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H4F
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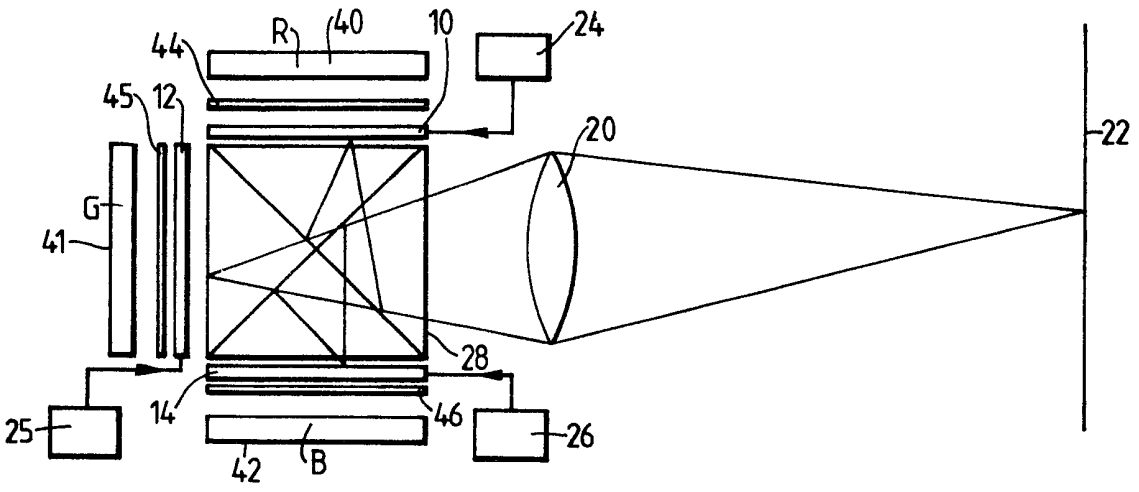
(54) Colour video display arrangement

(57) A colour video display arrangement includes three non-emissive electro-optic matrix display devices 10, 12, 14, for example LCDs, operating in transmission mode and respectively illuminated by light of a primary colour, R, G and B, so as to produce output image beams modulated with picture information in the associated colour, the images being optically combined into a single beam for projection onto a display screen 22. Each display device may have its own light source, e.g. one or more monochromatic flourescent lamps 40, 41, 42, emitting the appropriate colour light or a white light source may be employed in conjunction with an optical splitter to split the light into its primary colour components (Fig. 2).

Fig.1.



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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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Fig.1.

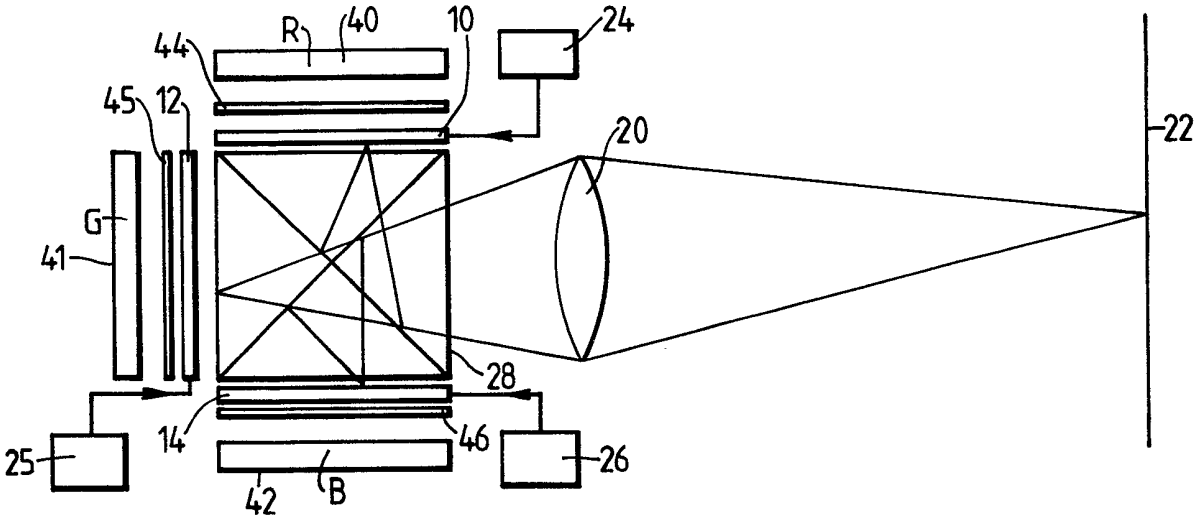


Fig.2.

