, -CH=CH- or a single bond,

30 Z^2 is -CO-O-, - CH_2O -, - OCH_2 -, - CH_2CH_2 -, -CH=CH- or a single bond,

A³ is a 1,4-phenylene group which is unsubstituted or monosubstituted or polysubstituted by halogen atoms and/or CN and/or CH₃ groups,

and

5 n is 0, 1 or 2,

with the provisos that

a) Z² is -CH₂O-, -OCH₂-, -CH₂CH₂-, -CH=CH- or a single bond in the case where n = 0 or 1, R¹ = alkoxy and A¹ = A² = A³ = unsubstituted 1,4-phenylene, and

10 b) 4-phenyltrifluoromethoxybenzene is excepted,

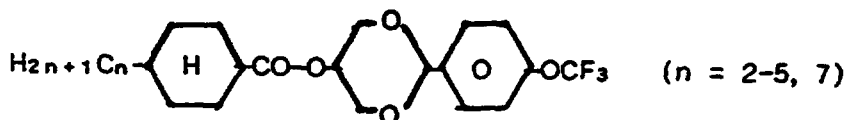
and to the use thereof as components in liquid-crystalline phases.

For reasons of simplicity below, Cyc is a 1,4-cyclohexylene group, Che is a 1,4-cyclohexenylene group, Dio is a 1,3-dioxane-2,5-diyl group, Dit is a 1,3-dithiane-2,5-diyl group, Phe is a 1,4-phenylene group, Pyd is a pyridine-2,5-diyl group, Pyr is a pyrimidine-2,5-diyl group and Bi is a bicyclo(2,2,2)octylene group, where Cyc and/or Phe may be unsubstituted or substituted by one or more halogen atoms and/or CH₃ groups and/or CN groups.

The compounds of the formula I can be used as components in liquid-crystalline phases, in particular for displays which are based on the principle of the twisted cell, the guest/host effect, the effect of deformation of aligned phases or the effect of dynamic scattering.

Similar compounds have already been disclosed: V.V. Titov et al. (Mol. Cryst. Liq. Cryst., 47, 1/2, 1978, 1-5) have investigated the mesogenic properties of p-trifluoromethoxybenzoic acid esters. However, these are said to have the tendency to form smectic phases and, in addition, have relatively low dielectric anisotropy values.

DE-A 35 11 111 describes compounds of the formula



However, these compounds do not have any liquid-crystalline phases.

US Patent No. 4,157,344 describes the preparation of 4-phenyltrifluoromethoxybenzene, but contains no indication that trifluoromethoxybenzene derivatives of this type are at all suitable as components of liquid-crystalline phases.

The invention had the object of discovering novel stable liquid-crystalline or mesogenic compounds which are suitable as components of liquid-crystalline phases and, in particular, have comparatively low viscosity and relatively high dielectric anisotropy.

It has now been found that compounds of the formula I are highly suitable as components of liquid-crystalline phases. In particular, they have comparatively low viscosities. They can be used to obtain stable liquid-crystalline phases having a broad mesophase range and advantageous values for optical and dielectrical anisotropy.

In addition, the provision of compounds of the formula I considerably extends, very generally, the range of liquid-crystalline substances which are suitable, from various applicational points of view, for the production of liquid-crystalline mixtures.

The compounds of the formula I have a broad field of application. Depending on the choice of substituents, these compounds can be used as base materials of which liquid-crystalline phases are predominantly composed, or compounds of the formula I can be added to liquid-crystalline base materials made of other classes of compounds in order, for example, to influence the dielectrical and/or optical anisotropy of a dielectric of this type and/or to optimise its threshold voltage and/or its viscosity.

The compounds of the formula I are colourless in the pure state and form liquid-crystalline mesophases in a temperature range which is favourable for electrooptical use. They are stable chemically, thermally and against light.

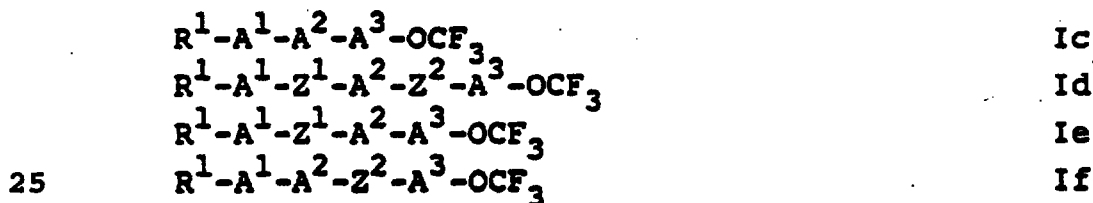
The invention thus relates to the compounds of the formula I and to the use of these compounds as components of liquid-crystalline phases. The invention furthermore relates to liquid-crystalline phases containing at least one compound of the formula I and to liquid-crystal display elements, in particular electrooptical display elements, which contain such phases.

Above and below, R^1 , A^1 , Z^1 , n , A^2 , Z^2 and A^3 have the meaning indicated, unless expressly stated otherwise.

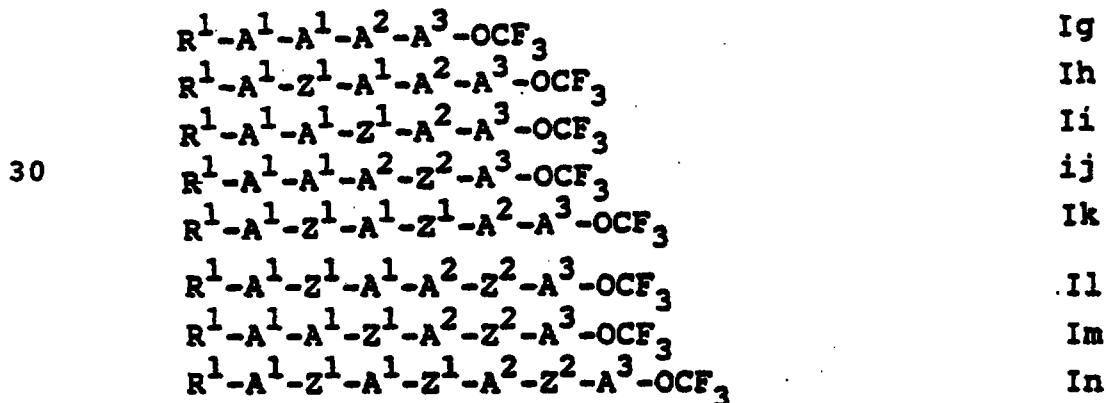
The compounds of the formula I accordingly cover compounds containing two rings of the sub-formulae Ia and Ib:



compounds containing three rings of the sub-formulae Ic to If:



and compounds containing four rings of the sub-formulae Ig to In:



Of these, those of the sub-formulae Ia, Ib, Ic, Id, Ie, If, Ih, Ij and Il are particularly preferred.

The preferred compounds of the sub-formula Ia cover those of the sub-formulae Iaa to Iaf:

5	R ¹ -Phe-Phe-OCF ₃	Iaa
	R ¹ -Dio-Phe-OCF ₃	Iab
	R ¹ -Pyr-Phe-OCF ₃	Iac
	R ¹ -Pyd-Phe-OCF ₃	Iad
	R ¹ -Cyc-Phe-OCF ₃	Iae
10	R ¹ -Che-Phe-OCF ₃	Iaf

Of these, those of the formulae Iaa, Iab, Iad and Iae are particularly preferred.

The preferred compounds of the sub-formula Ib cover those of the sub-formulae Iba to Ibl:

15	R ¹ -Phe-CH ₂ CH ₂ -Phe-OCF ₃	Iba
	R ¹ -Phe-OCH ₂ -Phe-OCF ₃	Ibb
	R ¹ -Cyc-CH ₂ CH ₂ -Phe-OCF ₃	Ibc
	R ¹ -A ² -CH ₂ CH ₂ -Phe-OCF ₃	Ibe
	R ¹ -A ² -CH ₂ O-Phe-OCF ₃	Ibf
20	R ¹ -A ² -OCH ₂ -Phe-OCF ₃	Ibg
	R ¹ -A ² -COO-Phe-OCF ₃	Ibh
	R ¹ -Che-CH ₂ CH ₂ -Phe-OCF ₃	Ibj
	R ¹ -Cyc-COO-Phe-OCF ₃	Ibl

The preferred compounds of the sub-formula Ic cover those of the sub-formulae Ica to Ici:

25	R ¹ -Phe-Phe-Phe-OCF ₃	Ica
	R ¹ -Phe-Dio-Phe-OCF ₃	Icb
	R ¹ -Cyc-Cyc-Phe-OCF ₃	Icc
	R ¹ -Pyd-Phe-Phe-OCF ₃	Icd
	R ¹ -Pyr-Phe-Phe-OCF ₃	Ice
30	R ¹ -Cyc-Phe-Phe-OCF ₃	Icf
	R ¹ -Dio-Phe-Phe-OCF ₃	Icg
	R ¹ -Che-Phe-Phe-OCF ₃	Ich
	R ¹ -Phe-Che-Phe-OCF ₃	Ici

Of these, those of the formulae Icc and Icf are particularly preferred.

The preferred compounds of the sub-formula Id cover those of the sub-formulae Ida to Idk:

5	$R^1\text{-Phe-Z}^1\text{-Phe-Z}^2\text{-Phe-OCF}_3$	Ida
	$R^1\text{-Phe-Z}^1\text{-Dio-Z}^2\text{-Phe-OCF}_3$	Idb
	$R^1\text{-Cyc-Z}^1\text{-Cyc-Z}^2\text{-Phe-OCF}_3$	Idc
	$R^1\text{-Pyd-Z}^1\text{-Phe-Z}^2\text{-Phe-OCF}_3$	Ide
	$R^1\text{-Phe-Z}^1\text{-Pyd-Z}^2\text{-Phe-OCF}_3$	Idf
10	$R^1\text{-Pyr-Z}^1\text{-Phe-Z}^2\text{-Phe-OCF}_3$	Idg
	$R^1\text{-Phe-Z}^1\text{-Pyr-Z}^2\text{-Phe-OCF}_3$	Idh
	$R^1\text{-Phe-Z}^1\text{-Cyc-Z}^2\text{-Phe-OCF}_3$	Idi
	$R^1\text{-Dio-Z}^1\text{-Phe-Z}^2\text{-Phe-OCF}_3$	Idj
	$R^1\text{-Che-Z}^1\text{-Phe-Z}^2\text{-Phe-OCF}_3$	Idk

15 The preferred compounds of the sub-formulae Ie cover those of the sub-formulae Iea to Iei:

	$R^1\text{-Pyr-Z}^1\text{-Phe-Phe-OCF}_3$	Iea
	$R^1\text{-Dio-Z}^1\text{-Phe-Phe-OCF}_3$	Ieb
	$R^1\text{-Cyc-Z}^1\text{-Phe-Phe-OCF}_3$	Iec
	$R^1\text{-Phe-Z}^1\text{-Cyc-Phe-OCF}_3$	Ied
20	$R^1\text{-Cyc-Z}^1\text{-Cyc-Phe-OCF}_3$	Iee
	$R^1\text{-Phe-Z}^1\text{-Dio-Phe-OCF}_3$	Ief
	$R^1\text{-Pyd-Z}^1\text{-Phe-Phe-OCF}_3$	Ieg
	$R^1\text{-Phe-Z}^1\text{-Pyr-Phe-OCF}_3$	Ieh
	$R^1\text{-Phe-Z}^1\text{-Che-Phe-OCF}_3$	Iei

25 The preferred compounds of the sub-formula If cover those of the sub-formulae Ifa to Ifm:

	$R^1\text{-Pyr-Phe-Z}^2\text{-Phe-OCF}_3$	Ifa
	$R^1\text{-Pyr-Phe-OCH}_2\text{-Phe-OCF}_3$	Ifb
	$R^1\text{-Phe-Phe-Z}^2\text{-Phe-OCF}_3$	Ifc

	R^1 -Cyc-Cyc- Z^2 -Phe-OCF ₃	Ifd
	R^1 -Cyc-Cyc-CH ₂ CH ₂ -Phe-OCF ₃	Ife
	R^1 -Pyd-Phe- Z^2 -Phe-OCF ₃	Iff
5	R^1 -Dio-Phe- Z^2 -Phe-OCF ₃	Ifg
	R^1 -Phe-Cyc- Z^2 -Phe-OCF ₃	Ifh
	R^1 -Phe-Pyd- Z^2 -Phe-OCF ₃	Ifi
	R^1 -Che-Phe- Z^2 -Phe-OCF ₃	Ifj
	R^1 -Phe-Che- Z^2 -Phe-OCF ₃	Ifk
10	R^1 -Pyr-Phe-CH ₂ CH ₂ -Phe-OCF ₃	Ifl
	R^1 -Cyc-Phe-CH ₂ CH ₂ -Phe-OCF ₃	Ifm

The preferred compounds of the sub-formulae Ig to
 15 In cover those of the sub-formulae Io to Iv:

	R^1 -Cyc-Cyc-Phe-Phe-OCF ₃	Io
	R^1 -A ¹ -CH ₂ O-A ¹ -A ² -Phe-OCF ₃	Ip
	R^1 -Cyc-Cyc- Z^1 -A ² -Phe-OCF ₃	Iq
	R^1 -A ¹ -A ¹ -A ² -CH ₂ CH ₂ -Phe-OCF ₃	Ir
20	R^1 -Phe- Z^1 -Phe- Z^1 -Dio-Phe-OCF ₃	Is
	R^1 -Phe- Z^1 -Phe-Phe- Z^2 -Phe-OCF ₃	It
	R^1 -A ¹ -A ¹ -COO-A ² - Z^2 -Phe-OCF ₃	Iv

In the compounds of the formulae above and below,
 25 R^1 is preferably alkyl, furthermore alkoxy. A¹ and A² are preferably Phe, Cyc, Che, Pyd, Pyr or Dio. The compounds of the formula I preferably contain no more than one of the radicals Bi, Pyd, Pyr, Dio and Dit.

