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Ref. 4701/141

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Method and Means for Disclination-Free Orienting
of Liquid Crystals

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The invention relates to a method of planar orienting of cholesteric liquid crystals free from disclinations between the two parallel plates of a liquid crystal. The invention also relates to means for working the method.

15

In the case of cholesteric liquid crystals used in optical components, particularly in optical filters, a liquid crystal layer has to be given a uniform planar orientation between the two parallel plates of a liquid crystal cell. "Planar" as used in this description means either molecule arrangements parallel to the plate or arrangements in which the molecules have a so-called "angle of inclination" of up to 30°C.

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During manufacture of these cells, focal and conical disclination lines occur, e.g. as a result of flow orientation or cooling of the liquid crystal from the isotropic phase. As a result of these disclination lines, incident light is scattered. The scattered light is also depolarized and thus reduces the filtering or polarizing efficiency of cholesteric liquid crystal filters (compare Jpn. J. Appl. Phys., Vol. 29, No. 10, 1990, pages 1974-1984, particularly page 1975).

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The appearance can be improved by cutting the glass plates, but this method does not completely eliminate the disclination lines and is also impracticable on a production scale.

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The aim of the invention is to avoid these interfering disclinations in cholesteric liquid crystal cells.

To this end, according to the invention, the cholesteric liquid crystal is mixed with a nematic or smectic liquid crystal material having negative dielectric anisotropy and the cell is subjected to an electric field directed at right angles to the plates.

The method according to the invention is surprisingly successful in giving a planar orientation over a large area to a cholesteric liquid cell mixture having a small pitch, the planar orientation being so uniform that not a single faulty disinclination line occurs over the entire oriented region.

It has also been found that this is possible even if only one or neither of the two cell substrates has a wall orientation aligning the liquid crystal molecule in a preferred direction. This is particularly surprising because these orientation layers have hitherto been considered essential.

An embodiment of the invention will now be described with reference to the accompanying drawing.

The single drawing is a diagram in section of a cholesteric liquid crystal filter/polarizer cell. These cells are known e.g. from the previously-mentioned article. In the present embodiment the cell comprises a cholesteric liquid crystal 3 between 2 plane parallel glass plates 1, 2 and having a pitch p . The glass plates, on their surfaces facing the liquid crystal, have ITO coatings 4, 5 which are known in liquid crystal displays. these ITO coatings however are not segmented here in the usual manner. The distance between the glass plates, which is not critical, is adjusted by spacers to about $8\text{ }\mu\text{m}$.

The ITO-coated glass plates 1,2 used for the cell can have a special orienting layer 6, 7 which aligns the liquid crystal molecule in a preferred direction parallel to the plate surface or at a given angle of inclination thereto.

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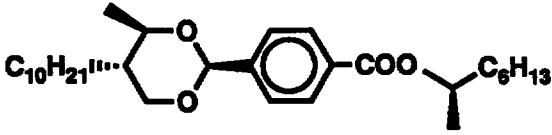
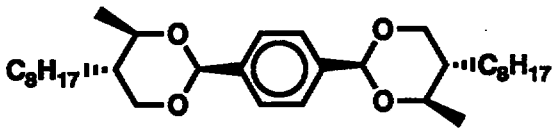
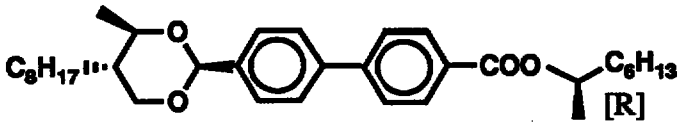
The crystal 3 consists of a mixture of three cholesteric compounds and a nematic "host" having negative dielectric anisotropy.

