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(71) Applicant
Pilkington P E Limited

(Incorporated in the United Kingdom)

Prescot Road, St Helens, Merseyside WA10 3TT, United Kingdom

(72) Inventor
Michael Harold Freeman

(74) Agent and/or Address for Service
Withers & Rogers
4 Dyer's Buildings, Holborn, London, EC1N 2JT, United Kingdom

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(54) Optical display apparatus

(57) Optical display apparatus particularly for head-up or head-down use in fighter aircraft, comprises two separate channels, a high resolution green channel H and a low resolution blue-red channel L. Each channel has an image source in the form of a cathode ray tube 1, 2 or a liquid crystal display (LCD) Figs, 2, 4 (not shown). A beam combining means 5 combines the two images from the image sources and may be a cube comprising a pair of contacting 45° prisms 6, 7 or a flat plate (5), Figs 3, 4 (not shown). The cube or the plate may include either a dichroic film HD or a holographic optical element HD. The combined images are seen by the viewer E through a partial reflector 11 which may include a holographic optical element 13.

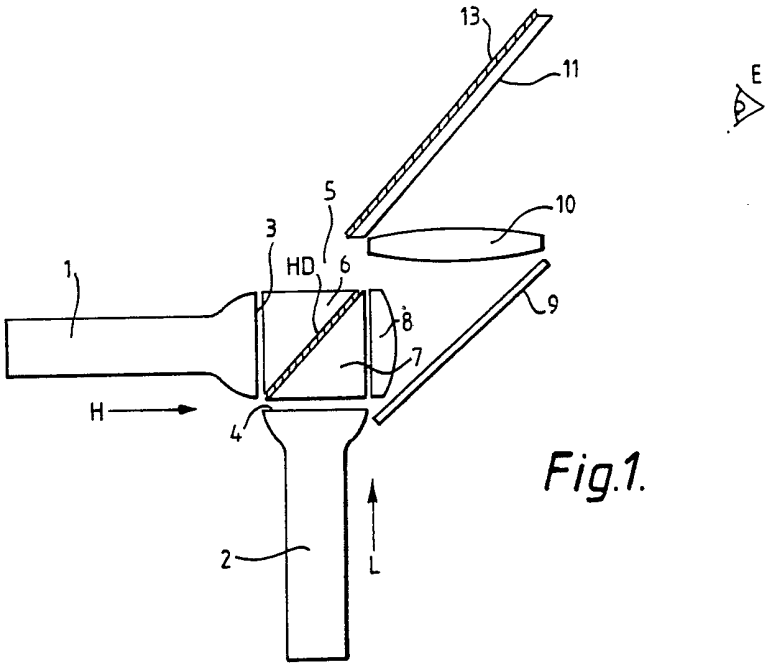

Fig.1.

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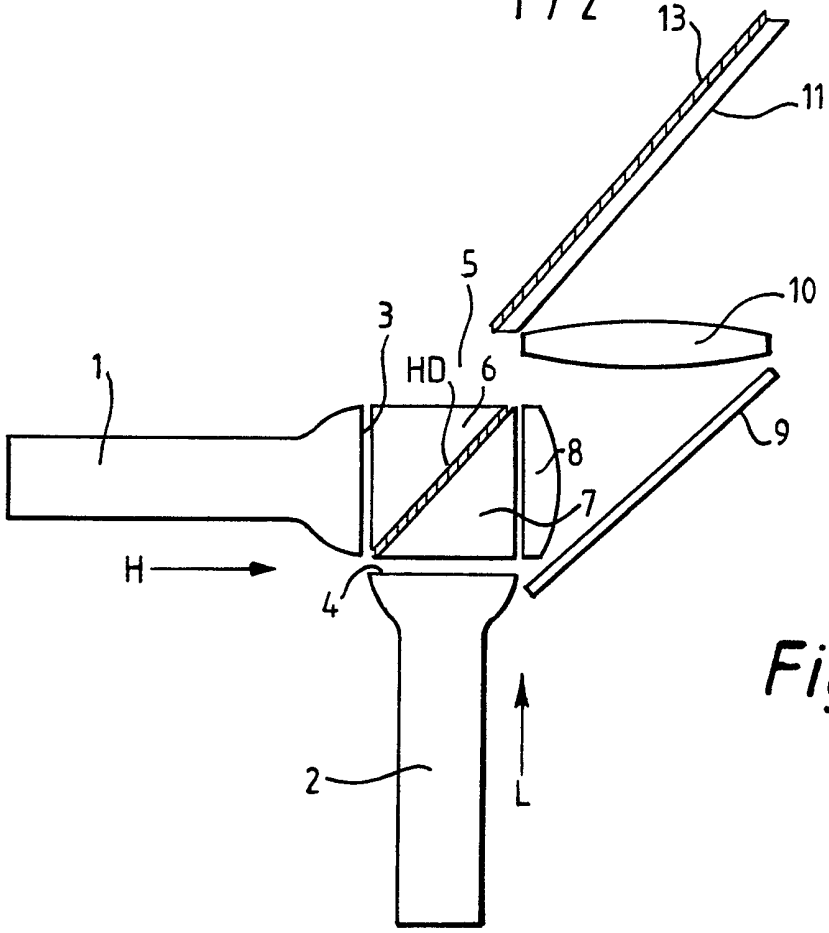

