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EP-A- 111 979
EP-A- 206 812
DE-A- 3 400 067

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JP-A-58 126 650 (HITACHI SEISAKUSHO
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Description

The invention relates to a display tube comprising an evacuated envelope having a display window which on its inside comprises a display screen and in front of which on its outside a transparent second window is provided substantially parallel to the outside and with a space between the display window and the second window, a third window being provided substantially parallel to and in front of the side of the second window remote from the display window, said third window forming with the second window a second space, the first mentioned space and the second space containing a cooling liquid, the second space communicating with the first mentioned space, whereby in operation the transparent cooling liquid in said second space flows in counter current to the liquid in the first mentioned space, a closed cooling system communicating with said first mentioned and said second spaces.

Such a display tube is known from Patent Abstracts of Japan relating to JP-A 58/126 650.

Another display tube with cooling is disclosed in Netherlands Patent Application 8 300 114 laid open to public inspection (see also DE-A 3 400 067). The latter display tube comprises a transparent second window outside and substantially parallel to the display window. The space between the display window and the second window is destined for laminar flow of a transparent cooling liquid.

Cooling of display tubes is of particular importance in display tubes for projection television, in which for obtaining the required great brightnesses the display screens are scanned by electron beams with high beam currents.

Although good results are obtained with the above-mentioned display tubes, it has been found that important improvements are possible. These relate to the improvement of the flow of cooling liquid through the space between the display window and the second window and the simplification of the construction so that fewer components and a simpler assembly and disassembly of the tube become possible.

One of the objects of the invention is to achieve the said improvements at least to a considerable extent.

Therefore, the display tube mentioned in the opening paragraph is characterized according to the invention in that the first mentioned space is destined for laminar flow of the transparent cooling liquid and in that the second space communicates with the first mentioned space beyond the light path of the display tube, and in that the closed cooling system is provided beyond said light path.

The use of a laminar flow of cooling liquid prevents inhomogeneities occurring in the cooling liquid and hence differences in refractive indices which are expressed as refractive patterns in the displayed picture.

For that purpose the spacing between the display window and the second window generally is approximately 3 to 4 mm.

In a display tube according to the invention, the

cooling system and the second window can particularly simply be assembled and disassembled due to the absence of hoses, pumps and associated arrangements, while the closed cooling system proves to provide a cooling which is sufficiently large to use the display tube at substantially any suitable angle.

A display tube in which the second space communicates with the first space beyond the light path of the display tube is described in EP-A 206 812 which forms prior art under art. 54(3) EPC. However, there is no teaching that the cooling liquid must have a laminar flow characteristic in the space between the display window and the second window.

By using a closed cooling system beyond the light path no glass components need be used in the light path but, for example, a synthetic resin may be used for the second and the third window and metal components may be used in the cooling system.

In a preferred embodiment of the display tube in accordance with the invention, the second window extends beyond the display window on at least one side thereof.

If the third window is a part of a system of lenses then a rapid and accurate positioning of the display tube with respect to the system of lenses is promoted. Optimum results are obtained with optical coupling of the windows and the cooling liquid. For that purpose, the refractive indices of the cooling liquid and of the display window and the second and third windows are adapted to each other.

The invention will now be described in greater detail, by way of example, with reference to the single figure of the accompanying drawing, which figure is a diagrammatic sectional view of a display tube according to the invention.

The display tube comprises an evacuated envelope 1 having a substantially rectangular display window 2 which comprises a display screen 3 on its inside and in front of which on its outside a transparent second window 4 is provided so as to be substantially parallel with the outside and having a space 5 between the display window 2 and the second window 4 which space is destined to laminar flow of a transparent liquid.

The flow of the transparent liquid through the space 5 in a display tube according to the invention is considerably improved in that beyond the light path of the display tube a closed cooling system 6, which may comprise a heat exchanger, is provided for cooling, beyond the light path, the cooling liquid heated during operation of the display tube. Moreover, in front of the side of the second window 4 remote from the display window 2 a third window 7 is provided substantially parallel to the remote side and with the second window 4 forms a second space 8 to return, in counter current with respect to the heated liquid, the cooled cooling liquid to the first space 5 between the display window 2 and the second window 4. The first and second spaces 5, 8 communicate with each other beyond the light path of the display tube. The flow of the cooling liquid is indicated by the arrows. If the cooling system 6 does not comprise a pump then the liquid flow is by convection.

The third window 7 preferably is a part of a system of lenses.

The spacing between the display window 2 and the second window 4 is 3 to 4 mm. The spacing between the second window 4 and the third window 7 is also 3 to 4 mm.

The cooling system 6 may be of metal, for example, aluminium, which enables a good cooling in a simple manner. The windows 4 and 7 may be of a synthetic resin, for example, polymethylmethacrylate, the refractive index of which corresponds to that of a cooling liquid consisting of a solution of glycol in water. In this manner an optical coupling between structural materials and cooling liquid is produced in a simple manner, so that annoying reflections are avoided. The cooling in the display tube according to the invention is so good that the angle at which the display tube is used is of at most minor influence on the cooling.