R^1 is preferably also an alkyl group in which two adjacent CH₂ groups have been replaced by -O- and -CO- or
 30 -CO- and -O-. Furthermore, R^1 is preferably an alkyl group in which one CH₂ group has been replaced by -C≡C- or -CH=CH-.

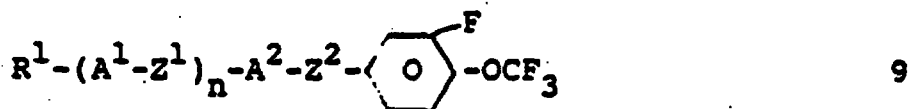
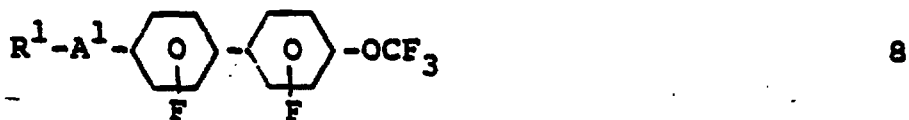
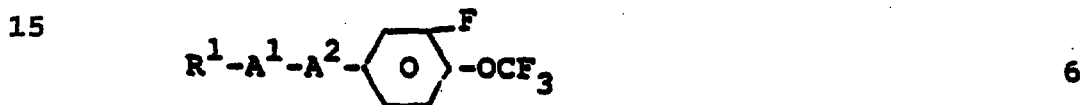
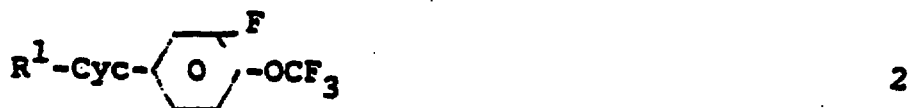
Preferred compounds of the formula I and of all the sub-formulae are also those in which A¹ and/or A² is
 35 (are) 1,4-phenylene which is substituted by one or more

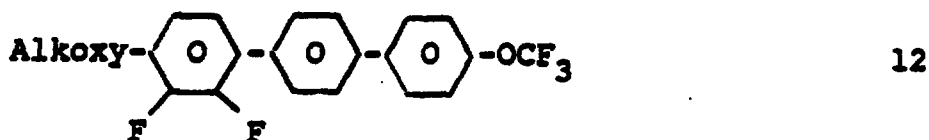
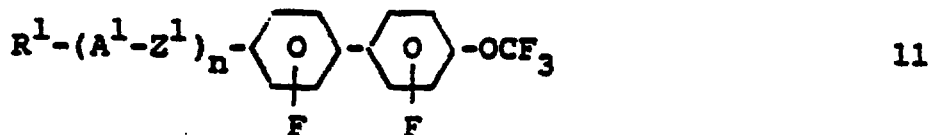
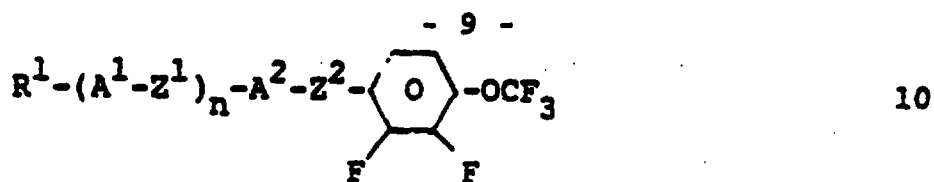
F atoms.

Z^1 and Z^2 are preferably single bonds, and secondarily preferably $-CH_2CH_2-$, $-CH_2O-$ or $-OCH_2-$. Furthermore the groups $-COO-$, $-OCO-$ or $-CH=CH-$ are preferred for Z^1 and Z^2 .

A^3 is preferably a 1,4-phenylene group which is unsubstituted or substituted by one or two F atoms.

The following compounds of the formula (sic) 1 to 13 are particularly preferred of the laterally substituted compounds:





5 If R^1 is an alkyl radical or an alkoxy radical, it may be straight-chain or branched. It is preferably straight-chain, has 2, 3, 4, 5, 6, 7, 8 or 9 C atoms and is accordingly preferably ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, ethoxy, propoxy, butoxy, 10 pentoxy, hexyloxy, heptyloxy, octyloxy or nonyloxy, furthermore also methyl, methoxy, decyl, undecyl, dodecyl, tridecyl, tetradecyl, decyloxy, undecyloxy, tridecyloxy or tetradecyloxy.

15 Oxaalkyl is preferably straight-chain 2-oxapropyl (= methoxymethyl), 2- (= ethoxymethyl) or 3-oxabutyl (= 2-methoxymethyl), 2-, 3- or 4-oxapentyl, 2-, 3-, 4- or 5-oxahexyl, 2-, 3-, 4-, 5- or 6-oxaheptyl, 2-, 3-, 4-, 5-, 6- or 7-oxaoctyl, 2-, 3-, 4-, 5-, 6-, 7- or 8-oxanonyl or 2-, 3-, 4-, 5-, 6-, 7-, 8- or 9-oxadecyl.

20 If R^1 is an alkyl radical in which a CH_2 group is replaced by $-\text{CH}=\text{CH}-$, it may be straight-chain or branched. It is preferably straight-chain and has 2 to 10 C atoms. It is accordingly preferably vinyl, prop-1- or prop(sic)-2-enyl, but-1-, -2- or but(sic)-3-enyl, pent-1- 25 , -2-, -3- or pent(sic)-4-enyl, hex-1-, -2-, -3-, -4- or hex(sic)-5-enyl, hept-1-, -2-, -3-, -4-, -5- or hept(sic)-6-enyl, oct-1-, -2-, -3-, -4-, -5-, -6- or oct(sic)-7-enyl, non-1-, -2-, -3-, -4-, -5-, -6-, -7- or non(sic)-8-enyl, or dec-1-, -2-, -3-, -4-, -5-, -6-, -7-,

-8- or dec(sic)-9-enyl.

Compounds of the formula 1 having a branched wing group R^1 may occasionally be important due to better solubility in the customary liquid-crystalline base materials, but in particular as chiral dopes if they are optically active. Compounds of the formula I having S_A phases are suitable for thermally addressed displays.

Branched groups of this type generally contain not more than one chain branch. Preferred branched radicals R^1 are isopropyl, 2-butyl (= 1-methylpropyl), isobutyl (= 2-methylpropyl), 2-methylbutyl, isopentyl (= 3-methylbutyl), 2-methylpentyl, 3-methylpentyl, 2-ethylhexyl, 2-propylpentyl, 2-octyl, isopropoxy, 2-methylpropoxy, 2-methylbutoxy, 3-methylbutoxy, 2-methylpentoxy, 3-methylpentoxy, 2-ethylhexoxy, 1-methylhexoxy, 2-octyloxy, 2-oxa-3-methylbutyl, 3-oxa-4-methylpentyl, 4-methylhexyl, 2-nonyl, 2-decyl, 2-dodecyl, 6-methyloctoxy, 6-methyl-octanoyloxy, 5-methylheptyloxy-carbonyl, 2-methylbutyryloxy, 3-methylvaleryloxy, 4-methylhexanoyloxy, 2-chloro-propionyloxy, 2-chloro-3-methylbutyryloxy, 2-chloro-4-methylvaleryloxy, 2-chloro-3-methylvaleryloxy, 2-methyl-3-oxapentyl and 2-methyl-3-oxahexyl.

Formula I covers the racemates of the compounds and the optical antipodes, and mixtures thereof.

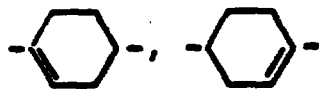
In the formula I, R^1 is furthermore alternatively perfluoroalkyl preferably having 2, 3, 4, 5, 6, 7, 8 or 9 C atoms.

Of these compounds of the formula I and of the sub-formulae, those are preferred in which at least one of the radicals present therein has one of the preferred meanings indicated.

In the compounds of the formula I, preferred stereoisomers are those in which the Cyc and piperidine rings are trans-1,4-disubstituted. Those of the abovementioned formulae which contain one or more Pyd, Pyr and/or Dio groups in each case include the two 2,5 positional isomers.

The 1,4-cyclohexenylene group preferably has the

following structures:



The compounds of the formula I are prepared by methods known per se, as described in the literature (for example in the standard works such as Houben-Weyl, Methoden der Organischen Chemie [Methods of Organic Chemistry], Georg-Thieme Verlag, Stuttgart, Vol. IX, pp. 867 ff.), namely under the reaction conditions which are known and suitable for the reactions mentioned. Variants which are known per se, but not described here in greater detail, can also be used here.

If desired, the starting materials can also be formed in situ in a manner such that they are not isolated from the reaction mixture but instead reacted further to form the compounds of the formula I.

Thus, compounds of the formula I can be prepared by reducing a compound which otherwise corresponds to the formula I, but contains one or more reducible groups and/or C-C bonds in place of H atoms.

Suitable reducible groups are preferably carbonyl groups, in particular keto groups, furthermore, for example, free of esterified hydroxyl groups or aromatically bound halogen atoms. Preferred starting materials for the reduction correspond to the formula I, but contain a cyclohexene ring or cyclohexanone ring in place of a cyclohexane ring and/or a -CH=CH- group in place of a -CH₂CH₂- group and/or a -CO- group in place of a -CH₂- group and/or a free or functionally derived (for example in the form of its p-toluenesulfonate) OH group in place of an H atom.

The reduction can be carried out, for example, by catalytic hydrogenation at temperatures between about 0° and about 200° and at pressures between about 1 and 200 bar in an inert solvent, for example an alcohol, such as methanol, ethanol or isopropanol, an ether, such as tetrahydrofuran (THF) or dioxane, an ester, such as ethyl

acetate, a carboxylic acid, such as acetic acid or a hydrocarbon, such as cyclohexane. Suitable catalysts are expediently noble metals, such as Pt or Pd, which can be employed in the form of oxides (for example PtO_2 or PdO),
5 on a support (for example Pd on charcoal, calcium carbonate or strontium carbonate) or in finely divided form.

Ketones can also be reduced by the method of Clemmensen (using zinc, amalgamated zinc or tin and hydrochloric acid, expediently in aqueous alcoholic
10 solution or in the heterogeneous phase with water/toluene at temperatures between about 80 and 120°) or by the method of Wolff-Kishner (using hydrazine, expediently in the presence of alkali, such as KOH or NaOH, in a high-boiling solvent, such as diethylene glycol or triethylene
15 glycol, at temperatures between about 100 and 200°) to form the corresponding compounds of the formula I, which contain alkyl groups and/or $-\text{CH}_2\text{CH}_2-$ bridges.

In addition, reductions using complex hydrides are possible, for example, arylsulfonyloxy groups can be
20 reductively removed using LiAlH_4 , and in particular p-toluenesulfonyloxymethyl groups can be reduced to methyl groups, expediently in an inert solvent, such as diethyl ether or THF, at temperatures between about 0 and 100° . Double bonds can be hydrogenated using NaBH_4 or tributyltin
25 hydride in methanol.

Esters of the formula I can also be obtained by esterification of corresponding carboxylic acids (or reactive derivatives thereof) using alcohols or phenols (or reactive derivatives thereof).

30 The appropriate carboxylic acids and alcohols or phenols are known and can be prepared analogously to known processes.

Suitable reactive derivatives of the carboxylic acids mentioned are, in particular, the acyl halides, above all the chlorides and bromides, furthermore the
35 anhydrides, for example also mixed anhydrides, azides or esters, in particular alkyl esters having 1-4 C atoms in the alkyl group.

Suitable reactive derivatives of the alcohols or

phenols mentioned are, in particular, the corresponding metal alkoxides or phenoxides, preferably of an alkali metal, such as sodium or potassium.

5 The esterification is advantageously carried out in the presence of an inert solvent. In particular, ethers, such as diethyl ether, di-n-butyl ether, THF, dioxane or anisole, ketones, such as acetone, butanone or cyclohexanone, amides such as DMF or hexamethylphosphoric triamide, hydrocarbons, such as benzene, toluene or
10 xylene, halogenated hydrocarbons, such as carbon tetrachloride or tetrachloroethylene, and sulfoxides, such as dimethyl sulfoxide or sulfolane, are highly suitable.

In order to prepare nitriles of the formula I (in which A^1 , A^2 and/or A^3 is substituted by at least one CN group), appropriate acid amides, for example those in
15 which a $CONH_2$ group is present in place of the CN radical, can be dehydrated. The amides can be obtained, for example, from the corresponding esters or acyl halides by reaction with ammonia. Suitable dehydrating agents are, for example, inorganic acid chlorides, such
20 as $SOCl_2$, PCl_3 , PCl_5 , $POCl_3$, SO_2Cl_2 , $COCl_2$, and further P_2O_5 , P_2S_5 , and $AlCl_3$ (for example as a double compound with $NaCl$), aromatic sulfonic acids and sulfonyl halides. This reaction can be carried out in the presence or absence of
25 an inert solvent at temperatures between about 0° and 150° ; suitable solvents are, for example, bases, such as pyridine or triethylamine, aromatic hydrocarbons, such as benzene, toluene or xylene, or amides, such as DMF.