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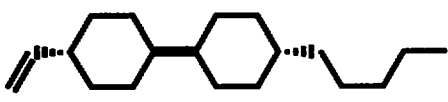
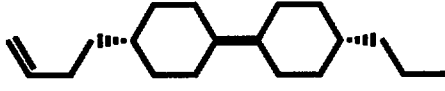
The three cholesteric compounds and their proportions by weight in the mixture are:

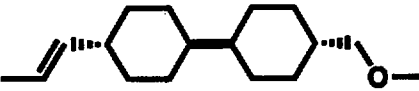
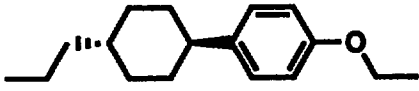
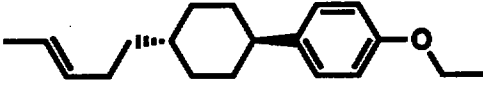
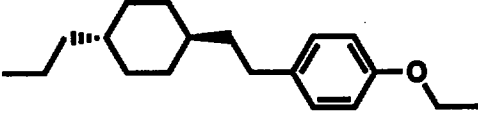
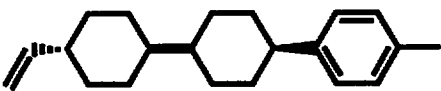
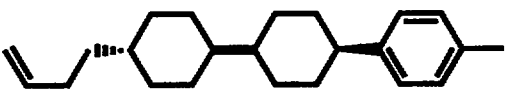
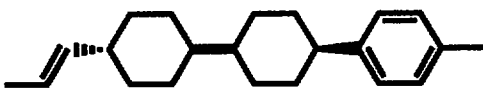
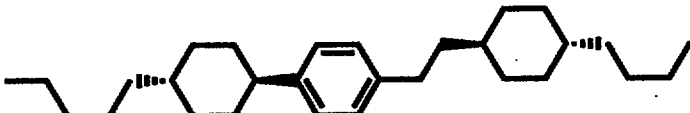
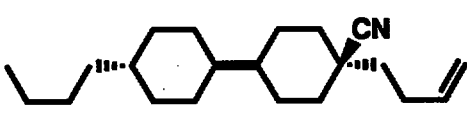
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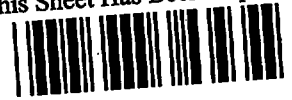


Structure	Proportion by weight [%]
	7.5
	8.0
	6.5

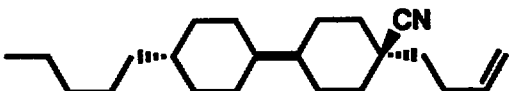
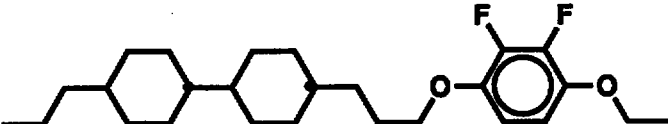
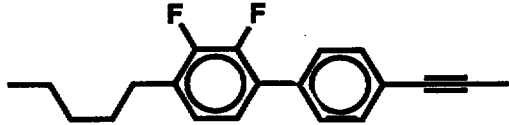
The nematic mixture is made up as follows:

Structure	Proportion by weight [%]
	4.1
	6.7
	2.6

	7.7
	1.5
	3.6
	7.2
	3.6
	4.1
	6.7
	3.6
	5.5





	3.9
	9.4
	7.8

This liquid crystal mixture has a negative dielectric anisotropy of $\epsilon = -1.6$ and a helical pitch of $p = 0.35$ nm at 22°C .

- 5 In order to eliminate the faulty disinclination lines which remain after filling the cell, in spite of surface orientation, an AC voltage of 20 - 60 V is applied to the cell for about 1 minute. A uniform planar orientation is produced, free from disinclination. This orientation remains even after the current has been switched
- 10 off, and is permanently stable.

Instead of providing an ITO coating on the plates and applying a voltage to them, the cells can be brought into or moved through an electric field generated for the required time outside

15 the cell, e.g. in the form of a corona discharge.

It has been found that removal of disinclination in this way is equally efficient if only one or neither glass plate has the two wall orientation layers. In other words, pre-orientation to eliminate

20 wall influences is not essential. This has the important advantage that orientation layers do not have to be applied when producing the aforementioned filter/polarizer cells.