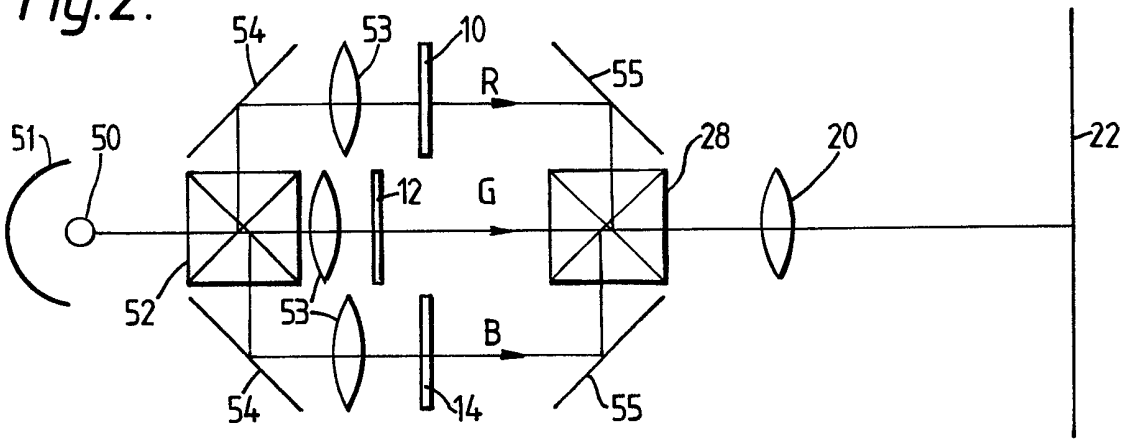
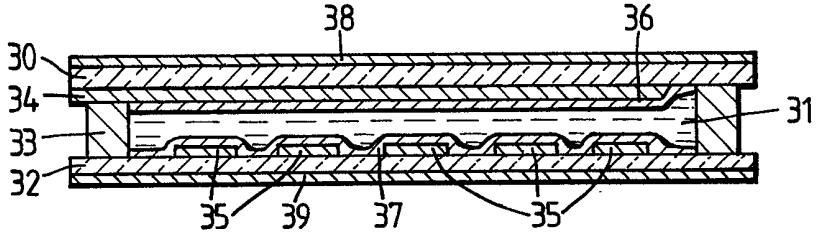


Fig.3.



SPECIFICATION

Colour video display arrangement

This invention relates to a colour video display arrangement, and in particular to a colour video display arrangement, for example a TV display arrangement, in which a non-emissive display device modulates light to produce a picture.

A known arrangement of this type comprises a matrix liquid display device having rows and columns of conductors carried on respective substrates between which a layer of liquid crystal material is disposed, the intersections between the electrode rows and columns defining a matrix of individual pixels each of which is separately controllable by appropriate addressing of the electrodes to act as a light shutter so as selectively to allow or prevent the passage of light therethrough. In order to achieve colour display, the device is illuminated from behind by a white light source and a colour filter is associated with such picture element, typically by means of a filter layer comprising an array of discrete red, green and blue colour filter areas arranged in groups of three and aligned with the pixels with groups of three adjacent pixels thereby forming colour triplet picture elements.

This approach has disadvantages. For example, the total number of picture elements in the displayed image is only one third of the total number of picture elements present, and so the resolution of the display is limited. Also, the transmission of the display is low since the colour filter array only transmits one third of the incident light even with ideal filters perfectly matched to the back light. This low transmission means that the brightness of the displayed image is rather low or that the power of the back light has to be increased by a factor of at least three to produce a brightness of display equivalent to that of a monochrome display.

It is an object of the present invention to provide a colour video display arrangement which has better resolution capabilities and which enables improved brightness output to be achieved more efficiently compared with this known kind of arrangement.

According to the present invention, there is provided a colour video display arrangement in which a non-emissive electro-optic display device modulates light to produce a picture, which is characterised in that the arrangement comprises three non-emissive matrix electro-optic display devices operating in transmission mode, each of which is supplied with light of a respective and different primary colour and is arranged to modulate the light to produce a respective image output in the associated primary colour light, and means for optically combining the image outputs produced by the devices into a single image beam for projection onto a screen.

An advantage of this arrangement is that the resulting, combined and projected image has the full resolution of each of the three display devices so that higher resolution colour pictures may be displayed.

A further advantage is that the overall transmission of the display arrangement, and hence the brightness of the displayed picture at the screen, is improved by a factor of about three times, assuming low transmission loss in the combing optics, compared with the aforementioned known display arrangement. The improvement in picture brightness arises for two reasons. Firstly, the loss of light which would occur in the known arrangement even with perfect filters does not occur in the arrangement of the present invention since no significantly absorbing components are present. Secondly the losses due to imperfection in the filters, resulting in, for example, the red filter absorbing some red light, are also eliminated, although some small losses may occur in the optical components.