In order to prepare the abovementioned nitriles
30 of the formula I, it is also possible to react appropriate acid halides, preferably the chlorides, with sulfamide, expediently in an inert solvent, such as tetramethylene sulfone, at temperatures between about 80° and 150° , preferably at 120° . After customary work-up,
35 the nitriles can be isolated directly.

Ethers of the formula I (in which R is an alkoxy group and/or Z^1 and/or Z^2 is an $-OCH_2-$ or $-CH_2O-$ group) can be obtained by etherification of the corresponding hydroxyl compounds, preferably the corresponding phenols,

the hydroxyl compound expediently first being converted into an appropriate metal derivative, for example into the corresponding alkali metal alkoxide or alkali metal phenoxide by treatment with NaH, NaNH₂, NaOH, KOH, Na₂CO₃, or K₂CO₃. This metal derivative can then be reacted with the appropriate alkyl halide alkylsulfonate or dialkyl sulfate, expediently in an inert solvent, such as acetone, 1,2-dimethoxyethane, DMF or dimethyl sulfoxide, or alternatively an excess of aqueous or aqueous alcoholic NaOH or KOH at temperatures between about 20° and 100°.

In order to prepare nitriles of the formula I (in which A¹, A² and/or A³ is substituted by at least one CN group), it is also possible to react corresponding chlorine or bromine compounds of the formula I (in which A¹ and/or A² and/or A³ is substituted by at least one Cl or Br atom) with a cyanide, expediently with a metal cyanide, such as NaCN, KCN or Cu₂(CN)₂, for example in the presence of pyridine in an inert solvent, such as DMF or N-methylpyrrolidone, at temperatures between 20° and 200°.

Compounds of the formula I in which A¹, A² and/or A³ is substituted by at least one F or Cl atom and/or a CN group can also be obtained from the corresponding diazonium salts by replacement of the diazonium group by a fluorine or chlorine atom or by a CN group, for example by the method of Schiemann or Sandmeyer.

Dioxane derivatives or dithiane derivatives of the formula I (in which one of the A¹ and/or A² groups is a 1,3-dioxane-2,5-diyl group or a 1,3-dithiane-2,5-diyl group) are expediently prepared by reacting a corresponding aldehyde (or a reactive derivative thereof) with an appropriate 1,3-diol (or a reactive derivative thereof) or an appropriate 1,3-dithiol, preferably in the presence of an inert solvent, such as benzene or toluene, and/or in the presence of a catalyst, for example a strong acid, such as sulfuric acid, benzenesulfonic acid or p-toluenesulfonic acid at temperatures between about 20° and about 150°, preferably between about 80° and 120°. Suitable

reactive derivatives of the starting materials are primarily acetals.

5 Some of the aldehydes and 1,3-diols or 1,3-dithiols mentioned, and the reactive derivatives thereof, are known and some can be prepared without difficulties by standard methods of organic chemistry from compounds known from the literature. For example, the aldehydes can be obtained by oxidation of the corresponding alkyls or by reduction of the corresponding carboxylic acids or
10 derivatives thereof, and the diols can be obtained by reduction of the corresponding diesters and the dithiols by reaction of the corresponding dihalides with NaSH.

 When preparing the compounds of the formula I, it is particularly advantageous to start from starting
15 compounds which already contain the -OCF₃ group, for example p-trifluoromethoxybenzaldehyde or 1-bromo-4-trifluoromethoxybenzene. A person skilled in the art can obtain further possible preparations from the literature mentioned or from the Examples.

20 The liquid-crystalline phases according to the invention comprise 2 to 25, preferably 3 to 15, components, including at least one compound of the formula I. The other components are selected from nematic or nematogenic substances, in particular the known substances from the classes comprising the azoxybenzenes,
25 benzylideneanilines, biphenyls, terphenyls, phenyl or cyclohexylbenzoates, phenyl or cyclohexyl cyclohexanoates, phenyl cyclohexanes, cyclohexylbiphenyls, cyclohexylcyclohexanes, cyclohexylnaphthalenes, 1,4-biscyclohexylbenzenes, 4,4'-biscyclohexylbiphenyls, phenyl- or
30 cyclohexylpyrimidines, phenyl- or cyclohexyldioxanes, phenyl- or cyclohexyldithianes, 1,2-bisphenylethanes, 1,2-biscyclohexylethanes, 1-phenyl-2-cyclohexylethanes, optionally halogenated stilbenes, benzyl phenyl ethers,
35 tolanes and substituted cinnamic acids.

 The most important compounds which are suitable as components of liquid-crystalline phases of this type may be characterised by the formula II



II

in which L and E are each a carbocyclic or heterocyclic ring system from the group formed from 1,4-disubstituted benzene and cyclohexane rings, 4,4'-disubstituted bi-phenyl, phenylcyclohexane and cyclohexylcyclohexane systems, 2,5-disubstituted pyrimidine and 1,3-dioxane rings, 2,6-disubstituted naphthalene, di- and tetrahydro-naphthalene, quinazoline and tetrahydroquinazoline,

G is

-CH=CH-	-N(O)=N-
-CH=CY-	-CH=N(O)-
-C=C-	-CH ₂ -CH ₂ -
-CO-O-	-CH ₂ -O-
-CO-S-	-CH ₂ -S-
-CH=N-	-COO-Phe-COO-

or a C-C single bond, Y is halogen, preferably chlorine or -CN, and R¹ and R² are alkyl, alkoxy, alkanoyloxy or alkoxycarbonyloxy having up to 18, preferably up to 8, carbon atoms, or one of these radicals is alternatively CN, NO₂, CF₃, F, Cl or Br.

In most of these compounds, R¹ and R² are different from one another, one of these radicals usually being an alkyl or alkoxy group. However, other variants of the proposed substituents are common. Many such substances or mixtures thereof are commercially available. All these substances can be prepared by methods known from the literature.

The liquid-crystalline phases according to the invention contain about 0.1 to 99, preferably 10 to 95%, of one or more compounds of the formula I. Further preferred liquid-crystalline phases are those which contain 0.1 - 50, in particular 0.5 - 30, % of one or more compounds of the formula I. It is also possible to use isotropic compounds of the formula I in the phases according to the invention.

The liquid-crystalline phases according to the invention are produced in a manner which is known per se. In general, the components are dissolved in one another, expediently at elevated temperature.

By means of suitable additives, the liquid-crystalline phases according to the invention can be modified so that they can be used in all types of liquid-crystal display elements which have been disclosed hitherto.

Such additives are known to those skilled in the art and described in detail in the literature. For example, conductive salts, preferably ethyldimethyldodecylammonium 4-hexyloxybenzoate, tetrabutylammonium tetraphenylboranate or complex salts of crown ethers (cf., for example, I. Haller et al., Mol. Cryst. Liq. Cryst., volume 24, pages 249-258 (1973)) can be added in order to improve the conductivity, dichroic dyes in order to produce coloured guest/host systems or substances in order to change the dielectric anisotropy, the viscosity and/or the orientation of the nematic phases. Such substances are described, for example, in DE-OS 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 below are intended to illustrate the invention without representing any limitation. Above and below, percentages mean per cent by weight. All temperatures are given in degrees Celsius. m.p. means melting point, c.p. = clear point. Furthermore, C = crystalline state, N = nematic phase, S = smectic phase and I = isotropic phase. The figures between these symbols are the transition temperatures.

Example 1

0.1 mol of p-trifluoromethoxybenzaldehyde, 0.1 mol of ethylpropanediol and 0.2 g of p-toluenesulfonic acid are refluxed for 2 hours in 100 ml of toluene. After evaporation of the solvent, vacuum distillation and subsequent crystallisation, trifluoromethoxy-4-(5-ethyl-1,3-dioxan-2-yl)benzene of m.p. = 31° and c.p. (extr.) = -90° is obtained.

The following are prepared analogously:
Trifluoromethoxy-4-(5-propyl-1,3-dioxan-2-yl)benzene, m.p. 36.3°, c.p. 35°

- Trifluoromethoxy-4-(5-butyl-1,3-dioxan-2-yl)benzene
Trifluoromethoxy-4-(5-pentyl-1,3-dioxan-2-yl)benzene,
m.p. 23°, c.p. 36°
Trifluoromethoxy-4-(5-hexyl-1,3-dioxan-2-yl)benzene
5 Trifluoromethoxy-4-(5-heptyl-1,3-dioxan-2-yl)benzene
Trifluoromethoxy-4-(5-octyl-1,3-dioxan-2-yl)benzene
Trifluoromethoxy-4-(5-nonyl-1,3-dioxan-2-yl)benzene
Trifluoromethoxy-4-(5-decyl-1,3-dioxan-2-yl)benzene
Trifluoromethoxy-4-[5-(trans-4-ethylcyclohexyl)-1,3-
10 dioxan-2-yl]benzene
Trifluoromethoxy-4-[5-(trans-4-propylcyclohexyl)-1,3-
dioxan-2-yl]benzene
Trifluoromethoxy-4-[5-(trans-4-butylcyclohexyl)-1,3-
dioxan-2-yl]benzene
15 Trifluoromethoxy-4-[5-(trans-4-pentylcyclohexyl)-1,3-
dioxan-2-yl]benzene, C 67° S, 146° N 150.5° I
Trifluoromethoxy-4-[5-(trans-4-hexylcyclohexyl)-1,3-
dioxan-2-yl]benzene
Trifluoromethoxy-4-[5-(trans-4-heptylcyclohexyl)-1,3-
20 dioxan-2-yl]benzene

Example 2

2 mol of anhydrous hydrofluoric acid are trans-
ferred into an autoclave which has been cooled to 0°. A
mixture of 0.18 mol of tetrachloromethane and 0.06 mol of
25 4-(trans-4-ethylcyclohexyl)phenol is then added. The
mixture is stirred for about 8 hours at 150°, cooled,
poured into ice water and washed with ether. The two
phases are stirred for about 30 minutes and separated,
and the ether solution is washed with 5% KOH until
30 alkaline. After drying, filtering off, distilling off and
purification, trifluoromethoxy-4-(trans-ethylcyclohexyl)-
benzene is obtained.

The following are prepared analogously:

- Trifluoromethoxy-4-(trans-4-propylcyclohexyl)benzene
35 Trifluoromethoxy-4-(trans-4-butylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-pentylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-hexylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-heptylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-octylcyclohexyl)benzene

Trifluoromethoxy-4-(trans-4-nonylcyclohexyl)benzene

Trifluoromethoxy-4-(trans-4-decylcyclohexyl)benzene

Example 3

0.42 g of lithium and 3.5 g of ZnBr₂ are added to
5 a mixture of 8.6 g of trans-4-(trans-4-propylcyclohexyl)-
cyclohexyl bromide and 50 ml of THF/toluene (1:4) at 0°. The reaction solution is treated with ultrasound for 3 hours at 0°-10°. After addition of 7.4 g of 1-bromo-4-(trifluoromethoxy)benzene and 0.44 g of 1,1-bis(diphenylphosphino)-ferrocene-palladium (II) dichloride [PdCl₂(dppf)], the mixture is stirred at room temperature for 24 hours, poured into 25 ml of water (+ 5 ml of 1 N HCl) and stirred for 15 minutes, the organic phase is separated off, and the aqueous phase is extracted with
15 toluene.

After work-up of the organic phases and purification by chromatography and/or crystallisation, trifluoromethoxy-4-[trans-4-(trans-4-propylcyclohexyl)-cyclohexyl]benzene is obtained, C 39° S 68° N 148.6° I.

20 The following are prepared analogously:

Trifluoromethoxy-4-[trans-4-(trans-4-ethylcyclohexyl)-cyclohexyl]benzene

Trifluoromethoxy-4-[trans-4-(trans-4-butylcyclohexyl)-cyclohexyl]benzene

25 Trifluoromethoxy-4-[trans-4-(trans-4-pentylcyclohexyl)-cyclohexyl]benzene

Trifluoromethoxy-4-[trans-4-(trans-4-hexylcyclohexyl)-cyclohexyl]benzene

30 Trifluoromethoxy-4-[trans-4-(trans-4-heptylcyclohexyl)-cyclohexyl]benzene

Trifluoromethoxy-4-[trans-4-(trans-4-octylcyclohexyl)-cyclohexyl]benzene

Trifluoromethoxy-4-[trans-4-(trans-4-nonylcyclohexyl)-cyclohexyl]benzene

35 Trifluoromethoxy-4-[trans-4-(trans-4-decylcyclohexyl)-cyclohexyl]benzene

Example 4

By etherification of 50 mmol of trifluoromethoxy-p-hydroxymethylbenzene with 50 mmol of 2-(p-hydroxy-

benzene)-5-nonylpyrimidine (sic) in 150 ml of THF in the presence of 55 mmol of triphenylphosphine and 55 mmol of diethyl azodi-carboxylate, 4-(5-nonylpyrimidin-2-yl)-phenyl p-trifluoro-methoxybenzyl ether of m.p. = 56° and c.p. = 155° is obtained.