In addition to the application in the aforementioned

25 embodiment, the invention has other applications. More

particularly the invention is not restricted to cells in which the liquid crystal is disposed between glass plates. Cells can be manufactured in the same manner with plastics plates or even in the form of chiral polymer foils free from disclination.

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As is known, compensation layers are used in liquid crystal displays comprising highly twisted nematic liquid crystals ("supertwist" LCDs), to avoid undesired discoloration when switched off. Normally the compensation layer is an additional
10 highly-twisted TN layer, which requires a third boundary wall with suitable orientation layers but without electrode coating. This method, which is very complicated as regards manufacture, can be replaced by planar-oriented chiral liquid crystal polymer sheets, which are produced according to the invention and stuck
15 to the actual display cell.

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Patent Claims

1. A method of planar orienting of cholesteric liquid crystals free from disclination between the two parallel plates of a liquid crystal, characterized in that the cholesteric liquid crystal (3) is mixed with a nematic or smectic liquid crystal material having negative dielectric anisotropy and the cell is subjected to an electric field directed at right angles to the plates (1, 2).
2. A method of orientation according to claim 1, characterized in that at least one of the plates does not have a coating (6, 7) for orienting the liquid crystal molecule in a preferred direction.
3. A method of orientation according to claim 1, characterized in that the plates are given electrode coatings (4, 5) to which a voltage is applied to generate the electric field.



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Abstract

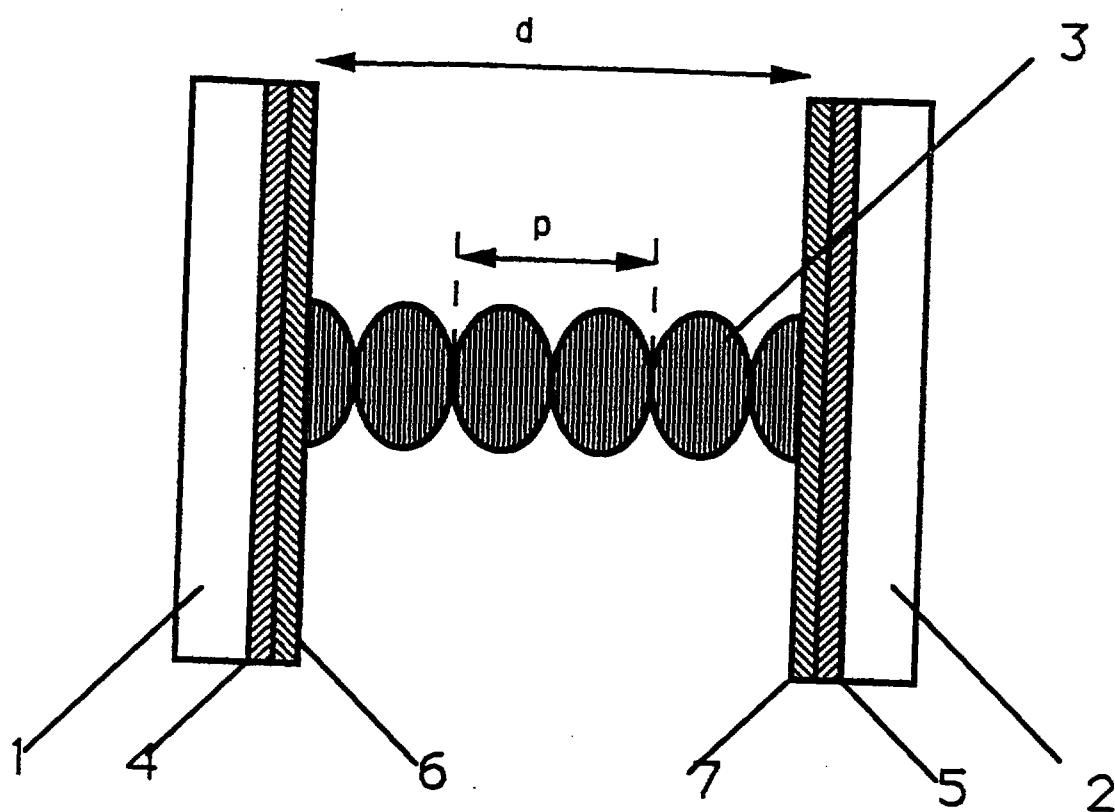
- A liquid crystal cell comprising a cholesteric liquid crystal (3) between parallel plates (1, 2) as used e.g. for optical filters.
- 5 The previously-avoidable interference through faulty disinclination is eliminated in that the cholesteric liquid crystal is mixed with a nematic or smectic liquid crystal material having negative dielectric anisotropy and the cell is subjected to an electric field directed at right angles to the plates.

