

The invention relates to a display device, having a plurality of display points formed on a display panel, wherein each display point is formed by the front end of an illuminatable optical fibre, a light conductor being secured on the display panel before each end of an optical fibre and having a round cross-section, which is greater than the cross-section of the optical fibre, said light collector forming a portion, which is convexly curved with a prescribed radius, when facing the end of the optical fibre.

In conventional display devices, the illuminated display areas of the display points are small, since the optical fibres have diameters of between 0.5 and 1 mm. In order to increase the display areas of the display points, the ends of the optical fibres have also already been connected to radiating bodies, which increase the display areas to approximately 5 mm. In order to permit large displays to be shown with such display points, such displays also being easily recognisable at relatively large distances, the display points must be disposed with small spacings therebetween. However, this leads to a very large number of display points. If various displays are also to be shown with the display device, switchable display points must be used, which have to be set in succession by a control means. In consequence, the outlay for a large display is also very great in respect of the control means.

A display device of the initially mentioned type is disclosed in EP 0 348 619 A1. In such case, light collectors in the form of convex lenses are placed before the front ends of the optical fibres (at the light emitting ends), said lenses being provided, on their convex external surface remote from the optical fibre, with a planar face, the size of which is to be adapted to

the envisaged light emitting angle. The lens is thereby inserted in the plane of a screw sleeve at the light emitting end and , for its part, said sleeve protrudes a relatively long way beyond the external surface of the display panel.

A single matrix display device is disclosed in DE 39 10 678 A1 and also has illuminated optical fibre bundles. It is stated and outlined here "that a switching process also moves flaps according to a known induction principle for covering permanently illuminating light emitting elements". A cover unit in the form of two half-shells is also mentioned; however, a lens is not mentioned. The publication does not give any clear technical teaching concerning the overall structure of the display device.

An object of the invention is to provide a display device of the initially mentioned type, wherein the number of display points for large displays is substantially reduced without the display being more difficult to recognise as a result.

This object is achieved, according to the invention, in that the light collector is provided with a circumferential chamfer, when remote from the end of the optical fibre, and said chamfer lies at a prescribed angle relative to the central axis of the display point, and in that the light collector is retained in bores in the display panel by a snug and/or press fit and merely protrudes beyond the front end of the display panel with the portion formed by the chamfer and beyond the rear end of the display panel with the convexly curved portion.

In such case, provision is made that the end face of the light collector remote from the end of the optical fibre is roughened.

The radiation angle of the display point is increased by means of the light collectors thus formed, so that the spacings between the display points can be increased and, in consequence, the number of display points per unit area can be considerably reduced. This embodiment of the display device is particularly advantageous for large displays which are viewed from a relatively large distance. Because the convexly curved portion of the light collector protrudes beyond the rear end of the display panel facing the end of the optical fibre, the entry of light into the light collector also becomes optimum. The roughened end face of the light collector ensures that this region of the light collector is also evenly illuminated, although the radiation face of the optical fibre is smaller. This is because of the scattering which occurs at the roughened end face.

The radiation angle of the display point can be fixed by the radius and the angle of the light collector, so that optimum conditions can be achieved with a considerably reduced number of display points, depending on the display size and viewing distance.

Another advantageous embodiment provides that the end of the optical fibre is connected to a radiating body, the diameter of which is greater than the diameter of the optical fibre, but is smaller than the diameter of the light collector, and in that the central longitudinal axis of the radiating body is orientated towards the central longitudinal axis of the light collector. The radiation face is already increased in this manner at the end of the optical fibre.

So that the display device can also be used for variably adjustable displays, another embodiment provides that the display panel is disposed at a spacing from the end of the optical fibres or radiating bodies, and that switching means are disposed between the ends of the optical fibres or of the radiating bodies and the light collectors, the optical connections between these component parts being blockable and releasable by said means.

The display device for variable displays is such, according to one embodiment, that a housing is provided with one compartment per optical fibre or radiating body, that the optical fibre or the radiating body is secured in a bore in the base of the associated compartment and protrudes into the compartment externally of the axis of rotation of a flap, which is mounted in the region of the open side of the compartment, that the optical fibre or the radiating body defines the rotary movement of the flap to approximately 90° , that the flap covers the associated compartment in one position and releases the optical connection between the optical fibre or the radiating body and the light collector in the other position, and that the flap is adjustable into one or other position by means of associated, pulse-controlled electromagnets, the positions being maintained by means of the remanence of the electromagnets.