The following are obtained analogously:

4-(5-Ethylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Methylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Propylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Butylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Pentylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Hexylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Heptylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether
4-(5-Octylpyrimidin-2-yl)phenyl p-trifluoromethoxybenzyl ether

Example 5

Equimolar amounts of p-trifluoromethoxybenzimidamide hydrochloride (can be prepared from the corresponding nitrile via the corresponding ethyl benzimidate hydrochloride) and heptylmalondialdehyde bisdiethyl acetal are heated at 150° for 15 hours. After cooling, the residue is dissolved in ethanol. Customary work-up gives 2-(p-trifluoromethoxybenzene)-5-heptylpyrimidine (sic) of m.p. 23° and c.p. 34°.

The following are prepared analogously:

2-(p-Trifluoromethoxybenzene)-5-ethylpyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-propylpyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-butylpyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-pentylpyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-hexylpyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-methoxypyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-ethoxypyrimidine (sic)

- 2-(p-Trifluoromethoxybenzene)-5-propoxypyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-butoxypyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-pentyloxypyrimidine (sic)
2-(p-Trifluoromethoxybenzene)-5-hexyloxypyrimidine (sic)
5 2-(p-Trifluoromethoxybenzene)-5-heptyloxypyrimidine (sic)

Example 6

- a) 95 g of trifluoromethoxybenzaldehyde in 150 ml of THF are added over the course of 2-3 hours at -10° to -5° to a mixture of 300 g of trans-4-(trans-4-propylcyclohexyl)cyclohexylmethyltriphenylphosphonium iodide, 56 g of potassium tert.-butoxide and 500 ml of THF. The mixture is allowed to warm to room temperature and neutralised using 2 N HCl, water is added, and the mixture is extracted with methyl tert.-butyl ether. After work-up of the organic phase and purification by chromatography on silicagel, 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]ethene is obtained.
- 10
- 15
- 20 b) 162 g of the ethene derivative are hydrogenated at room temperature and atmospheric pressure in 800 ml of THF over 40 g of 5 % Pd/C. After work-up and purification by crystallisation, 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)-cyclohexyl]ethane having C 24° C 60° (sic) S₀ 76° N 133.7° I is obtained.
- 25

The following are prepared analogously:

- 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-ethylcyclohexyl)cyclohexyl]ethane
- 30 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]ethane
- 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]ethane, C 44° S₀ 108° N 139° I
- 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]ethane
- 35 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-heptylcyclohexyl)cyclohexyl]ethane

Example 7

15.5 g of 1-bromo-4-(trans-4-pentylcyclohexyl)-

benzene in 50 ml of THF are added to a boiling mixture of 1.2 g of magnesium and 25 ml of THF. When the addition is complete, the mixture is heated for a further 1 hour, cooled and added to a solution of 6.7 g of ZnBr₂ in 50 ml of THF at 0°-15°. After stirring for 1 hour, 12.3 g of 1-bromo-4-(trifluoromethoxy)benzene and 0.75 g of PdCl₂(dppf) are added. The mixture is stirred at 5° for 15 minutes and then at room temperature for 24 hours. The mixture is poured onto 100 ml of saturated NH₄Cl solution, and the organic phase is separated off and extracted with toluene. After work-up of the organic phase and purification by chromatography and/or crystallisation, trifluoro-methoxy-4-[4-(trans-4-pentylcyclohexyl)phenyl]benzene, C 43° S, 128° N 147.4° I is obtained.

The following are prepared analogously:

- Trifluoromethoxy-4-[4-(trans-4-ethylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-propylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-butylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-hexylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-heptylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-octylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-nonylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-4-[4-(trans-4-decylcyclohexyl)phenyl]-benzene
- Trifluoromethoxy-2-fluoro-4-[4-(trans-4-ethylcyclohexyl)phenyl]benzene
- Trifluoromethoxy-2-fluoro-4-[4-(trans-4-propylcyclohexyl)phenyl]benzene
- Trifluoromethoxy-2-fluoro-4-[4-(trans-4-butylcyclohexyl)phenyl]benzene
- Trifluoromethoxy-2-fluoro-4-[4-(trans-4-pentylcyclo-

- hexyl)phenyl]benzene
Trifluoromethoxy-2-fluoro-4-[4-(trans-4-hexylcyclohexyl)-
phenyl]benzene
Trifluoromethoxy-2-fluoro-4-[4-(trans-4-heptylcyclo-
5 hexyl)phenyl]benzene
Trifluoromethoxy-2-fluoro-4-[4-(trans-4-octylcyclohexyl)-
phenyl]benzene
Trifluoromethoxy-2-fluoro-4-[4-(trans-4-nonylcyclohexyl)-
phenyl]benzene
10 Trifluoromethoxy-2-fluoro-4-[4-(trans-4-decylcyclohexyl)-
phenyl]benzene

Example 8

- Analogously to Example 7, from 4-bromo-4'-pentyl-
biphenyl and trifluoromethoxy-4-bromobenzene, the cor-
15 responding trifluoromethoxy-4-(4'-pentylbiphenyl-4-yl)-
benzene is obtained.

The following are prepared analogously:

- Trifluoromethoxy-4-(4'-ethylbiphenyl-4-yl)benzene
Trifluoromethoxy-4-(4'-propylbiphenyl-4-yl)benzene
20 Trifluoromethoxy-4-(4'-butylbiphenyl-4-yl)benzene
Trifluoromethoxy-4-(4'-hexylbiphenyl-4-yl)benzene
Trifluoromethoxy-4-(4'-heptylbiphenyl-4-yl)benzene
Trifluoromethoxy-4-(4'-octylbiphenyl-4-yl)benzene
Trifluoromethoxy-2-fluoro-4-(4'-ethylbiphenyl-4-yl)-
25 benzene
Trifluoromethoxy-2-fluoro-4-(4'-propylbiphenyl-4-yl)-
benzene
Trifluoromethoxy-2-fluoro-4-(4'-butylbiphenyl-4-yl)-
benzene
30 Trifluoromethoxy-2-fluoro-4-(4'-pentylbiphenyl-4-yl)-
benzene
Trifluoromethoxy-2-fluoro-4-(4'-hexylbiphenyl-4-yl)-
benzene
Trifluoromethoxy-2-fluoro-4-(4'-heptylbiphenyl-4-yl)-
35 benzene
Trifluoromethoxy-2-fluoro-4-(4'-octylbiphenyl-4-yl)-
benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-ethoxybiphenyl-4-
yl)-benzene

- Trifluoromethoxy-4-(2',3'-difluoro-4'-propoxybiphenyl-4-yl)-benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-butoxybiphenyl-4-yl)-benzene
5 Trifluoromethoxy-4-(2',3'-difluoro-4'-pentyloxybiphenyl-4-yl)-benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-hexyloxybiphenyl-4-yl)-benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-ethylbiphenyl-4-yl)-benzene
10 Trifluoromethoxy-4-(2',3'-difluoro-4'-propylbiphenyl-4-yl)-benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-butylbiphenyl-4-yl)-benzene
15 Trifluoromethoxy-4-(2',3'-difluoro-4'-pentylbiphenyl-4-yl)-benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-hexylbiphenyl-4-yl)-benzene
Trifluoromethoxy-4-(2',3'-difluoro-4'-heptylbiphenyl-4-yl)-benzene
20

Example 9

37 ml of butyllithium (15 % in hexane) are added at -75° to a mixture of 12 g of 2-ethoxy-5-bromopyridine and 50 ml of THF, and the mixture is stirred for a
25 further 1 hour. 7.5 g of ZnBr₂ in 25 ml of THF are subsequently added at -70° to -65°, and the mixture is again stirred for 1 hour. 14.5 g of trifluoromethoxy-4-bromobenzene in 25 ml of THF and 1 g of PdCl₂ (dppf) are then added. The temperature is allowed to rise to room temperature, and the mixture is then stirred for 16 hours.
30 Work-up is effected analogously to Example 7, and 2-ethoxy-5-(4-trifluoromethoxyphenyl)pyridine having C 36° S_A ((33°)) I is obtained after purification by chromatography and/or crystallisation.

- 35 The following are prepared analogously:
2-Methoxy-5-(4-trifluoromethoxyphenyl)pyridine
2-Propoxy-5-(4-trifluoromethoxyphenyl)pyridine
2-Butoxy-5-(4-trifluoromethoxyphenyl)pyridine
2-Pentyloxy-5-(4-trifluoromethoxyphenyl)pyridine

2-Hexyloxy-5-(4-trifluoromethoxyphenyl)pyridine
2-Heptyloxy-5-(4-trifluoromethoxyphenyl)pyridine
2-Octyloxy-5-(4-trifluoromethoxyphenyl)pyridine
2-Methyl-5-(4-trifluoromethoxyphenyl)pyridine
5 2-Ethyl-5-(4-trifluoromethoxyphenyl)pyridine
2-Propyl-5-(4-trifluoromethoxyphenyl)pyridine
2-Butyl-5-(4-trifluoromethoxyphenyl)pyridine
2-Pentyl-5-(4-trifluoromethoxyphenyl)pyridine
2-Hexyl-5-(4-trifluoromethoxyphenyl)pyridine
10 2-Heptyl-5-(4-trifluoromethoxyphenyl)pyridine
2-Octyl-5-(4-trifluoromethoxyphenyl)pyridine

Example 10

Analogously to Example 9, by reacting 14.0 g of
2-(4-bromophenyl)-5-propylpyrimidine and 12.1 g of
15 trifluoromethoxy-4-bromobenzene, the corresponding 2-(4'-
trifluoromethoxybiphenyl-4-yl)-5-propylpyrimidine having
C 125° S_c 1110 S_a 218° I is obtained.

The following are prepared analogously:

2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-methylpyrimidine
20 2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-ethylpyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-butylpyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-pentylpyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-hexylpyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-heptylpyrimidine
25 2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-octylpyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-methoxypyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-ethoxypyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-propoxypyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-butoxypyrimidine
30 2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-pentyloxypyrimid-
ine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-hexyloxypyrimidine
2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-heptyloxypyrimid-
ine
35 2-(4'-Trifluoromethoxybiphenyl-4-yl)-5-octyloxypyrimid-
ine.

Example 11

a) A mixture of 2.8 g of 4-(5-heptylpyrimidin-2-yl)-
styrene, 3.7 g of trifluoromethoxy-4-bromobenzene,

1.4 ml of triethylamine, 25 ml of acetonitrile, 50 mg of Pd(II) acetate and 125 mg of tri-*o*-tolylphosphine is refluxed for 36 hours. After cooling, the mixture is evaporated and, after purification by chromatography, 1-(4-trifluoromethoxyphenyl)-2-[4-(5-heptylpyrimidin-2-yl)phenyl]ethene having C 123° S_c 151° S_A 242° I is obtained.

b) This vinyl compound is hydrogenated at room temperature and atmospheric pressure in THF using Pd (5% on C). After work-up and purification by chromatography and/or crystallisation, 1-(4-trifluoromethoxyphenyl)-2-[4-(5-heptylpyrimidin-2-yl)phenyl]ethane having C 63° S_c 98° S_A 144° I is obtained.

The following are prepared analogously:

15 1-(4-Trifluoromethoxyphenyl)-2-[4-(5-ethylpyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-propylpyrimidin-2-yl)phenyl]ethane

20 1-(4-Trifluoromethoxyphenyl)-2-[4-(5-butylpyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-pentylpyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-hexylpyrimidin-2-yl)phenyl]ethane

25 1-(4-Trifluoromethoxyphenyl)-2-[4-(5-octylpyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-ethoxypyrimidin-2-yl)phenyl]ethane

30 1-(4-Trifluoromethoxyphenyl)-2-[4-(5-propoxypyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-butoxypyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-pentyloxypyrimidin-2-yl)phenyl]ethane

35 1-(4-Trifluoromethoxyphenyl)-2-[4-(5-hexyloxypyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-heptyloxypyrimidin-2-yl)phenyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[4-(5-octyloxypyrimidin-2-yl)phenyl]ethane

Example 12

- 5 a) A mixture of 25.7 g of 4-(trans-4-pentylcyclohexyl)-styrene, 14.5 g of 4-(trifluoromethoxy)-iodobenzene, 100 ml of acetonitrile, 7 ml of triethylamine, 0.23 g of Pd(II) acetate and 0.6 g of tri-*o*-tolylphosphine is heated at the boiling point for 24 hours. After cooling to 0°, filtering off the precipitated substance with suction, and washing with acetonitrile and water, 1-(4-trifluoromethoxyphenyl)-2-[4-(trans-4-pentylcyclohexyl)phenyl]ethene having C 72° S_B 168° S_A 194° N 224.1° I, is obtained after purification by crystallisation from ethanol/ethyl acetate.
- 10
- 15
- b) The ethene derivative from a) is hydrogenated in THF using Pd/C at room temperature and atmospheric pressure. After work-up and purification by crystallisation, 1-(4-trifluoromethoxyphenyl)-2-[4-(trans-4-pentylcyclohexyl)phenyl]-ethane is obtained.
- 20

The following are prepared analogously:

- 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-methylcyclohexyl)phenyl]-ethane
- 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-ethylcyclohexyl)phenyl]-ethane
- 25 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-propylcyclohexyl)phenyl]-ethane
- 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-butylcyclohexyl)phenyl]-ethane
- 30 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-pentylcyclohexyl)phenyl]-ethane
- 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-hexylcyclohexyl)phenyl]-ethane
- 1-(4-Trifluoromethoxyphenyl)-2-[4-(trans-4-heptylcyclohexyl)phenyl]-ethane
- 35

Example 13

A Grignard compound is prepared from 1.2 g of magnesium, 50 ml of THF and 11.4 g of 4-pentyl-bromobenzene in 25 ml of THF. When the addition is complete, the

mixture is refluxed for a further 1 hour and cooled to 10°, and 14 g of 4-trifluoromethoxy-bromobenzene in 25 ml of THF and 0.73 g of PdCl₂ (dppf) are added. The cooling is removed, but the reaction mixture should not climb above 20°. The mixture is subsequently stirred at room temperature for 16 hours, poured into 100 ml of saturated NH₄Cl solution and stirred for a further 15 minutes, and the organic phase is then worked up. After purification by crystallisation, trifluoromethoxy-4-(4-pentylphenyl)-benzene having C 67° I is obtained.