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Fig. 1

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A method and means for giving cholesteric liquid crystals a planar orientation free from faulty inclination

The invention relates to a method of planar orienting of cholesteric liquid crystals free from faulty inclination between the two parallel plates of a liquid crystal. The invention also relates to means for working the method.

In the case of cholesteric liquid crystals used in optical components, particularly in optical filters, a liquid crystal layer has to be given a uniform planar orientation between the two parallel plates of a liquid crystal cell. "Planar" as used in this description means either molecule arrangements parallel to the plate or arrangements in which the molecules have a so-called "angle of inclination" of up to 30°C.

During manufacture of these cells, focal and conical faulty inclination lines occur, e.g. as a result of flow orientation or cooling of the liquid crystal from the isotropic phase. As a result of these faulty inclination lines, incident light is scattered. The scattered light is also depolarized and thus reduces the filtering or polarizing efficiency of cholesteric liquid crystal filters (compare Jpn. J. Appl. Phys., Vol. 29, No. 10, 1990, pages 1974-1984, particularly page 1975).

The appearance can be improved by cutting the glass plates, but this method does not completely eliminate the faulty inclination lines and is also impracticable on a production scale.

The aim of the invention is to avoid these interfering faulty inclinations in cholesteric liquid crystal cells.

To this end, according to the invention, the cholesteric liquid crystal is mixed with a nematic or smectic liquid crystal material having negative dielectric anisotropy and the cell is subjected to an electric field directed at right angles to the plates.

The method according to the invention is surprisingly successful in giving a planar orientation over a large area to a cholesteric liquid cell mixture having a small pitch, the planar

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orientation being so uniform that not a single faulty disinclination line occurs over the entire oriented region.

It has also been found that this is possible even if only one or neither of the two cell substrates has a wall orientation aligning the liquid crystal molecule in a preferred direction. This is particularly surprising because these orientation layers have hitherto been considered essential.

An embodiment of the invention will now be described with reference to the accompanying drawing.

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The ITO-coated glass plates 1,2 used for the cell can have a special orienting layer 6, 7 which aligns the liquid crystal molecule in a preferred direction parallel to the plate surface or at a given angle of inclination thereto.

The crystal 3 consists of a mixture of three cholesteric compounds and a nematic "host" having negative dielectric anisotropy.

The three cholesteric compounds and their proportions by weight in the mixture are:

Structure	Proportion by weight [%]
	7.5
	8.0
	6.5

The nematic mixture is made up as follows:

Structure	Proportion by weight [%]
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	3.6
	7.2
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	4.1
	6.7
	3.6
	5.5
	3.9
	9.4
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This liquid crystal mixture has a negative dielectric anisotropy of $\epsilon = -1.6$ and a helical pitch of $p = 0.35$ nm at 22°C .

In order to eliminate the faulty disinclination lines which remain after filling the cell, in spite of surface orientation, an AC voltage of 20 - 60 V is applied to the cell for about 1 minute. A uniform planar orientation is produced, free from faulty inclination. This orientation remains even after the current has been switched off, and is permanently stable.

Instead of providing an ITO coating on the plates and applying a voltage to them, the cells can be brought into or moved through an electric field generated for the required time outside the cell, e.g. in the form of a corona discharge.