Fig.1.

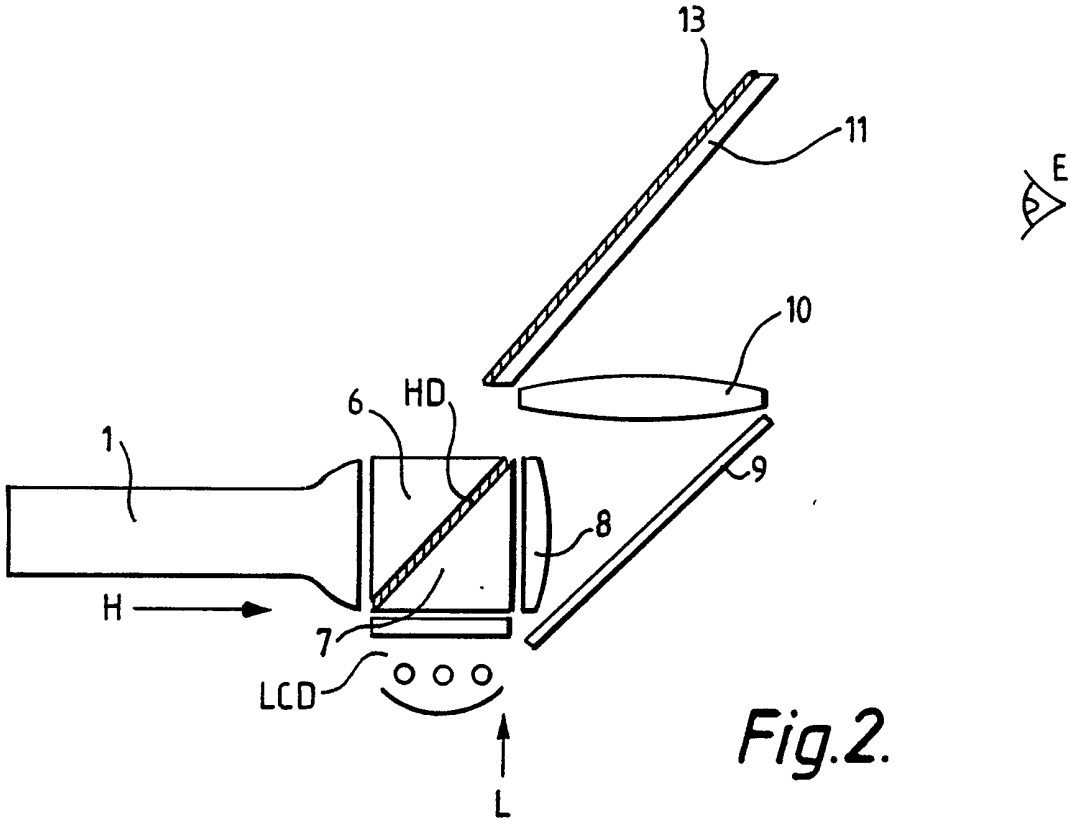

Fig.2.