The following are prepared analogously:

Trifluoromethoxy-4-(4-methylphenyl)benzene
Trifluoromethoxy-4-(4-ethylphenyl)benzene
Trifluoromethoxy-4-(4-propylphenyl)benzene
15 Trifluoromethoxy-4-(4-butylphenyl)benzene
Trifluoromethoxy-4-(4-hexylphenyl)benzene
Trifluoromethoxy-4-(4-heptylphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-methylphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-ethylphenyl)benzene
20 Trifluoromethoxy-4-(2,3-difluoro-4-propylphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-butylphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-pentylphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-ethoxyphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-methoxyphenyl)benzene
25 Trifluoromethoxy-4-(2,3-difluoro-4-propoxyphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-butoxyphenyl)benzene
Trifluoromethoxy-4-(2,3-difluoro-4-pentyloxyphenyl)benzene

Example 14

30 By reacting 7.5 g of 4-ethoxystyrene with 14.4 g of 4-trifluoromethoxyiodobenzene, 6.9 ml of triethylamine, 0.23 g of Pd(II) acetate and 0.6 g of tri-o-tolylphosphine in 75 ml of acetonitrile, 1-(4-trifluoromethoxyphenyl)-2-(4-ethoxyphenyl)-ethene is obtained analogously to Example 12a).

The following are prepared analogously:

1-(4-Trifluoromethoxyphenyl)-2-(4-methoxyphenyl)-ethene
1-(4-Trifluoromethoxyphenyl)-2-(4-propoxyphenyl)-ethene
1-(4-Trifluoromethoxyphenyl)-2-(4-butoxyphenyl)-ethene

- 1- (4-Trifluoromethoxyphenyl) -2- (4-pentyloxyphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-hexyloxyphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-heptyloxyphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-methylphenyl) -ethene
5 1- (4-Trifluoromethoxyphenyl) -2- (4-ethylphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-propylphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-butylphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-pentylphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-hexylphenyl) -ethene
10 1- (4-Trifluoromethoxyphenyl) -2- (4-heptylphenyl) -ethene
1- (4-Trifluoromethoxyphenyl) -2- (4-octylphenyl) -ethene

Example 15

By hydrogenation of the ethene derivatives, prepared in Example 14, using Pd/C in THF, the corresponding ethane derivatives are obtained:

- 15 1- (4-Trifluoromethoxyphenyl) -2- (4-ethoxyphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-methoxyphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-propoxyphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-butoxyphenyl) -ethane
20 1- (4-Trifluoromethoxyphenyl) -2- (4-pentyloxyphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-hexyloxyphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-heptyloxyphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-methylphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-ethylphenyl) -ethane
25 1- (4-Trifluoromethoxyphenyl) -2- (4-propylphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-butylphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-pentylphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-hexylphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (4-heptylphenyl) -ethane
30 1- (4-Trifluoromethoxyphenyl) -2- (4-octylphenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (2,3-difluoro-4-ethoxy-phenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (2,3-difluoro-4-propoxy-phenyl) -ethane
35 1- (4-Trifluoromethoxyphenyl) -2- (2,3-difluoro-4-butoxy-phenyl) -ethane
1- (4-Trifluoromethoxyphenyl) -2- (2,3-difluoro-4-pentyloxy-phenyl) -ethane

1-(4-Trifluoromethoxyphenyl)-2-(2,3-difluoro-4-ethyl-phenyl)-ethane

1-(4-Trifluoromethoxyphenyl)-2-(2,3-difluoro-4-propyl-phenyl)-ethane

5 1-(4-Trifluoromethoxyphenyl)-2-(2,3-difluoro-4-butyl-phenyl)-ethane

1-(4-Trifluoromethoxyphenyl)-2-(2,3-difluoro-4-pentyl-phenyl)-ethane

Example 16

10 0.7 g of lithium and 5.7 g of ZnBr₂ are added at 0° to a mixture of 15.4 g of trans-4-pentylcyclohexyl-ethyl iodide and 100 ml of THF/toluene (1:4), and the reaction mixture is treated with ultrasound at 0-10° for 4 hours. 14.8 g of 4-trifluoromethoxybromobenzene and
15 0.88 g of PdCl₂ (dppf) are subsequently added at 5°. The mixture is allowed to warm to room temperature and is stirred for a further 16 hours. The mixture is then poured into 100 ml of saturated NH₄Cl solution, and the organic phase is worked up. After purification by chroma-
20 tography and/or crystallisation, 1-(4-trifluoromethoxy-phenyl)-2-(trans-4-pentylcyclohexyl)-ethane is obtained.

The following are prepared analogously:

1-(4-Trifluoromethoxyphenyl)-2-(trans-4-ethylcyclohexyl)-ethane

25 1-(4-Trifluoromethoxyphenyl)-2-(trans-4-propylcyclohexyl)-ethane

1-(4-Trifluoromethoxyphenyl)-2-(trans-4-butylcyclohexyl)-ethane

30 1-(4-Trifluoromethoxyphenyl)-2-(trans-4-hexylcyclohexyl)-ethane

1-(4-Trifluoromethoxyphenyl)-2-(trans-4-heptylcyclohexyl)-ethane

Example 17

35 Trifluoromethoxy-4-(trans-4-propylcyclohexyl)-benzene is obtained analogously to Example 16 from 15.4 g of trans-4-propylcyclohexyl bromide and 18.2 g of 4-trifluoromethoxybromobenzene after purification by chromatography and/or vacuum distillation.

The following are prepared analogously:

- Trifluoromethoxy-4-(trans-4-ethylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-butylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-pentylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-hexylcyclohexyl)benzene
5 Trifluoromethoxy-4-(trans-4-heptylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-octylcyclohexyl)benzene

Example 18

First, 4.6 g of dicyclohexylcarbodiimide in 80 ml of toluene are added to a mixture of 4 g of 4-trifluoromethoxyphenol and 20 ml of toluene, 0.2 g of dimethylaminopyridine is then added, the mixture is stirred at room temperature for 1 hour, and 3.8 g of trans-4-ethylcyclohexanecarboxylic acid are then added. After work-up and purification by chromatography and/or crystallisation, 4-(trifluoromethoxy)phenyl trans-4-ethylcyclohexanecarboxylate is obtained.

The following are prepared analogously:

- | | | |
|----|----------------------------|--|
| | 4-(Trifluoromethoxy)phenyl | trans-4-propylcyclohexanecarboxylate |
| 20 | 4-(Trifluoromethoxy)phenyl | trans-4-butylcyclohexanecarboxylate |
| | 4-(Trifluoromethoxy)phenyl | trans-4-pentylcyclohexanecarboxylate |
| | 4-(Trifluoromethoxy)phenyl | trans-4-hexylcyclohexanecarboxylate |
| 25 | 4-(Trifluoromethoxy)phenyl | trans-4-heptylcyclohexanecarboxylate |
| | 4-(Trifluoromethoxy)phenyl | trans-4-(trans-4-propylcyclohexyl)cyclohexanecarboxylate |
| 30 | 4-(Trifluoromethoxy)phenyl | trans-4-(trans-4-ethylcyclohexyl)cyclohexanecarboxylate |
| | 4-(Trifluoromethoxy)phenyl | trans-4-(trans-4-butylcyclohexyl)cyclohexanecarboxylate |
| | 4-(Trifluoromethoxy)phenyl | trans-4-(trans-4-pentylcyclohexyl)cyclohexanecarboxylate |
| 35 | 4-(Trifluoromethoxy)phenyl | trans-4-(trans-4-hexylcyclohexyl)cyclohexanecarboxylate |
| | 4-(Trifluoromethoxy)phenyl | trans-4-(trans-4-heptylcyclohexyl)cyclohexanecarboxylate |

The examples below concern liquid-crystalline phases according to the invention:

Example A:

A liquid-crystalline phase, comprising

5 16 % of p-trans-4-propylcyclohexylbenzonitrile,
4 % of p-trans-4-pentylcyclohexylbenzonitrile,
9 % of trifluoromethoxy-4-(5-propyl-1,3-dioxan-2-yl)-
benzene,
9 % of trifluoromethoxy-4-(5-pentyl-1,3-dioxan-2-yl)-
10 benzene,
20 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,
11 % of 4-ethyl-4'-(trans-4-propylcyclohexyl)biphenyl,
11 % of 4-ethyl-4'-(trans-4-pentylcyclohexyl)biphenyl,
4 % of 4,4'-bis-(trans-4-propylcyclohexyl)biphenyl,
15 6 % of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propyl-
cyclohexyl)biphenyl,
3 % of 4-(trans-4-propylcyclohexyl)-2'-fluoro-4'-(trans-
4-propylcyclohexyl)biphenyl,
4 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-
20 4-propylcyclohexyl)biphenyl
and
3 % of 4-(trans-4-pentylcyclohexyl)-2'-fluoro-4'-(trans-
4-pentylcyclohexyl)biphenyl,
has a melting point of -17°, a clear point of 92° and a
25 viscosity of 21 mm²/s at 20°.

Example B

A liquid-crystalline phase, comprising

8 % of p-trans-4-propylcyclohexylbenzonitrile,
12 % of trifluoromethoxy-4-(5-propyl-1,3-dioxan-2-yl)-
30 benzene,
10 % of p-trans-4-butylcyclohexylbenzonitrile,
12 % of trans-1-p-ethylphenyl-4-propylcyclohexane,
6 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,
13 % of 4-ethyl-4'-(trans-4-propylcyclohexyl)biphenyl,
35 12 % of 4-ethyl-4'-(trans-4-pentylcyclohexyl)biphenyl,
3 % of 4,4'-bis-(trans-4-propylcyclohexyl)biphenyl,
6 % of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propyl-
cyclohexyl)biphenyl,
3 % of 4,4'-bis-(trans-4-pentylcyclohexyl)biphenyl,

4 % of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)biphenyl,

7 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)biphenyl,

5 and

4 % of 4-(trans-4-pentylcyclohexyl)-2'-fluoro-4'-(trans-4-pentylcyclohexyl)biphenyl,

has a melting point of -20.8° , a clear point of 108° and a viscosity of $25 \text{ mm}^2/\text{s}$ at 20° .

10 Example C:

A liquid-crystalline phase, comprising

7 % of 2-p-cyanophenyl-5-propyl-1,3-dioxane,

6 % of 2-p-cyanophenyl-5-butyl-1,3-dioxane,

4 % of 2-p-cyanophenyl-5-pentyl-1,3-dioxane,

15 9 % of trifluoromethoxy-4-(5-propyl-1,3-dioxan-2-yl)-benzene

9 % of trifluoromethoxy-4-(5-pentyl-1,3-dioxan-2-yl)-benzene,

12 % of 4-ethyl-4'-(trans-4-propylcyclohexyl)biphenyl,

20 10 % of 4-ethyl-4'-(trans-4-pentylcyclohexyl)biphenyl,

5 % of 2-p-pentyloxyphenyl-5-hexylpyrimidine,

5 % of 2-p-hexyloxyphenyl-5-hexylpyrimidine,

5 % of 2-p-heptyloxyphenyl-5-hexylpyrimidine,

4 % of 2-p-propoxyphenyl-5-hexylpyrimidine,

25 4 % of 2-p-heptyloxyphenyl-5-heptylpyrimidine,

4 % of 2-p-nonyloxyphenyl-5-heptylpyrimidine,

7 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)biphenyl,

and

30 9 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,

has C -17° Sm 30° N 70° I.

Example D

A liquid-crystalline phase comprising

20 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-ethane,

35

20 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-ethane,

20 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,

20 % of trans-1-p-ethoxyphenyl-4-propylcyclohexane
and

20 % of trans-1-p-butoxyphenyl-4-propylcyclohexane
has a melting point of -6.2° , a clear point of 64° and a
viscosity of $12 \text{ mm}^2/\text{s}$ at 20° .

Example E:

A liquid-crystalline phase comprising
20 % of p-trans-4-propylcyclohexyl-benzonitrile,
20 % of trans-1-p-propylphenyl-4-pentylcyclohexane,
15 % of trans-1-p-ethoxyphenyl-4-propylcyclohexane,
15 % of trans-1-p-butoxyphenyl-4-propylcyclohexane,
15 % of 4-trifluoromethoxy-4'-(trans-4-propylcyclohexyl)-
biphenyl

and

15 % of 4-trifluoromethoxy-4'-(trans-4-pentylcyclohexyl)-
biphenyl

has a clear point of 62° , a viscosity of $12 \text{ mm}^2/\text{s}$ at 20°
and $\Delta n = +0.12$.