It has been found that removal of faulty inclination in this way is equally efficient if only one or neither glass plate has the two wall orientation layers. In other words, pre-orientation to eliminate wall influences is not essential. This has the important advantage that orientation layers do not have to be applied when producing the aforementioned filter/polarizer cells.

In addition to the application in the aforementioned embodiment, the invention has other applications. More particularly the invention is not restricted to cells in which the liquid crystal is disposed between glass plates. Cells can be manufactured in the same manner with plastics plates or even in the form of chiral polymer foils free from faulty inclination.

As is known, compensation layers are used in liquid crystal displays comprising highly twisted nematic liquid crystals ("supertwist" LCDs), to avoid undesired discoloration when switched off. Normally the compensation layer is an additional highly-twisted TN layer, which requires a third boundary wall with suitable orientation layers but without electrode coating. This method, which is very complicated as regards manufacture, can be replaced by planar-oriented chiral liquid crystal polymer sheets, which are produced according to the invention and stuck to the actual display cell.

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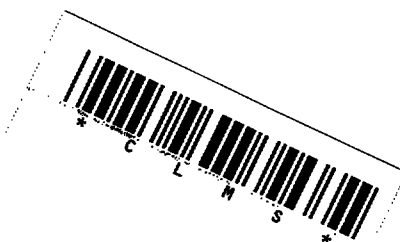
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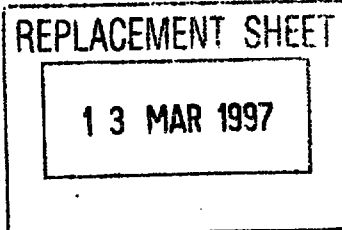
Patent Claims

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3. A method of orientation according to claim 1, characterized in that the plates are given electrode coatings (4, 5) to which a voltage is applied to generate the electric field.





ABSTRACT OF THE DISCLOSURE

A METHOD AND MEANS FOR GIVING CHOLESTERIC LIQUID CRYSTALS A PLANAR ORIENTATION FREE FROM FAULTY INCLINATION

A liquid crystal cell comprising a cholesteric liquid crystal (3) between parallel plates (1, 2) as used e.g. for optical filters. The previously-avoidable interference through faulty disinclination is eliminated in that the cholesteric liquid crystal is mixed with a nematic or smectic liquid crystal material having negative dielectric anisotropy and the cell is subjected to an electric field directed at right angles to the plates.

FIGURE 1

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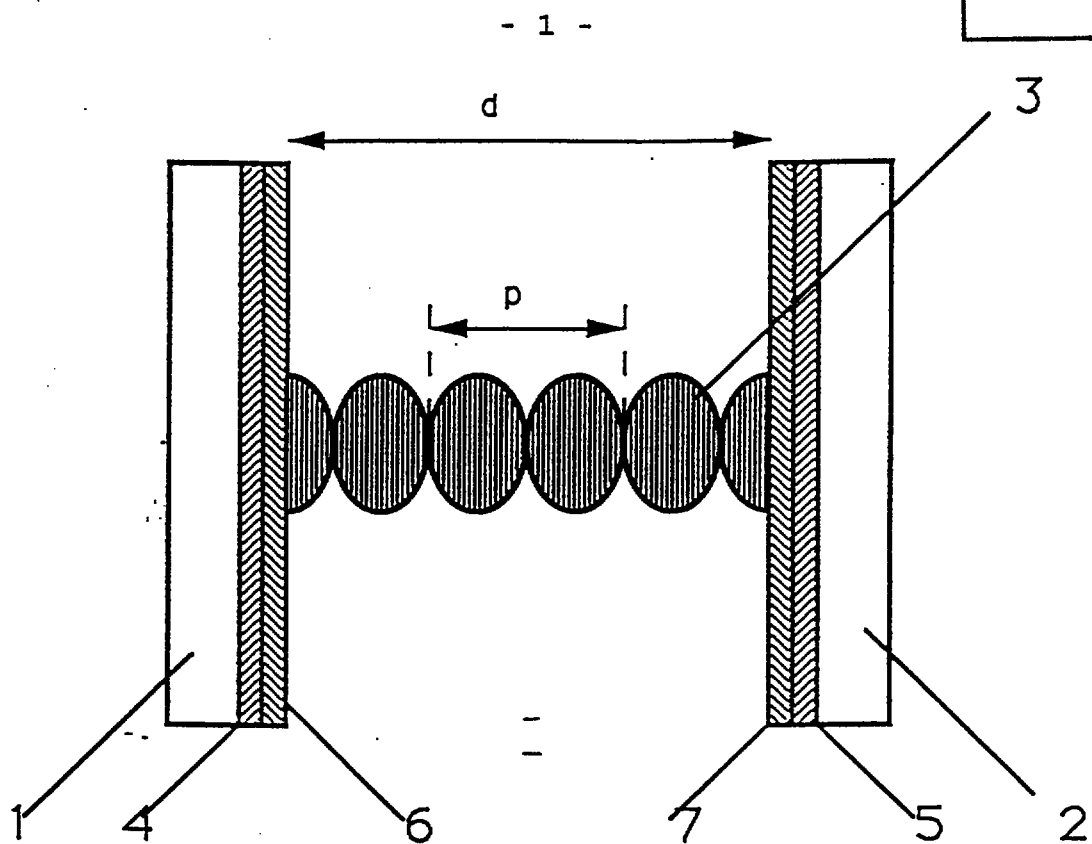