The optically combining means may comprise a dichroic combiner.

The non-emissive matrix display devices are preferably liquid crystal matrix light valve devices and may be of any conventional form. Such devices are commonly known. In one example, the device comprises nematic liquid crystal material disposed between a pair of spaced, optically transparent, substrates carrying transparent electrodes, for example row and column conductors, which define a matrix of pixels individually controllable by appropriate addressing to act as light shutters. A first polariser (analyser) is positioned adjacent one substrate and a second polariser having an axis of polarisation normal to that of the first polariser positioned adjacent the other substrate.

In one embodiment, the arrangement may further include a respective colour monochromatic light source associated with each of the display devices. These light sources may comprise fluorescent lamps producing, respectively, red, green and blue light outputs. Optical means, for example a diffuser or a field or condenser lens, may be interposed between each light source and its associated display device to provide uniform illumination over that display device.

In another embodiment, the arrangement may further include chromatic light source and a dichroic beam splitter separating light from the source into red, green and blue light beam outputs which are directed, for example, via mirrors and condenser lenses, to a respective display device.

The former embodiment has the advantage that a beam splitter is unnecessary whilst the latter embodiment has the advantage that only one light source is needed.

Embodiments of a colour video display arrangement, in particular a TV display arrangement, in accordance with the invention will now be described, by way of example, with reference to the accompanying drawing in which:—

Figure 1 shows schematically a first embodiment of the invention using three, differently-coloured light sources;

Figure 2 shows schematically a second embodiment of the invention using a single light source, and

Figure 3 is a schematic cross-sectional view

through one of the display devices used in both the first and second embodiments.

With reference to Figures 1 and 2, both embodiments of the colour TV display arrangement have three non-emissive matrix electro-optic display devices, namely liquid crystal devices, 10, 12 and 14, operating in transmission mode. Each of the display devices is illuminated from one side by a light of a respective primary colour, red, green and blue, and is controlled to act as a matrix light shutter or valve so as to modulate that light in accordance with the picture information so that an image of the picture to be displayed is generated in the respective primary colour at the other, output side, of the display device.

The differently-coloured images from the three display devices 10, 12 and 14 are then optically combined into a single multi-colour image beam which is projected by a projection lens 20, shown as a single element lens in Figures 1 and 2 for simplicity, to form a multi-colour picture image on a screen 22 visible to a viewer on the side of screen 22 opposite the projection lens 20. The matrix liquid crystal display devices 10, 12 and 14 may be of any known form suitable for acting as a matrix light shutter. One example of a suitable device is illustrated schematically in Figure 3, which shows a cross-section through the device. Referring to Figure 3, this device comprises a pair of flat, optically transparent, support plates 30 and 32 spaced apart and sealed together around their peripheries by a sealing frame 33 to form a cell which is filled with TN (twisted nematic) liquid crystal 31 material. The plates 30 and 32 carry rows 34 and columns 35 of strip electrodes respectively which extend at right angles to one another and form at their cross-overs a matrix of individual picture elements. These electrodes are covered by orientation layers 36 and 37. On the outer surfaces of the plate 30 and 32 are disposed polarisers 38 and 39. The polariser 39 has an axis of polarisation normal to that of the polariser 38 (the analyser) through which the light image produced by the device is transmitted.

The display device shown in Figure 3 and the above description thereof have deliberately been kept relatively simple. In actual practice the device has considerably more electrodes than shown in Figure 3 and may be of the matrix addressed kind in which a matrix of active switching elements, for example thin film transistors, is integrated into the device, typically on one of the plates, and in which the configuration of the electrodes is changed accordingly.

The display devices 10, 12 and 14 are controlled in scanning fashion and are each driven in a conventional manner separately, but in synchronism, by an associated driving circuits, 24, 25 and 26, (omitted from Figure 2 for simplicity) in accordance respectively with R, G and B video signals supplied thereto from a video decoder (not shown). Thus, when illuminated evenly and continuously from behind by its associated primary colour light, each scanning light transmissive matrix device 10, 12 and 14 modulates that light to produce at its output a picture image in the associated colour, these images subsequently being combined by an optical combiner 28 and thence projected as a single beam onto the screen 22 to form a synthesised, full colour, pictorial image comprising the three differently-coloured images superimposed on one another.