Example F

A liquid-crystalline phase comprising
10 % of p-trans-4-propylcyclohexyl-benzonitrile,
10 % of 2-p-cyanophenyl-5-propyl-1,3-dioxane,
10 % of 4-propyl-4'-cyanobiphenyl,
10 % of p-cyanophenyl 4-propylbenzoate,
10 % of 3-fluoro-4-cyanophenyl 4-propylbenzoate,
10 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,
10 % of trans-1-p-ethoxyphenyl-4-propylcyclohexane,
15 % of 4-ethyl-1-trans-4-(trans-4-propylcyclohexyl)-
cyclohexyl-benzene

and

15 % of 4-trifluoromethoxy-1-trans-4-(trans-4-propyl-
cyclohexyl)cyclohexyl-benzene

has a clear point of 66° , a viscosity of $22 \text{ mm}^2/\text{s}$ and Δn
 $= +0.14$.

Example G

A liquid-crystalline phase comprising
7 % of 2-p-cyanophenyl-5-propyl-1,3-dioxane,
6 % of 2-p-cyanophenyl-5-butyl-1,3-dioxane,
4 % of 2-p-cyanophenyl-5-pentyl-1,3-dioxane,

9 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-ethane,

9 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-ethane,

5 12 % of 4-ethyl-4'-(trans-4-propylcyclohexyl)-biphenyl,

10 % of 4-ethyl-4'-(trans-4-pentylcyclohexyl)-biphenyl,

5 % of 2-p-pentyloxyphenyl-5-hexylpyrimidine,

5 % of 2-p-hexyloxyphenyl-5-hexylpyrimidine,

5 % of 2-p-heptyloxyphenyl-5-hexylpyrimidine,

10 4 % of 2-p-propoxyphenyl-5-hexylpyrimidine,

4 % of 2-p-heptyloxyphenyl-5-heptylpyrimidine,

4 % of 2-p-nonyloxyphenyl-5-heptylpyrimidine,

7 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl

15 and

9 % of trans-1-p-methoxyphenyl-4-propylcyclohexane
has a melting point of -17° , a clear point of 99° and a
viscosity of $32 \text{ mm}^2/\text{s}$ at 20° .

Example H

20 A liquid-crystalline phase comprising

8 % of p-trans-4-propylcyclohexyl-benzonitrile,

12 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-ethane,

10 % of p-trans-4-butylcyclohexyl-benzonitrile,

25 12 % of trans-1-p-ethylphenyl-4-propylcyclohexane,

6 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,

13 % of 4-ethyl-4'-(trans-4-propylcyclohexyl)-biphenyl,

12 % of 4-ethyl-4'-(trans-4-pentylcyclohexyl)-biphenyl,

3 % of 4,4'-bis-(trans-4-propylcyclohexyl)-biphenyl,

30 6 % of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl,

3 % of 4,4'-bis-(trans-4-pentylcyclohexyl)-biphenyl,

4 % of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl,

35 7 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl

and

4 % of 4-(trans-4-pentylcyclohexyl)-2'-fluoro-4'-(trans-4-pentylcyclohexyl)-biphenyl

has a melting point of -21° , a clear point of 123° and a viscosity of $27 \text{ mm}^2/\text{s}$ at 20° .

Example I

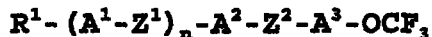
A liquid-crystalline phase comprising

- 5 16 % of p-trans-4-propylcyclohexyl-benzonitrile,
4 % of p-trans-4-pentylcyclohexyl-benzonitrile,
9 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-ethane,
9 % of 1-(4-trifluoromethoxyphenyl)-2-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-ethane,
10 20 % of trans-1-p-methoxyphenyl-4-propylcyclohexane,
11 % of 4-ethyl-4'-(trans-4-propylcyclohexyl)-biphenyl,
11 % of 4-ethyl-4'-(trans-4-pentylcyclohexyl)-biphenyl,
4 % of 4,4'-bis-(trans-4-propylcyclohexyl)-biphenyl,
15 6 % of 4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl,
3 % of 4-(trans-4-propylcyclohexyl)-2'-fluoro-4'-(trans-4-propylcyclohexyl)-biphenyl,
4 % of 2-fluoro-4-(trans-4-pentylcyclohexyl)-4'-(trans-4-propylcyclohexyl)-biphenyl
20 and
3 % of 4-(trans-4-pentylcyclohexyl)-2'-fluoro-4'-(trans-4-pentylcyclohexyl)-biphenyl
has a melting point of -15° , a clear point of 120° and a
25 viscosity of $23 \text{ mm}^2/\text{s}$ at 20° .



Patent Claim [sic]

1. Substituted phenyl trifluoromethyl ethers of the formula I



I

5 in which

10 R^1 is H or alkyl having 1-18 C atoms in which one or more CH_2 groups may also be replaced by -E-, -O-, -S- and/or -CO-, where two heteroatoms are not linked directly to one another, or perfluoroalkyl having 1-18 C atoms in which one or more CF_2 groups may also be replaced by - CH_2 -, -E-, -O-, -S- and/or -CO-, where two heteroatoms are not linked directly to one another,

15 E is $CH=CH$, $CH=CH$, $C\equiv C$, CHY , $CH-CH$ or $CH-CH$,

X is Y, CH_2 or H,

Y is CN, NCS, NCO or halogen,

20 A^1 and A^2 , independently of one another, are each 1,4-cyclohexylene, in which one or two non-adjacent CH_2 groups may also be replaced by -O- and/or S atoms, 1,4-cyclohexenylene, 1,4-bicyclo-(2.2.2)octylene, piperidine-1,4-diyl or 1,4-phenylene, in which one or more CH groups may be replaced by N, which is unsubstituted or monosubstituted or polysubstituted by halogen atoms
25 and/or CN and/or CH_2 groups,

Z^1 is -O-CO-, - CH_2O -, - OCH_2 -, - CH_2CH_2 -, -CH=CH- or a single bond,

30 Z^2 is -CO-O-, - CH_2O -, - OCH_2 -, - CH_2CH_2 -, -CH=CH- or a single bond,

A^3 is a 1,4-phenylene group which is unsubstituted



or monosubstituted or polysubstituted by halogen atoms and/or CN and/or CH₃ groups,

and

n is 0, 1 or 2,

5 with the provisos that

a) Z² is -CH₂O-, -OCH₂-, -CH₂CH₂-, -CH=CH- or a single bond in the case where n = 0 or 1, R¹ = alkoxy and A¹ = A² = A³ = unsubstituted 1,4-phenylene, and

10 b) 4-phenyltrifluoromethoxybenzene is excepted.

2. Phenyl trifluoromethyl ethers according to Claim 1, selected from the sub-formulae Ia and Ib:



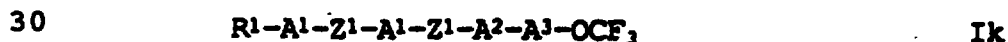
15 in which R¹, A², A³ and Z² are as defined in Claim 1.

3. Phenyl trifluoromethyl ethers according to Claim 1, selected from the sub-formulae Ic to If:



in which R¹, A¹, A², A³, Z¹ and Z² are as defined in Claim 1.

4. Phenyl trifluoromethyl ethers according to Claim 25 1, selected from the sub-formulae Ig to In:





$R^1-A^1-Z^1-A^1-A^2-Z^2-A^3-OCF_3$ Il

$R^1-A^1-A^1-Z^1-A^2-Z^2-A^3-OCF_3$ Im

$R^1-A^1-Z^1-A^1-Z^1-A^2-Z^2-A^3-OCF_3$ In

5 in which R^1 , A^1 , A^2 , A^3 , Z^1 and Z^2 are as defined in Claim 1.

5. Phenyl trifluoromethyl ethers according to Claim 2, selected from the sub-formulae Iaa to Iaf:

	$R^1-Phe-Phe-OCF_3$	Iaa
	$R^1-Dio-Phe-OCF_3$	Iab
10	$R^1-Pyr-Phe-OCF_3$	Iac
	$R^1-Pyd-Phe-OCF_3$	Iad
	$R^1-Cyc-Phe-OCF_3$	Iae
	$R^1-Che-Phe-OCF_3$	Iaf

in which

15 R^1 is as defined in Claim 1,

Phe is a 1,4-phenylene group which is unsubstituted or substituted by one or more halogen atoms and/or CH_3 groups and/or CN groups,

Dio is a 1,3-dioxane-2,5-diyl group,

20 Pyr is a pyrimidine-2,5-diyl group,

Pyd is a pyridine-2,5-diyl group,

Cyc is a 1,4-cyclohexylene group which is unsubstituted or substituted by one or more halogen atoms and/or CH_3 groups and/or CN groups, and

25 Che is a 1,4-cyclohexenylene group.

6. Phenyl trifluoromethyl ethers according to Claim 3, selected from the sub-formulae Ica to Ici:



- 4 -

	R ¹ -Phe-Phe-Phe-OCF ₃	Ica
	R ¹ -Phe-Dio-Phe-OCF ₃	Icb
	R ¹ -Cyc-Cyc-Phe-OCF ₃	Icc
	R ¹ -Pyd-Phe-Phe-OCF ₃	Icd
	R ¹ -Pyr-Phe-Phe-OCF ₃	Ice
5	R ¹ -Cyc-Phe-Phe-OCF ₃	Icf
	R ¹ -Dio-Phe-Phe-OCF ₃	Icg
	R ¹ -Che-Phe-Phe-OCF ₃	Ich
	R ¹ -Phe-Che-Phe-OCF ₃	Ici

in which R¹ is as defined in Claim 1, and Phe, Dio, Cycl, Pyd, Pyr and Che are as defined in Claim 5.

- 10 7. Phenyl trifluoromethyl ethers according to Claim 3, selected from the sub-formulae Iea to Iei:

	R ¹ -Pyr-Z ¹ -Phe-Phe-OCF ₃	Iea
	R ¹ -Dio-Z ¹ -Phe-Phe-OCF ₃	Ieb
	R ¹ -Cyc-Z ¹ -Phe-Phe-OCF ₃	Iec
	R ¹ -Phe-Z ¹ -Cyc-Phe-OCF ₃	Ied
15	R ¹ -Cyc-Z ¹ -Cyc-Phe-OCF ₃	Iee
	R ¹ -Phe-Z ¹ -Dio-Phe-OCF ₃	Ief
	R ¹ -Pyd-Z ¹ -Phe-Phe-OCF ₃	Ieg
	R ¹ -Phe-Z ¹ -Pyr-Phe-OCF ₃	Ieh
20	R ¹ -Phe-Z ¹ -Che-Phe-OCF ₃	Iei

in which R¹ and Z¹ are as defined in Claim 1, and Phe, Dio, Cyc, Pyr and Che are as defined in Claim 5.

8. Phenyl trifluoromethyl ethers according to Claim 3, selected from the sub-formulae Ifa to Ifm:

	R ¹ -Pyr-Phe-Z ² -Phe-OCF ₃	Ifa
25	R ¹ -Pyr-Phe-OCH ₂ -Phe-OCF ₃	Ifb
	R ¹ -Phe-Phe-Z ² -Phe-OCF ₃	Ifc
	R ¹ -Cyc-Cyc-Z ² -Phe-OCF ₃	Ifd
	R ¹ -Cyc-Cyc-CH ₂ CH ₂ -Phe-OCF ₃	Ife
30	R ¹ -Pyd-Phe-Z ² -Phe-OCF ₃	Iff
	R ¹ -Dio-Phe-Z ² -Phe-OCF ₃	Ifg
	R ¹ -Phe-Cyc-Z ² -Phe-OCF ₃	Ifh



$R^1\text{-Phe-Pyd-Z}^2\text{-Phe-OCF}_3$	Ifi
$R^1\text{-Che-Phe-Z}^2\text{-Phe-OCF}_3$	Ifj
$R^1\text{-Phe-Che-Z}^2\text{-Phe-OCF}_3$	Ifk
$R^1\text{-Pyr-Phe-CH}_2\text{CH}_2\text{-Phe-OCF}_3$	If1
$R^1\text{-Cyc-Phe-CH}_2\text{CH}_2\text{-Phe-OCF}_3$	Ifm

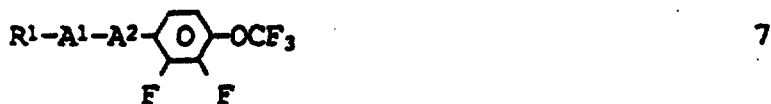
5 in which R^1 and Z^1 are as defined in Claim 1, and Phe, Dio, Cyc, Pyd, Pyr and Che are as defined in Claim 5.

9. Phenyl trifluoromethyl ethers according to one of Claims 1 to 4, characterised in that A^3 is a 1,4-phenylene group which is unsubstituted or substituted by one or two F atoms.

