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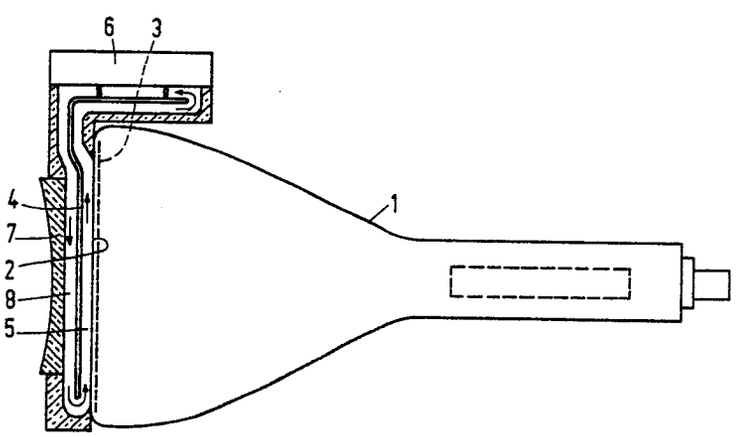
(54) **Display tube.**

(57) In a known display tube, in particular for projection television, cooling is used by causing a cooling liquid to flow laminarly between the display window and a second window.

An important improvement of the cooling is obtained according to the invention by cooling the heated cooling liquid in a cooling system beyond the light path and returning it via a space between the second window and a third window to the space between the display window and the second window.



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Display tube.

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 which is destined for laminar flow of a transparent cooling liquid.

Such a display tube is disclosed in Netherlands Patent Application 8300114 laid open to plublic inspection.

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.

Ths 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.

Although good results are obtained with the abovementioned display tube, 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 simplificcation 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 a third window is 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 containing the cooling liquid, the second space communicating with the first mentioned space beyond the light path of the display tube, and in that a closed cooling system is provided beyond said light path, the cooling system communicating with said first mentioned and said second spaces whereby the transparent cooling fluid in said second space flows in counter current to the liquid in the first mentioned space.

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.

By using a closed cooling system behond 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 third window is a part of a system of lenses.

This construction promotes a rapid and accurate positioning of the display tube with respect to the system of lenses. Optimum results are obtained with optical coupling of the windows and the cooling liquid. For that purpose, the refractive indices of the cooling liuquid 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 4forms a second space 8 to return, in counter current with respect to the heatedliquid, 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.

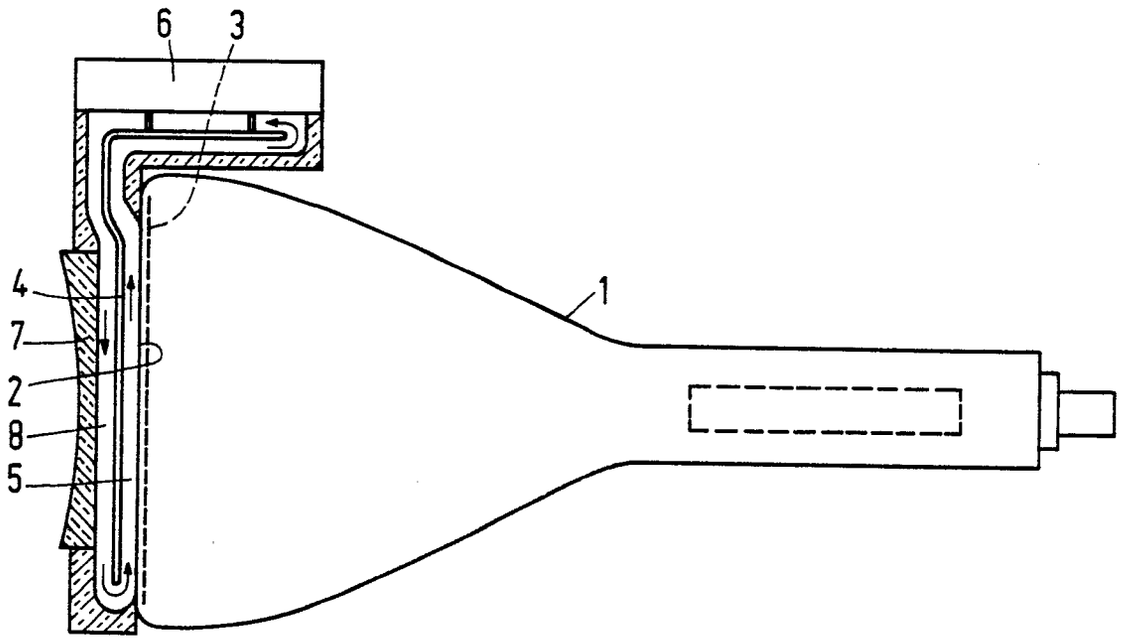
The assembly and disassembly of the cooling system is very simple, as well as the positioning with respect to the system of lenses.

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 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 which is destined for laminar flow of a transparent cooling liquid, characterized in that a third window is 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 containing the cooling liquid, the second space communicating with the first mentioned space beyond the light path of the display tube, and in that a closed cooling system is provided beyond said light path, the cooling system communicating with said first mentioned and said second spaces whereby the transparent cooling fluid in said second space flows in counter current to the liquid in the first-mentioned space.

2. A display tube as claimed in Claim 1, characterized in that the third window forms part of a system of lenses.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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 86 20 1199

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 236 (E-205)[1381], 20th October 1983; & JP-A-58 126 650 (HITACHI SEISAKUSHO K.K.) 28-07-1983	1	H 01 J 29/00

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 J 29

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	02-10-1986	WITH F.B.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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