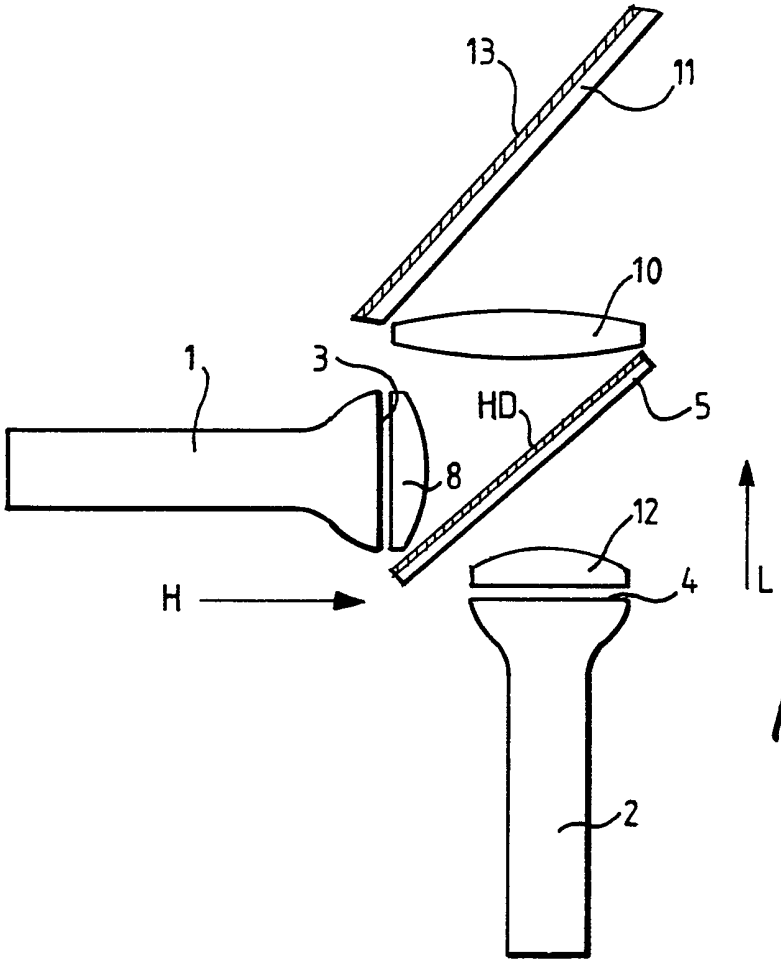

Fig.3.

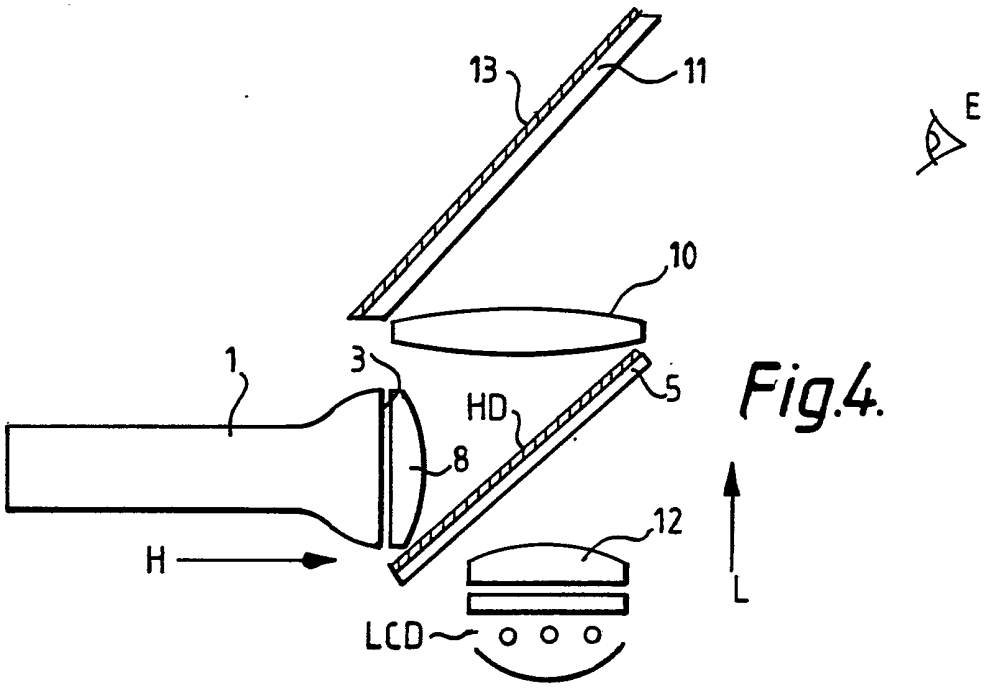

Fig.4.

OPTICAL DISPLAY APPARATUS

The present invention relates to an optical display apparatus and is particularly, although not exclusively, concerned with head-up or head-down display apparatus which find utility, for example, in a fighter aircraft.