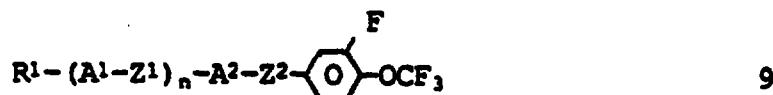
10 10. Phenyl trifluoromethyl ethers according to Claim 9, selected from the formulae 1 to 13:

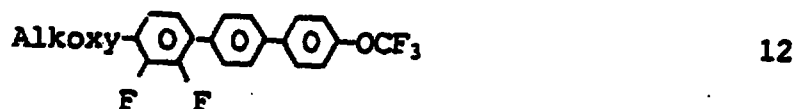
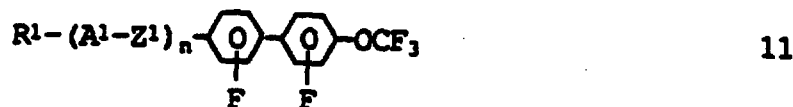
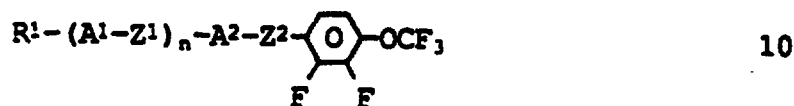


15



20





5

11. Trifluoromethyl phenyl ethers according to Claim 5, selected from:

- Trifluoromethoxy-4-(trans-ethylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-propylcyclohexyl)benzene
10 Trifluoromethoxy-4-(trans-4-butylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-pentylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-hexylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-heptylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-octylcyclohexyl)benzene
15 Trifluoromethoxy-4-(trans-4-nonylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-decylcyclohexyl)benzene

12. Trifluoromethyl phenyl ethers according to Claim 6, selected from

- Trifluoromethoxy-4-[trans-4-(trans-4-propylcyclohexyl)-
20 cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-ethylcyclohexyl)-
cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-butylcyclohexyl)-
cyclohexyl]benzene
25 Trifluoromethoxy-4-[trans-4-(trans-4-pentylcyclohexyl)-
cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-hexylcyclohexyl)-
cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-heptylcyclohexyl)-
30 cyclohexyl]benzene



Trifluoromethoxy-4-[trans-4-(trans-4-octylcyclohexyl)-cyclohexyl]benzene

Trifluoromethoxy-4-[trans-4-(trans-4-nonylcyclohexyl)-cyclohexyl]benzene

5 Trifluoromethoxy-4-[trans-4-(trans-4-decylcyclohexyl)-cyclohexyl]benzene

13. Trifluoromethyl phenyl ethers according to Claim 8, selected from:

10 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propyl-cyclohexyl)cyclohexyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-ethyl-cyclohexyl)cyclohexyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-butyl-cyclohexyl)cyclohexyl]ethane

15 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-pentyl-cyclohexyl)cyclohexyl]ethane

1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-hexyl-cyclohexyl)cyclohexyl]ethane

20 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-heptyl-cyclohexyl)cyclohexyl]ethane

14. Use of the compounds of the formula I according to Claim 1 as components of liquid-crystalline phases.

15. Liquid-crystalline phase containing at least two liquid-crystalline components, characterised in that it
25 contains at least one compound of the formula I according to Claim 1.

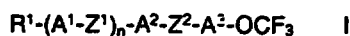
16. Liquid-crystal display element, characterised in that it contains a liquid-crystalline phase according to Claim 15.

30 17. Electrooptical display element, characterised in that it contains, as dielectric, a liquid-crystalline phase according to Claim 15.



Claims [as printed]

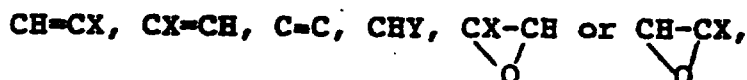
1. Substituted phenyl trifluoromethyl ethers of the formula I



in which

R^1 is H or alkyl having 1-18 C atoms in which one or more CH_2 groups may also be replaced by -E-, -O-, -S- and/or -CO-, where two heteroatoms are not linked directly to one another, or perfluoroalkyl having 1-18 C atoms in which one or more CF_2 groups may also be replaced by - CH_2 -, -E-, -O-, -S- and/or -CO-, where two heteroatoms are not linked directly to one another,

E is



X is Y, CH_3 or H,
Y is CN, NCS, NCO or halogen,

A^1 and A^2 , independently of one another, are each 1,4-cyclohexylene, in which one or two non-adjacent CH_2 groups may also be replaced by -O- and/or S atoms, 1,4-cyclohexenylene, 1,4-bicyclo(2.2.2)octylene, piperidine-1,4-diyl or 1,4-phenylene, in which one or more CH groups may be replaced by N, which is unsubstituted or monosubstituted or Polysubstituted by halogen atoms and/or CN and/or CH_3 groups,

Z^1 is -O-CO-, $-CH_2O$ -, $-OCH_2$ -, $-CH_2CH_2$ -, $-CH=CH$ - or a single bond,

Z^2 is -CO-O-, $-CH_2O$ -, $-OCH_2$ -, $-CH_2CH_2$ -, $-CH=CH$ - or a single bond,

A^3 is a 1,4-phenylene group which is unsubstituted or monosubstituted or polysubstituted by halogen atoms and/or CN and/or CH_3 groups,
and

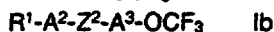
n is 0, 1 or 2,

with the provisos that

a) Z^2 is $-CH_2O$ -, $-OCH_2$ -, $-CH_2CH_2$ -, $-CH=CH$ - or a single bond in the case where $n = 0$ or 1, R^1 = alkoxy and $A^1 = A^2 = A^3$ = unsubstituted 1,4-phenylene, and

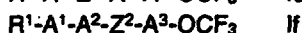
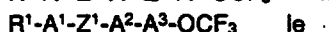
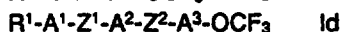
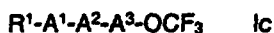
b) 4-phenyltrifluoromethoxybenzene is excepted.

2. Phenyl trifluoromethyl ethers according to Claim 1, selected from the sub-formulae Ia and Ib:



in which R^1 , A^2 , A^3 and Z^2 are as defined in Claim 1.

3. Phenyl trifluoromethyl ethers according to Claim 1, selected from the sub-formulae Ic to If:



in which R^1 , A^1 , A^2 , A^3 , Z^1 and Z^2 are as defined in Claim 1.



4. Phenyl trifluoromethyl ethers according to Claim 1, selected from the sub-formulae Ig to In:

$R^1-A^1-A^1-A^2-A^3-OCF_3$	Ig
$R^1-A^1-Z^1-A^1-A^2-A^3-OCF_3$	Ih
$R^1-A^1-A^1-Z^1-A^2-A^3-OCF_3$	Ii
$R^1-A^1-A^1-A^2-Z^2-A^3-OCF_3$	Ij
$R^1-A^1-Z^1-A^1-Z^1-A^2-A^3-OCF_3$	Ik
$R^1-A^1-Z^1-A^1-A^2-Z^2-A^3-OCF_3$	Il
$R^1-A^1-A^1-Z^1-A^2-Z^2-A^3-OCF_3$	Im
$R^1-A^1-Z^1-A^1-Z^1-A^2-Z^2-A^3-OCF_3$	In

in which R^1 , A^1 , A^2 , A^3 , Z^1 and Z^2 are as defined in Claim 1.

5. Phenyl trifluoromethyl ethers according to Claim 2, selected from the sub-formulae Iaa to Iaf:

$R^1-Phe-Phe-OCF_3$	Iaa
$R^1-Dio-Phe-OCF_3$	Iab
$R^1-Pyr-Phe-OCF_3$	Iac
$R^1-Pyd-Phe-OCF_3$	Iad
$R^1-Cyc-Phe-OCF_3$	Iae
$R^1-Che-Phe-OCF_3$	Iaf

in which

R^1	is as defined in Claim 1,
Phe	is a 1,4-phenylene group which is unsubstituted or substituted by one or more halogen atoms and/or CH_3 groups and/or CN groups,
Dio	is a 1,3-dioxane-2,5-diyl group,
Pyr	is a pyrimidine-2,5-diyl group,
Pyd	is a pyridine-2,5-diyl group,
Cyc	is a 1,4-cyclohexylene group which is unsubstituted or substituted by one or more halogen atoms and/or CH_3 groups and/or CN groups, and
Che	is a 1,4-cyclohexenylene group.

6. Phenyl trifluoromethyl ethers according to Claim 3, selected from the sub-formulae Ica to Ici

$R^1-Phe-Phe-Phe-OCF_3$	Ica
$R^1-Phe-Dio-Phe-OCF_3$	Icb
$R^1-Cyc-Cyc-Phe-OCF_3$	Icc
$R^1-Pyd-Phe-Phe-OCF_3$	Icd
$R^1-Pyr-Phe-Phe-OCF_3$	Ice
$R^1-Cyc-Phe-Phe-OCF_3$	Icf
$R^1-Dio-Phe-Phe-OCF_3$	Icg
$R^1-Che-Phe-Phe-OCF_3$	Ich
$R^1-Phe-Che-Phe-OCF_3$	Ici

in which R^1 is as defined in Claim 1, and Phe, Dio, Cyc, Pyd, Pyr and Che are as defined in Claim 5.

7. Phenyl trifluoromethyl ethers according to Claim 3, selected from the sub-formulae Iea to Iei:

$R^1-Pyr-Z^1-Phe-Phe-OCF_3$	Iea
$R^1-Dio-Z^1-Phe-Phe-OCF_3$	Ieb
$R^1-Cyc-Z^1-Phe-Phe-OCF_3$	Iec
$R^1-Phe-Z^1-Cyc-Phe-OCF_3$	Ied
$R^1-Cyc-Z^1-Cyc-Phe-OCF_3$	Iee
$R^1-Phe-Z^1-Dio-Phe-OCF_3$	Ief
$R^1-Pyd-Z^1-Phe-Phe-OCF_3$	Ieg
$R^1-Phe-Z^1-Pyr-Phe-OCF_3$	Ieh
$R^1-Phe-Z^1-Che-Phe-OCF_3$	Iei



in which R¹ and Z¹ are as defined in Claim 1, and Phe, Dio, Cyc, Pyr and Che are as defined in Claim 5.

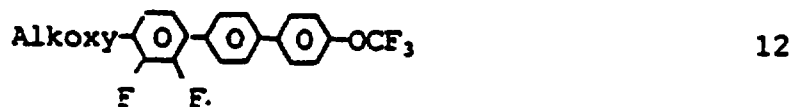
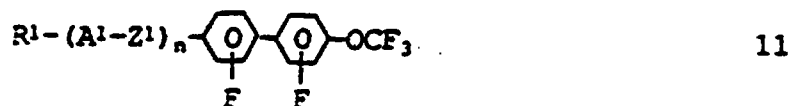
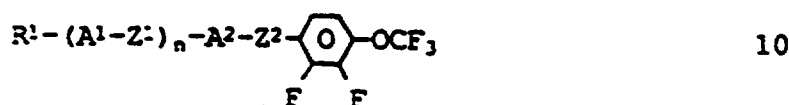
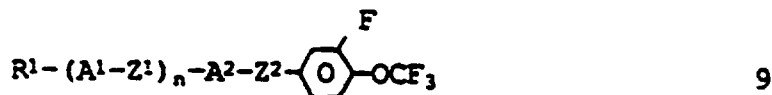
8. Phenyl trifluoromethyl ethers according to Claim 3, selected from the sub-formulae lfa to lfm:

R¹-Pyr-Phe-Z²-Phe-OCF₃ lfa
 R¹-Pyr-Phe-OCH₂-Phe-OCF₃ lfb
 R¹-Phe-Phe-Z²-Phe-OCF₃ lfc
 R¹-Cyc-Cyc-Z²-Phe-OCF₃ lfd
 R¹-Cyc-Cyc-CH₂CH₂-Phe-OCF₃ lfe
 R¹-Pyr-Phe-Z²-Phe-OCF₃ lff
 R¹-Dio-Phe-Z²-Phe-OCF₃ lfg
 R¹-Phe-Cyc-Z²-Phe-OCF₃ lfh
 R¹-Phe-Pyr-Z²-Phe-OCF₃ lfi
 R¹-Che-Phe-Z²-Phe-OCF₃ lif
 R¹-Phe-Che-Z²-Phe-OCF₃ lik
 R¹-Pyr-Phe-CH₂CH₂-Phe-OCF₃ lif
 R¹-Cyc-Phe-CH₂CH₂-Phe-OCF₃ lfm

in which R¹ and Z¹ are as defined in Claim 1, and Phe, Dio, Cyc, Pyd, Pyr and Che are as defined in Claim 5.

9. Phenyl trifluoromethyl ethers according to one of Claims 1 to 4, characterised in that A³ is a 1,4-phenylene group which is unsubstituted or substituted by one or two F atoms.
10. Phenyl trifluoromethyl ethers according to Claim 9, selected from the formulae 1 to 13:





11. Trifluoromethyl phenyl ethers according to Claim 5, selected from:

Trifluoromethoxy-4-(trans-ethylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-propylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-butylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-pentylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-hexylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-heptylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-octylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-nonylcyclohexyl)benzene
Trifluoromethoxy-4-(trans-4-decylcyclohexyl)benzene

12. Trifluoromethyl phenyl ethers according to Claim 6, selected from

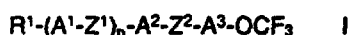
Trifluoromethoxy-4-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-ethylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-heptylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-octylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-nonylcyclohexyl)cyclohexyl]benzene
Trifluoromethoxy-4-[trans-4-(trans-4-decylcyclohexyl)cyclohexyl]benzene



13. Trifluoromethyl phenyl ethers according to Claim 8, selected from:
- 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]ethane
 - 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-ethylcyclohexyl)cyclohexyl]ethane
 - 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]ethane
 - 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]ethane
 - 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]ethane
 - 1-(4-Trifluoromethoxyphenyl)-2-[trans-4-(trans-4-heptylcyclohexyl)cyclohexyl]ethane
14. Use of the compounds of the formula I according to Claim 1 as components of liquid-crystalline phases.
15. Liquid-crystalline phase containing at least two liquid-crystalline components, characterised in that it contains at least one compound of the formula I according to Claim 1.
16. Liquid-crystal display element, characterised in that it contains a liquid-crystalline phase according to Claim 15.
17. Electrooptical display element, characterised in that it contains, as dielectric, a liquid-crystalline phase according to Claim 15.