Referring now to the embodiment shown in Figure 1, the display devices are arranged with the major planes of the devices 10 and 14 parallel and facing one another and at right angles to the major plane of device 12 forming three sides of a rectangle. Each of the display devices 10, 12 and 14 is back-lighted by a separate monochromatic light source, 40, 41 and 42 producing light at a wavelength corresponding to a respective one of the primary colours. Thus the light source 40 produces red light, the light source 41 produces green light and the light source 42 produces blue light. The light sources 40, 41 and 42 are fluorescent lamps adapted to produce the desired light colour by appropriate selection of their phosphor material. The fluorescent lamps may be planar and substantially co-extensive with their associated display device so as to illuminate the device uniformly. Alternatively the fluorescent lamps may be miniature tubular lamps. One or a number of such lamps arranged side by side may be associated with each display device together with a diffuser as indicated at 44, 45 and 46. The lamps include reflectors to direct the light output over the display devices.

A field or condenser lens may be interposed between each light source and its display device to collect light emitted by the lamp and provide uniform illumination over the device input side. Red, green and blue light emanating from the display devices 10, 12 and 14, and modulated in accordance with picture information to constitute red, green and blue picture image components, is directed into the optical combiner 28, arranged within the volume bounded by the devices, where the three differently-coloured images generated by the display devices are combined and directed as a single image beam to the projection lens 20. The combiner 28 is of standard form using dichroic principles and comprises glass prisms cemented together with dichroic layers being applied to mating surfaces. Crossed dichroic mirrors could be used instead to the same effect. To illustrate the operation of the combiner 28 and projection lens 20, typical ray paths from correspondingly positioned picture elements of the display devices 10, 12 and 14 are indicated in Figure 1.

Referring to Figure 2, this embodiment uses a single light source, referenced at 50, emitting white light comprising a mixture of red, green and blue chromatic components. Light from the source 50, which may be one or more fluorescent lamps, is directed with the aid of a reflector 51 into an optical, dichroic, beam splitter 52 which separates the light into its three colour components, to produce three primary colour beams (R, G and B). The green beam passes substantially straight through the beam splitter 52 and is directed onto the display device 12

to illuminate uniformly the device by way of a condenser lens 53. The display devices 10, 12 and 14 are arranged with their major planes parallel to each other and symmetrical with respect to the beam splitter 52 and the combiner 28. A folded optical arrangement employing mirrors 54 and 55 is used for the red and blue light beams. The red and blue component beams are directed respectively upwardly and downwardly in Figure 2 from the beam splitter 52 and deflected by the mirrors 54 through condenser lenses 53 onto the display devices 10 and 14.

The beam splitter 52 is of similar construction to the combiner 28 but, of course, operates in the opposite sense.

Green light, modulated in accordance with picture information by the display device 12 and constituting the green light image component is directed into the optical combiner 28. Red and blue light emanating from the display devices 10 and 14 and modulated thereby to constitute red and blue picture image components is deflected into the combiner 28 by way of the mirrors 55. The three separate red, green and blue light images are combined in the combiner 28 to form a single multi-colour output beam which is projected onto the screen 22 by the projection lens 20. Typical rays for a picture element approximately at the centre of the picture/display devices are indicated in Figure 2 by way of example.

Instead of liquid crystal display devices, other non-emissive matrix electro-optic display devices may be used in the display arrangement, for example electroscopic matrix display devices operative in transmission mode or ferroelectric light valves.

The invention is not restricted to the above-described embodiments which can be varied in a number of ways within the scope of the invention in accordance with the appended claims.

CLAIMS

1. A colour TV display arrangement in which a non-emissive electro-optic display device modulates light to produce a picture, which is characterised in that the arrangement comprises three non-emissive matrix electro-optic display devices operating in transmission mode, each of which is supplied with light of a respective and different primary colour and is arranged to modulate the light to produce a respective image output in the associated primary colour light, and means for optically combining the image outputs produced by the devices into a single image beam for projection onto a screen.

2. A colour TV display arrangement according to Claim 1, characterised in that the non-emissive matrix display devices comprise liquid crystal matrix light valve devices.

3. A colour TV display arrangement according to Claim 1 or Claim 2, characterised in that the optically combining means comprises a dichroic combiner.

4. A colour TV display arrangement according to any one of Claims 1, 2 or 3, characterised in that the arrangement further includes red, green and blue light sources with a respective colour light source being associated with each of the display devices.

5. A colour TV display arrangement according to any one of Claims 1, 2 or 3, characterised in that the arrangement further includes a chromatic light source and a dichroic beam splitter for separating light from the light source into red, green and blue light outputs which are directed to a respective display device.

6. A colour TV display arrangement according to any one of the preceding claims, characterised in that the or each light source comprises one or more fluorescent lamps.

7. A colour TV display arrangement substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

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