In an exemplary embodiment of a display tube having a power of 30 W and a room temperature of 20°C, the rise in temperature of the cooling liquid was at most 40°C. This rise in temperature stabilised itself after 2 hours.

The assembly and disassembly of the cooling system is very simple, as well as the positioning with respect to the system of lenses.

It will be obvious that the invention is not restricted to the example described, but that many variation possibilities are available to those skilled in the art without departing from the scope of the present invention.

Claims

1. A display tube comprising an evacuated envelope (1) having a display window (2) which on its inside comprises a display screen (3) and in front of which on its outside a transparent second window (4) is provided substantially parallel to the outside and with a space (5) between the display window (2) and the second window (4), a third window (7) being provided substantially parallel to and in front of the side of the second window (4) remote from the display window (2), said third window (7) forming with the second window (4) a second space (8), the first mentioned space (5) and the second space (8) containing a cooling liquid, the second space (8) communicating with the first mentioned space (5), whereby in operation the transparent cooling liquid in said second space (8) flows in counter current to the liquid in the first-mentioned space (5), a closed cooling system (6) communicating with said first mentioned and said second spaces, characterized in that the first mentioned space (5) is destined for laminar flow of the transparent cooling liquid and in that said second space (8) communicates with the first mentioned space (5) beyond the light path of the display tube, and in that the closed cooling system (6) is provided beyond said light path.

2. A display tube as claimed in Claim 1, characterized in that the second window (4) extends beyond the display window (2) on at least one side thereof.

Patentansprüche

1. Bildwiedergaberöhre mit einem evakuierten Kolben (1), dessen Wiedergabefenster (2) an der Innenseite einen Wiedergabeschirm (3) enthält und vor dem an der Außenseite ein durchsichtiges zweites Fenster (4) im wesentlichen parallel zur Außenseite und mit einem Raum (5) zwischen dem Wiedergabefenster (2) und dem zweiten Fenster (4) aufweist, wobei ein drittes Fenster (7) im wesentlichen parallel zu und vor der Seite des zweiten Fensters (4) im Abstand vom Wiedergabefenster (2) vorgesehen ist und dieses dritte Fenster (7) mit dem zweiten Fenster (4) einen zweiten Raum (8) bildet, wobei der erstgenannte Raum (5) und der zweite Raum (8) eine Kühlflüssigkeit enthalten, der zweite Raum (8) mit dem erstgenannten Raum (5) in Verbindung steht, im Betrieb die durchsichtige Kühlflüssigkeit im zweiten Raum (8) in bezug auf die Flüssigkeit im erstgenannten Raum (5) in entgegengesetzter Richtung fließt, und ein geschlossenes Kühlsystem (6) mit dem erstgenannten und mit dem zweiten Raum in Verbindung steht, dadurch gekennzeichnet, daß der erstgenannte Raum (5) für Laminarströmung der durchsichtigen Kühlflüssigkeit dient und daß der zweite Raum (8) mit dem erstgenannten Raum (5) außerhalb des Lichtweges der Wiedergaberöhre in Verbindung steht, und daß das geschlossene Kühlsystem (6) außerhalb dieses Lichtweges vorgesehen ist.

2. Wiedergaberöhre nach Anspruch 1, dadurch gekennzeichnet, daß das zweite Fenster (4) sich außerhalb des Wiedergabefensters (2) an wenigstens einer Seite dieses Fensters erstreckt.

Revendications

1. Tube de reproduction d'images comportant une enveloppe sous vide (1) ayant une fenêtre d'image (2) qui, à l'intérieur, comporte un écran d'image (3) et, en face de laquelle, à l'extérieur, est réalisée une seconde fenêtre (4) transparente sensiblement parallèle au côté extérieur avec un espace (5) entre la fenêtre d'image (2) et la seconde fenêtre (4), une troisième fenêtre (7) étant réalisée de façon sensiblement parallèle à et en face du côté de la seconde fenêtre (4) situé à l'opposé de la fenêtre d'image (2), ladite troisième fenêtre formant avec la seconde fenêtre (4) un second espace (8), le premier espace mentionné (5) et le second espace (8) contenant un liquide de refroidissement, le second espace (8) communiquant avec le premier espace mentionné (5), le liquide de refroidissement transparent dans ledit second espace (8) coulant pendant le fonctionnement à contre-courant du liquide dans le premier espace mentionné (5), un système de refroidissement fermé (6) communiquant avec ledit premier espace mentionné et lesdits seconds espaces, caractérisé en ce que le premier espace mentionné (5) est destiné au flux laminaire du liquide de refroidissement transparent et en ce que le second espace (8) communique avec le premier espace mentionné (5) à l'extérieur du trajet lumineux du tube de reproduction d'images, et en ce que le système de

refroidissement fermé (6) est prévu à l'extérieur du-
dit trajet lumineux.

2. Tube de reproduction d'images selon la reven-
dication 1, caractérisé en ce que la seconde fenêtre
(4) s'étend à l'extérieur de la fenêtre d'image à au
moins un côté de celle-ci.

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