As modern fighter aircraft become faster, there is an increasing requirement to provide a pilot with accurate and readily understandable real-time information. In an attempt to meet this requirement, colour display systems have been designed which readily enable the presentation of different pieces of information to the pilot in different colours. Such systems facilitate rapid distinguishability of the different pieces of information.

Systems of this type, however, tend to become rather complex, bulky and expensive and do not necessarily provide a high degree of resolution of image for presentation to the pilot.

An aim of this invention is to provide an optical display apparatus which overcomes the aforementioned disadvantages in a relatively simple, efficient and inexpensive manner.

According to the present invention there is provided an optical display apparatus for presentation of a composite image from images from two separate image sources to a viewer, the apparatus comprising a first optical channel including a first image source which transmits a first light beam in a relatively

narrow spectral wavelength band of the spectral range of the eye, a second optical channel including a second image source which transmits a second light beam in a different and relatively broad spectral wavelength band of the spectral range of the eye, and beam combining means for receiving said first and second light beams whereby the first beam is transmitted and the second beam is reflected in the same direction within a single common light beam, wherein the first optical channel is a high resolution optical channel and the second optical channel is a low resolution optical channel.

Preferably the first optical channel is arranged for operation within the green spectral wavelength band while the second optical channel is arranged for operation in the spectral wavelength band extending to cover colours other than green.

The first image source may take the form of a monochromatic high resolution green cathode ray tube.

The second image source may take the form of either a conventional three-gun three-colour cathode ray tube in which only the red and blue guns are used, or a flat colour display device, preferably a back illuminated liquid crystal display device or alternatively an electroluminescent display device.

It is envisaged that both the first and second image sources may take the form of flat display devices.

The beam combining means in one arrangement of the display apparatus may be dichroic. In another arrangement, the beam combining means may take the form of a diffractive or holographic optical element.

The beam combining means may take the form of a cube comprising two contacting 45° prisms wherein at least one of the contacting faces of the prisms includes either a dichroic film or a holographic optical element.

In another arrangement of the display device the beam combining means may take the form of a relatively thin plate of optically flat glass incorporating either a dichroic film or holographic optical element on one of the optically flat surfaces.

In the display arrangements including the cube as a beam combiner, it is preferable for a common lens element to be included in the path of the single common light beam output from the beam combiner.

In the above mentioned arrangements it is also preferable for a folding mirror to be included in the path of the single common light beam following the common lens element.

The optical display arrangements incorporated herein may incorporate a diffractive holographic optical element or a partial reflection means for transmitting the composite image to the viewer and this is usually disposed in the path of the single common light beam at an angle to the viewer's straight ahead line-of-sight.

A further lens element is preferably included in the path of the single common light beam immediately before the partial reflection means.

In the arrangement where the beam combining means takes the form of a plate, a first lens element is preferably included in

the path of the first light beam output from the cathode ray tube and a second lens element is preferably included in the path of the second light beam output from the liquid crystal display.

The invention will be more readily understood from the following description of several exemplary embodiments which should be read in conjunction with the accompanying drawings in which:

Fig. 1 illustrates a schematic diagram of one arrangement of the apparatus in accordance with this invention;

Fig. 2 illustrates a schematic diagram of a variant arrangement of the apparatus in accordance with this invention;

Fig. 3 illustrates a schematic diagram of a further variant arrangement of the apparatus in accordance with this invention; and,

Fig. 4 illustrates a schematic diagram of yet a further variant arrangement of the apparatus according to this invention.

Before discussing the detailed construction of the optical display apparatus it is appropriate to appreciate the general principle by which this particular apparatus is able to provide an improved display image.

The arrangement is based on the fact that the eye/brain sensory system has the characteristic that it will recognise the

combination of a high resolution picture in the central part of the spectral response range of the eye, in the green say, with a low resolution picture in any or all of the remainder of the spectrum, as sharp and acceptable as a viewable scene.

Referring now to the drawings, it should be understood that, for simplicity, like components in the various embodiments shown in Figs. 1 to 4 have been identically designated.

Referring particularly to Fig. 1, it will be seen that the arrangement shown incorporates two cathode ray tubes (c.r.t.'s) 1 and 2 arranged orthogonally with respect to one another. The screens 3 and 4, upon which images are formed, each face a dichroic beam combiner which takes the form of a cube comprising two 45° prisms 6 and 7 with at least one of the contacting surfaces of one of the prisms being dichroically treated, for example, by the deposition of a dichroic film HD.