For a radiation angle of the display point of 7° , provision is made that the radiating body has a diameter of 5 mm for a radiation angle of 7° , that the light collector, having a diameter of 20 mm, is disposed at a spacing of 15 mm from the radiation face of the radiating body, and that the chamfer has an angle α equal to 60° , and the radius of the portion has a value of 25 mm.

The invention is explained more fully with reference to one switchable display point illustrated in the drawing. In the drawing:

Fig. 1 is a cross-sectional view through a switchable display point according to the invention, which is in its display position; and

Fig. 2 is a cross-sectional view through the same display point in its initial position, i.e. non-display position.

The display device according to the invention includes a housing 10 for the rotatable mounting of flaps 15, as is apparent from Fig. 1. This housing 10 substantially comprises a plate, which has compartments 11 of a square cross-section towards the display side, the walls of said compartments being fitted on the plate. This housing 10 may also be composed of a plurality of partial housings disposed in adjacent rows, in order to achieve a matrix-like display device of sufficient size. The compartments 11 are arranged in lines and columns. A flap 15 is rotatably mounted in each required compartment 11 with the axis of rotation 14, such that this flap 15 covers the associated compartment 11 in the initial position, which is illustrated in Fig. 1 and corresponds to the non-display position. A bore 12 is provided in the base of the compartment 11 and accommodates the radiating body 30 mounted on the end of the optical fibre 31. The bore 12 is so configured that the radiating body 30 is retained therein by a snug and/or press fit and protrudes into the associated compartment 11. The arrangement is such that the radiating body 30 lies externally of the axis of rotation 14 of the flap 15, which preferably extends diagonally in the compartment 11 and is disposed in the region of the

open side of the compartment 11. The pairs of electromagnets 13, which are associated with the flap 15 and by which the two positions of the flap 15 are set, are disposed behind the compartment 11 on the external surface of the base, i.e. of the plate. In the display position of Fig. 1, however, the flap 15 cannot rotate through 180° , since the radiating body 30 forms a stop for the flap 15, with the result that said flap can only rotate through approximately 90° and releases the light emerging from the radiating body 30 and allows it to pass to a light collector 22, which is secured before the radiating body 30 in a display panel 20. The spacing of the display panel 20 is so selected that the flaps 15 can be set into the display position of Fig. 1. The light collectors 22 have a round cross-section and are configured as portions of a glass rod or of a transparent plastics material rod. The cross-section of the light collectors 22 is greater than the cross-section of the radiating bodies 30. The central longitudinal axes of the light collectors 22 are orientated towards the central longitudinal axes of the associated radiating bodies 30. The display panel 20 has bores 21 for the light collectors 22, which are retained therein by a snug and/or press fit.

In order to increase the radiation angle of the display point, the light collector 22, facing the radiating body 30, is provided with the portion 23 which is convexly curved with a radius r . On the side remote from the radiating body 30, the light collector 22 protrudes with a portion provided with a chamfer 24 beyond the display panel 20. This chamfer 24 lies at an angle relative to the central longitudinal axis of the light collector 22. The radius r and the angle α are the dimensions with which a desirable radiation angle can be achieved. The end face 25 of the light collector 22

remote from the radiating body 30 is roughened so that it is evenly illuminated. This is achieved by means of the stray light despite the radiating body 30 having a relatively small radiation face. Because of the increased radiation angle, the display point becomes even greater with an increasing spacing from the display panel 20, so that the adjacent display points of the display device can be fixed at a correspondingly enlarged spacing in the display panel 20. Numbers and letters can be represented, for example, with a 5x7 matrix of display points, and such are easily recognisable even at a distance of 10 to 20 metres with a height of approx. 50 cm. A radiation angle of the display point of 7° has thereby been achieved with the following dimensions:

diameter of the radiating body 30	50 mm
diameter of the light collector 22	20 mm
spacing between radiating body 30 and light collector 22	15 mm
radius r of the light collector 22	25 mm
angle α of the chamfer 24	60°.