Revendications [as printed]

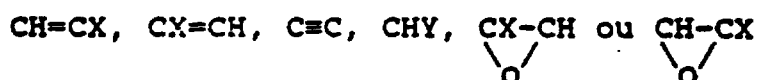
1. Phényltrifluorométhyléthers substitués de formule I



dans laquelle

R^1 représente H ou bien un groupe alkyle contenant de 1 à 18 atomes de carbone, dans lequel un ou plusieurs groupes CH_2 peuvent également être remplacés par -E-, -O-, -S- et/ou -CO-, deux hétéro-atomes n'étant pas reliés directement l'un à l'autre, ou encore un groupe perfluoroalkyle contenant de 1 à 18 atomes de carbone, dans lequel un ou plusieurs groupes CF_2 peuvent également être remplacés par $-CH_2-$, -E-, -O-, -S- et/ou -CO-, deux hétéro-atomes n'étant pas reliés directement l'un à l'autre,

E représente



X représente Y, CH_3 , H,

Y représente CN, NCS, NCO, un atome d'halogène,

A^1 et A^2 représentent chacun, indépendamment l'un de l'autre, un groupe 1,4-phénylène non substitué ou substitué une ou plusieurs fois par des atomes d'halogène et/ou par des groupes CN et/ou CH_3 , un ou plusieurs groupes CH pouvant également être remplacés par N, un groupe 1,4-cyclohexylène dans lequel un ou deux groupes CH_2 non voisins peuvent également être remplacés par des atomes -O- et/ou S, un groupe 1,4-cyclohexénylène, un groupe 1,4-bicyclo(2.2.2)octylène ou un groupe pipéridine-1,4-diyle,

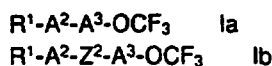


- Z¹ représente -O-CO-, -CH₂O-, -OCH₂-, -CH₂CH₂-, -CH=CH- ou une liaison simple,
Z² représente -CO-O-, -CH₂O-, -OCH₂-, -CH₂CH₂-, -CH=CH- ou une liaison simple,
A³ représente un groupe 1,4-phénylène non substitué ou substitué une ou plusieurs fois par des atomes d'halogène et/ou par des groupes CN et/ou CH₃, et
n est égal à 0, 1 ou 2,

avec les mesures que :

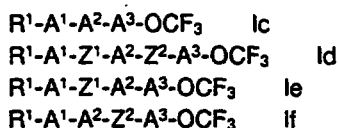
- a) au cas où n est égal à 0 ou 1, R¹ = un groupe alcoxy et A¹ = A² = A³ = un groupe 1,4-phénylène non substitué, Z² représente -CH₂O-, -OCH₂-, -CH₂CH₂-, -CH=CH- ou une liaison simple, et
b) le groupe 4-phényltrifluorométhoxybenzène est exclus.

2. Phényltrifluorométhyléthers selon la revendication 1, choisis parmi les formules partielles la et lb :



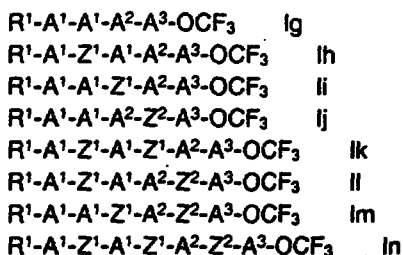
dans lesquelles R¹, A², A³ et Z² ont la signification indiquée à la revendication 1.

3. Phényltrifluorométhyléthers selon la revendication 1, choisis parmi les formules partielles lc à lf :



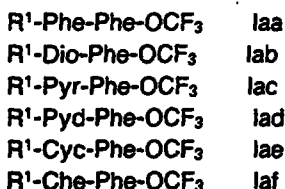
dans lesquelles R¹, A¹, A², A³, Z¹ et Z² ont la signification indiquée à la revendication 1.

4. Phényltrifluorométhyléthers selon la revendication 1, choisis parmi les formules partielles lg à ln :



dans lesquelles R¹, A¹, A², A³, Z¹ et Z² ont la signification indiquée à la revendication 1.

5. Phényltrifluorométhyléthers selon la revendication 2, choisis parmi les formules partielles laa à laf :



- R¹ a la signification indiquée dans la revendication 1,
Phe désigne un groupe 1,4-phénylène non substitué ou substitué par un ou plusieurs atomes d'halogène et/ou par des groupes CH₃ et/ou par des groupes CN,
Dio désigne un groupe 1,3-dioxanne-2,5-diyle,
Pyr désigne un groupe pyrimidine-2,5-diyle,
Pyd désigne un groupe pyridine-2,5-diyle,
Cyc désigne un groupe 1,4-cyclohexylène non substitué ou substitué par un ou plusieurs atomes d'halogène et/ou par des groupes CH₃ et/ou par des groupes CN,
Che désigne un groupe 1,4-cyclohexénylène.



6. Phényltrifluorométhyléthers selon la revendication 3, choisis parmi les formules partielles lca à lci :

R ¹ -Phe-Phe-Phe-OCF ₃	lca
R ¹ -Phe-Dio-Phe-OCF ₃	lcb
R ¹ -Cyc-Cyc-Phe-OCF ₃	lcc
R ¹ -Pyd-Phe-Phe-OCF ₃	lcd
R ¹ -Pyr-Phe-Phe-OCF ₃	lce
R ¹ -Cyc-Phe-Phe-OCF ₃	lcf
R ¹ -Dio-Phe-Phe-OCF ₃	lcg
R ¹ -Che-Phe-Phe-OCF ₃	lch
R ¹ -Phe-Che-Phe-OCF ₃	lci

dans lesquelles R¹ a la signification indiquée à la revendication 1 et Phe, Dio, Cyc, Pyd, Pyr et Che ont la signification indiquée à la revendication 5.

7. Phényltrifluorométhyléthers selon la revendication 3, choisis parmi les formules partielles lea à lei :

R ¹ -Pyr-Z ¹ -Phe-Phe-OCF ₃	lea
R ¹ -Dio-Z ¹ -Phe-Phe-OCF ₃	leb
R ¹ -Cyc-Z ¹ -Phe-Phe-OCF ₃	lec
R ¹ -Phe-Z ¹ -Cyc-Phe-OCF ₃	led
R ¹ -Cyc-Z ¹ -Cyc-Phe-OCF ₃	lee
R ¹ -Phe-Z ¹ -Dio-Phe-OCF ₃	lef
R ¹ -Pyd-Z ¹ -Phe-Phe-OCF ₃	leg
R ¹ -Phe-Z ¹ -Pyr-Phe-OCF ₃	leh
R ¹ -Phe-Z ¹ -Che-Phe-OCF ₃	lei

dans lesquelles R¹ et Z¹ ont la signification indiquée à la revendication 1 et Phe, Dio, Cyc, Pyr et Che ont la signification indiquée à la revendication 5.

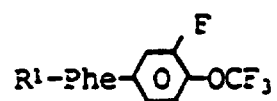
8. Phényltrifluorométhyléthers selon la revendication 3, choisis parmi les formules partielles lfa à lfm :

R ¹ -Pyr-Phe-Z ² -Phe-OCF ₃	lfa
R ¹ -Pyr-Phe-OCH ₂ -Phe-OCF ₃	lfb
R ¹ -Phe-Phe-Z ² -Phe-OCF ₃	lfc
R ¹ -Cyc-Cyc-Z ² -Phe-OCF ₃	lfd
R ¹ -Cyc-Cyc-CH ₂ CH ₂ -Phe-OCF ₃	lfe
R ¹ -Pyd-Phe-Z ² -Phe-OCF ₃	lff
R ¹ -Dio-Phe-Z ² -Phe-OCF ₃	lfg
R ¹ -Phe-Cyc-Z ² -Phe-OCF ₃	lfh
R ¹ -Phe-Pyd-Z ² -Phe-OCF ₃	lfi
R ¹ -Che-Phe-Z ² -Phe-OCF ₃	lfj
R ¹ -Phe-Che-Z ² -Phe-OCF ₃	lfk
R ¹ -Pyr-Phe-CH ₂ CH ₂ -Phe-OCF ₃	lfl
R ¹ -Cyc-Phe-CH ₂ CH ₂ -Phe-OCF ₃	lfm

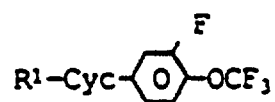
dans lesquelles R¹ et Z¹ ont la signification indiquée à la revendication 1 et Phe, Dio, Cyc, Pyd, Pyr et Che ont la signification indiquée à la revendication 5.

9. Phényltrifluorométhyléthers selon l'une quelconque des revendications 1 à 4, caractérisés en ce que A³ représente un groupe 1,4-phénylène non substitué ou substitué par un ou deux atomes de F.

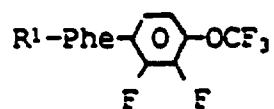
10. Phényltrifluorométhyléthers selon la revendication 9, choisis parmi les formules 1 à 13 :



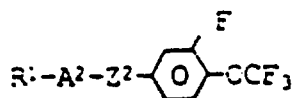
1



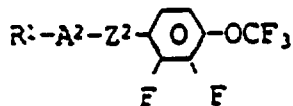
2



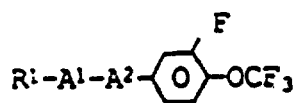
3



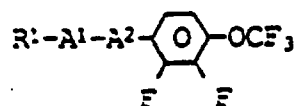
4



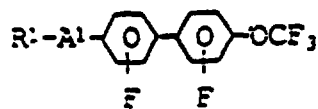
5



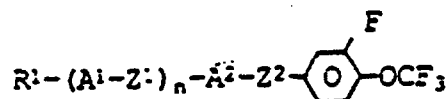
6



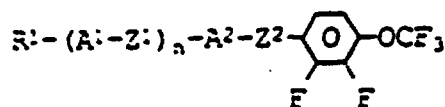
7



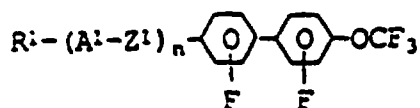
8



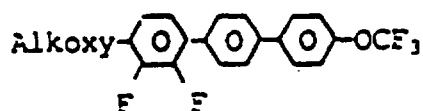
9



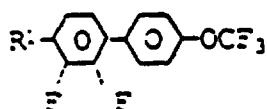
10



11



12



13

11. Phényltrifluorométhyléthers selon la revendication 5, choisis parmi :
- le trifluorométhoxy-4-(trans-4-éthylcyclohexyl)-benzène
 - le trifluorométhoxy-4-(trans-4-propylcyclohexyl)-benzène
 - le trifluorométhoxy-4-(trans-4-butylcyclohexyl)-benzène



le trifluorométhoxy-4-(trans-4-pentylcyclohexyl)-benzène
le trifluorométhoxy-4-(trans-4-hexylcyclohexyl)-benzène
le trifluorométhoxy-4-(trans-4-heptylcyclohexyl)-benzène
le trifluorométhoxy-4-(trans-4-octylcyclohexyl)-benzène
le trifluorométhoxy-4-(trans-4-nonylcyclohexyl)-benzène
le trifluorométhoxy-4-(trans-4-décylicyclohexyl)-benzène

12. Phényltrifluorométhyléthers selon la revendication 6, choisis parmi :

le trifluorométhoxy-4-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-benzène
le trifluorométhoxy-4-[trans-4-(trans-4-éthylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-heptylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-octylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-nonylcyclohexyl)cyclohexyl]-benzène
trifluorométhoxy-4-[trans-4-(trans-4-décylicyclohexyl)cyclohexyl]-benzène

13. Phényltrifluorométhyléthers selon la revendication 8, choisis parmi

le 1-(4-trifluorométhoxyphényl)-2-[trans-4-(trans-4-propylcyclohexyl)cyclohexyl]-éthane
le 1-(4-trifluorométhoxyphényl)-2-[trans-4-(trans-4-éthylcyclohexyl)cyclohexyl]-éthane
le 1-(4-trifluorométhoxyphényl)-2-[trans-4-(trans-4-butylcyclohexyl)cyclohexyl]-éthane
le 1-(4-trifluorométhoxyphényl)-2-[trans-4-(trans-4-pentylcyclohexyl)cyclohexyl]-éthane
le 1-(4-trifluorométhoxyphényl)-2-[trans-4-(trans-4-hexylcyclohexyl)cyclohexyl]-éthane
le 1-(4-trifluorométhoxyphényl)-2-[trans-4-(trans-4-heptylcyclohexyl)cyclohexyl]-éthane

14. Utilisation des composés de formule I selon la revendication 1, comme composants de phases à cristaux liquides.
15. Phase à cristaux liquides contenant au moins deux composants à cristaux liquides, caractérisée en ce qu'elle contient au moins un composé de formule I selon la revendication 1.
16. Élément d'affichage à cristaux liquides, caractérisé en ce qu'il contient une phase à cristaux liquides selon la revendication 15.
17. Élément d'affichage électro-optique caractérisé en ce qu'il contient, comme diélectrique, une phase à cristaux liquides selon la revendication 15.