Cathode ray tube 1 is a monochromatic high resolution green tube which transmits a high resolution image in a relatively narrow wavelength band for a high resolution optical channel H, whereas cathode ray tube 2 is a conventional low resolution three-gun three-colour (red, blue and green) tube which transmits a low resolution image in a relatively broad wavelength band for a low resolution optical channel L.

In the display apparatus, it is arranged for only the red and blue guns of the cathode ray tube 2 to be used. The other colour, required for providing a full colour composite image for presentation to the pilot or viewer E being obtained from the high

resolution optical channel H.

Thus, in operation, the image from c.r.t. 1 at a first spectral wavelength (green) is transmitted in a first light beam by the dichroic combiner 5, whereas the image from the other c.r.t. 2 at a second spectral wavelength (including all other colours, other than green, of the spectral wavelength band) in a second light beam is reflected by the dichroic combiner 5. The first and second light beams are thus combined in a single common light beam and transmitted through a common lens element 8 located adjacent the dichroic combiner 5 and transmitted onward to a folding mirror 9 of conventional form.

The single common beam is transmitted through a further lens element 10 to a conventional partial reflector 11 inserted at an angle to the viewer's straight-ahead line of sight.

The single common light beam is received on the front of the reflector 11 (the viewer's E side) and the images from the two image sources (c.r.t.'s 1 and 2) superimposed on the external view as seen by the viewer E through the partial reflector 11.

Referring now to Fig. 2 this is substantially identical with the arrangement shown in Fig. 1 except that the c.r.t. 2 is replaced by a back-illuminated colour liquid crystal display LCD. This display is flat and consequently does not consume as much space as the equivalent c.r.t. display. This is a distinct advantage when space is limited as is the case in a fighter aircraft cockpit.

The operation of the arrangement of Fig. 2 is identical with

that described for Fig. 1, the image for the low resolution optical channel L being generated by the liquid crystal display LCD instead of the c.r.t. 2.

Referring now to Fig. 3 which shows a very similar arrangement to Fig. 1 except that the cube dichroic beam combiner has been dispensed with. The beam combining fuction is in this case performed by a modified folding mirror 5 where the low resolution channel image source is positioned directly below the mirror.

The folding mirror in this arrangement takes the form of a relatively thin plate of optically flat glass which includes a dichroic film HD on one of its surfaces.

This arrangement requires the c.r.t. 1 to be relatively close to a first lens element 8 and of course requires the addition of a similar second lens element 12 arranged in relation to the c.r.t. 2 in a manner similar to the first lens element 8 in relation to c.r.t. 1 of Fig 3.

While this arrangement will not be as heavy as the arrangement of Fig. 1 and Fig. 2 its operation is substantially identical with that described in respect of the arrangement illustrated in Fig. 1 and Fig. 2.

Referring finally to Fig. 4, this is substantially identical with that arrangement shown in Fig. 3 except that, in the manner of the arrangement of Fig. 2, the low resolution channel c.r.t. 2 is replaced by a back illuminated colour liquid crystal display LCD. The liquid crystal display also requires the addition of

a second lens element 12 as is required for the c.r.t. 2 in Fig 3.

This arrangement provides similar advantages as accrued, with the arrangement of Fig. 2 and is even more compact providing an additional option of the apparatus which would find particular utility in an aircraft cockpit where equipment mounting space is limited. Otherwise the arrangement of Fig. 4 operates in a manner substantially similar to that described in relation to the arrangement illustrated in Fig. 3.

It will be apparent to those skilled in the art that the low resolution optical channel L may employ other types of cathode ray tube to produce the two colours red and blue without departing from the features of this invention. One such type, for instance, is that known as a 'penetron' c.r.t. which is also known as a 'punch through' c.r.t.

It will be appreciated by those skilled in the art that the beam combiner 5 and the reflection means 11 may incorporate a diffractive or holographic optical element HD, 13, arranged for operation either in the transmit or reflection modes as appropriate.

It is envisaged that, subject to the availability of suitable high resolution devices, the image source of the high resolution optical channel H may, instead of employing a cathode ray tube, employ a flat colour display device.

While this invention has been described in relation to employment of flat display devices of the back lit liquid crystal

display type by way of example, it will be apparent to those skilled in the art that other types of flat display devices may be employed, for instance, an electroluminescent type display device.