FIGURE 1

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METHOD AND MEANS FOR DISCLINATION-FREE ORIENTING OF LIQUID CRYSTALS

The invention relates to a method of planar orienting of cholesteric liquid crystals free from faulty inclination between the two parallel plates of a liquid crystal. The invention also relates to means for working the method.

In the case of cholesteric liquid crystals used in optical components, particularly in optical filters, a liquid crystal layer has to be given a uniform planar orientation between the two parallel plates of a liquid crystal cell. "Planar" as used in this description means either molecule arrangements parallel to the plate or arrangements in which the molecules have a so-called "angle of inclination" of up to 30°C.

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To this end, according to the invention, the cholesteric liquid crystal is mixed with a nematic or smectic liquid crystal material having negative dielectric anisotropy and the cell is subjected to an electric field directed at right angles to the plates.

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Instead of providing an ITO coating on the plates and applying a voltage to them, the cells can be brought into or moved through an electric field generated for the required time outside the cell, e.g. in the form of a corona discharge.

It has been found that removal of faulty inclination in this way is equally efficient if only one or neither glass plate has the two wall orientation layers. In other words, pre-orientation to eliminate wall influences is not essential. This has the important advantage that orientation layers do not have to be applied when producing the aforementioned filter/polarizer cells.

In addition to the application in the aforementioned embodiment, the invention has other applications. More particularly the invention is not restricted to cells in which the liquid crystal is disposed between glass plates. Cells can be manufactured in the same manner with plastics plates or even in the form of chiral polymer foils free from disclination.

As is known, compensation layers are used in liquid crystal displays comprising highly twisted nematic liquid crystals ("supertwist" LCDs), to avoid undesired discoloration when switched off. Normally the compensation layer is an additional highly-twisted TN layer, which requires a third boundary wall with suitable orientation layers but without electrode coating. This method, which is very complicated as regards manufacture, can be replaced by planar-oriented chiral liquid crystal polymer sheets, which are produced according to the invention and stuck to the actual display cell.

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**METHOD AND MEANS FOR DISCLINATION-FREE ORIENTING OF LIQUID
CRYSTALS**

A method of and means for planar orienting cholesteric liquid crystals (3) free from disclinations between two parallel plates (1,2) of a liquid crystal cell as used e.g. for optical filters, is described. To eliminate faulty inclinations lines the cholesteric liquid crystal is mixed with a nematic or a smectic liquid crystal material having negative dielectric anisotropy and the cell filled therewith is subjected to an electric field at right angles to the plates (1,2). The unitary planar orientation is retained after the field is switched off.

Figure. 1