The electromagnets 13 have a remanence, so that the respectively set position of the flaps 15 is maintained until a triggering occurs for the other position. In consequence, a pair of electromagnets 13 is associated with each compartment 11, i.e. of each flap 15. The respective electromagnets 13 of the pairs serve to set and maintain the display position of Fig. 1, while the flaps 15 are brought into the initial position of Fig. 2 by exciting the other electromagnets 13 of the pairs and are retained therein. In the initial position, i.e. the non-display position, the flaps 15

seal the associated compartments 11, whereby a side wall of the compartment 11 serves as a stop. The illuminated optical fibre 31, having the radiating body 30, is thereby covered, so that no light can pass to the associated, preconnected light collector 22. The end face 25 of the light collector 22 and the chamfer 24 thus remain absolutely dark, so that a very high switching ratio is achieved between the display position and the initial position, i.e. non-display position, of a flap 15.

The display device may be constructed in matrix form, whereby the flaps 15 are disposed with the electromagnets 13 in lines and columns. A printed circuit board may take over the wiring, and the housing 10 can be mounted on said board with the electromagnet connections and soldered thereto. The setting coils of the pairs of electromagnets 13 thereby form the setting matrix, while the resetting coils of the pairs of electromagnets 13 form the resetting matrix.

CLAIMS

1. Display device, having a plurality of display points formed on a display panel (20), wherein each display point is formed by the front end of an illuminatable optical fibre, a light collector (22) being secured on the display panel (20) before each end of an optical fibre (31) and having a round cross-section, which is greater than the cross-section of the optical fibre (31), said light collector forming a portion (23), which is convexly curved with a prescribed radius (r), when facing the end of the optical fibre (31), characterised in that the light collector (22) is provided with a circumferential chamfer (24), when remote from the end of the optical fibre (31), and said chamfer lies at a prescribed angle (α) relative to the central axis of the display point, and in that the light collector (22) is retained in bores (21) in the display panel (20) by a snug and/or press fit and merely protrudes beyond the front end of the display panel (20) with the portion formed by the chamfer (24) and beyond the rear end of the display panel (20) with the convexly curved portion, and in that the end face (25) of the light collector (22) remote from the end of the optical fibre (31) is roughened.

2. Display device according to claim 1, characterised in that the light collectors are configured as portions of a glass rod or of a transparent plastics material rod.

3. Display device according to claim 1 or 2, characterised in that the radiation angle of the display point is fixed by the radius (r) and the angle (α) of the light collector (22).

4. Display device according to one of claims 1 to 3, characterised in that the end of the optical fibre (31) is connected to a radiating body (30), the diameter of which is greater than the diameter of the optical fibre (31), but is smaller than the diameter of the light collector (22), and in that the central longitudinal axis of the radiating body (30) is orientated towards the central longitudinal axis of the light collector (22).

5. Display device according to one of claims 1 to 4, characterised in that the display panel (20) is disposed at a spacing from the end of the optical fibres (31) or radiating bodies (30), and in that switching means are disposed between the ends of the optical fibres (31) or of the radiating bodies (30) and the light collectors (22), the optical connections between these component parts being blockable and releasable by said means.

6. Display device according to claim 5, characterised in that a housing (10) is provided with one compartment (11) per optical fibre (31) or radiating body (30), in that the optical fibre (31) or the radiating body (30) is secured in a bore (12) in the base of the associated compartment (11) and protrudes into the compartment (11) externally of the axis of rotation (14) of a flap (15), which is mounted in the region of the open side of the compartment (11), in that the optical fibre (31) or the radiating body (30) defines the rotary movement of the flap (15) to approximately 90°, in that the flap (15) covers the associated compartment (11) in one position and releases

the optical connection between the optical fibre (31) or the radiating body (30) and the light collector (22) in the other position, and in that the flap (15) is adjustable into one or other position by means of associated, pulse-controlled electromagnets (13), the positions being maintained by means of the remanence of the electromagnets (13).

7. Display device according to one of claims 1 to 6, characterised in that the radiating body (30) has a diameter of 5 mm for a radiation angle of 7° , in that the light collector (22), having a diameter of 20 mm, is disposed at a spacing of 15 mm from the radiation face of the radiating body (30), and in that the chamfer (24) has an angle α equal to 60° , and the radius (r) of the portion (23) has a value of 25 mm.