CLAIMS

1. Optical display apparatus for presentation of a composite image from images from two separate image sources to a viewer, the apparatus comprising a first optical channel including a first image source which transmits a first light beam in a relatively narrow spectral wavelength band of the spectral range of the eye, a second optical channel including a second image source which transmits a light beam in a different and relatively broad spectral wavelength band of the spectral range of the eye, and beam combining means for receiving said first and second light beams whereby the first beam is transmitted and the second beam is reflected in the same direction within a single common light beam, wherein the first optical channel is a high resolution optical channel and the second optical channel is a low resolution optical channel.

2. Optical display apparatus as claimed in claim 1, wherein the first optical channel is arranged for operation within the green spectral wavelength band.

3. Optical display apparatus as claimed in claim 2, wherein the second optical channel is arranged for operation in the spectral wavelength band extending to cover colours other than green.

4. Optical display apparatus as claimed in claim 1, 2 or 3, wherein the first image source is a monochromatic high resolution green cathode ray tube.

5. Optical display apparatus as claimed in claim 1, 2 or 3, wherein the first image source is a high resolution green flat display device.

6. Optical display apparatus as claimed in claim 4 or 5, wherein the second image source is a conventional three-gun three-colour cathode ray tube in which only the red and blue guns are used.

7. Optical display apparatus as claimed in claim 4 or 5, wherein the second image source is a flat colour display device.

8. Optical display apparatus as claimed in claim 7, wherein the flat colour display device is a back illuminated liquid crystal display device.

9. Optical display apparatus as claimed in claim 7, wherein the flat colour display device is an electroluminescent display device.

10. Optical display apparatus as claimed in any one preceding claim, wherein the beam combining means incorporates a dichroic film.

11. Optical display apparatus as claimed in any one of claims 1 to 9, wherein the beam combining means incorporates diffractive or holographic optical element.

12. Optical display apparatus as claimed in claim 10 or 11, wherein the beam combining means comprises a cube comprising two contacting 45° prisms.

13. Optical display apparatus as claimed in claim 10 or 11, wherein the beam combining means comprises a relatively thin plate of optically flat glass.

14. Optical display apparatus as claimed in claim 13, wherein a first lens element is included in the first light beam output from the monochromatic cathode ray tube.

15. Optical display apparatus as claimed in claim 14, wherein a second lens element is included in the second light beam output from the flat colour display device.

16. Optical display apparatus as claimed in claim 10, 11 or 12, wherein a common lens element is included in the path of the single common light beam output from the beam combiner.

17. Optical display apparatus as claimed in claim 16, wherein a folding mirror is included in the path of the single common

light beam following the common lens element.

18. Optical display apparatus as claimed in any preceding claim, wherein a reflection means is included in the path of the single common light beam at an angle to the viewer's straight ahead line-of-sight.

19. Optical display apparatus as claimed in claim 18, wherein a further lens element is included in the path of the single common light beam immediately before the reflection means.

20. Optical display apparatus as claimed in claim 19, wherein the reflection means is constituted by a diffractive or holographic optical element.

21. Optical display apparatus as claimed in any of claim 19, wherein the reflection means is a partial reflector.

22. Optical display apparatus for presentation of a composite image derived from first and second component images, wherein the apparatus comprises:-

a first optical channel having a first image source operable to transmit a first light beam in a first wavelength band which is part of the spectral wavelength range of the human eye;

a second optical channel of lower resolution than the first optical channel and having a second image source operable to transmit a second light beam in a second wavelength band occupying the spectral wavelength range of the human eye, the second wavelength band covering a broader range of wavelengths than the first wavelength band; and

beam combining means for receiving the first and second light beams and optically combining them to be transmitted both in the same direction as a single composite beam.

23. Apparatus according to claim 18, wherein the first image source is a monochromatic source.

24. Apparatus according to claim 18, wherein the first image source is operable to generate radiation only in the green part of the spectral range of the human eye.

25. Apparatus according to claim 20, wherein the second image source is operable to generate radiation at shorter and longer wavelengths than radiation in the green part of the spectral range of the human eye.

26. Apparatus according to claim 21, wherein the second image source is a cathode ray tube having a plurality of electron guns.

27. Apparatus according to claim 22, wherein the beam combining means comprises a pair of 45° prisms.

28. Optical display apparatus substantially as herein described with reference to, and as shown, in the accompanying drawings.

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