structure simultaneously provides the functions of the black matrix and the mullions, but the mullion lines are not visible, as such, to the viewer because all lines in the pattern on the optical integrator structure **1220** are essentially the same and are virtually indistinguishable. Accordingly, the viewer simply sees a uniform pattern of black lines. A key feature of this aspect of the subject invention is the precise specification of the pattern of black lines and mullions on the disclosed optical integrator structure so that the physical gaps between tiles are hidden from the viewer, and at the same time so that little or no emitted light is blocked from exiting the display. In addition, the black matrix and the mullions do not disturb the continuity of the larger image, even across the gaps between tiles.

[0076] As set forth above, the front glass plate **1220** with the black matrix lines **1210** may be used with a full-size display to add a black matrix to the display device. When the display device is formed, as described above, with the active pixel elements having a dark-colored background, a front glass plate **1220** may further enhance the contrast of the display by providing a reinforcing black matrix to the display device. The use of a black matrix on such a display may also make it unnecessary to mask the reflective row and/or column electrodes with a dark material as these areas will be covered by the black matrix.

[0077] To more easily describe the optical integrator structure shown in **FIG. 12, a** method of joining tiles using discrete mullions is first described. **FIG. 13** is a cross section of portions of two tiles **100**, according to the present invention, which are joined by a mullion **1310**. Each of the tiles includes a glass substrate **120**; the remainder of the tile structure is not shown in **FIG. 13**. The exemplary tiles include active display material (not shown) located proximate to the bottom surface of the glass substrate **120**. The exemplary tiles also include black lines **1313** which form a portion of the black matrix.

[0078] **FIG. 14** is a perspective drawing of an exemplary mullion **1310** suitable for use with a display device according to the subject invention. The mullion **1310** includes a top surface **1410** which may be formed from a black material or may be printed or painted black. To ensure that the mullion does not create artifacts on the display device, it is desirable for the top surface of the mullion to closely match the black stripes **1313** in size, color and gloss. The mullion **1310** also includes a bottom stem having side surfaces **1412** which are desirably formed from a light-colored material (e.g. white). Alternatively, the bottom stem of the mullion may be transparent and have an index of refraction close to that of the transparent substrate **120**. It is desirable for the bottom stem of the mullion to be light-colored or transparent so that any light scattered in the vicinity of the mullion has the same properties as light that is scattered among pixels at the interior of a tile. If light scatters differently at the edge of a tile than near the center then the edge may be visible, for example, as a band of reduced brightness in the displayed image. Two or more of the side surfaces **1412** and the underside **1414** of the top bar of the mullion may be coated with adhesive to attach the mullion **1310** to the two tiles which it joins. If all of these surfaces are coated with adhesive, the mullions may be used to join the tiles into a display device without using the integrating structure **1220**. In this instance, a black matrix according to the present invention may be formed on the viewer surface of the transparent substrates **120** of the individual tiles.

[0079] To determine the optimum placement for a black stripe or a mullion on the front surface of the glass substrate of an emissive display, it is helpful to understand the properties of light emitted by the display. **FIG. 15** shows a cross section of an exemplary glass substrate **120** which includes a bottom surface **1510** and a top surface **1512**. A number of representative optical rays, **1514**, **1516** and **1518** are shown emanating from a point on the bottom surface **1510**. Some rays **1514** exit the glass and some rays **1518** are totally internally reflected from the top surface **1512** and are trapped in the sheet of glass. At the transition between these two types of rays are rays **1516** which are refracted to an angle parallel to the top surface **1512** of the substrate **120**.

[0080] The angle of incidence of the rays **1516** which are at the transition is called the critical angle (Θc). Light reaching the surface **1512** with angles less than the critical angle exits the glass, and light reaching the surface **1512** with angles larger that the critical angle are totally internally reflected. The critical angle is dependent on the index of refraction, n_{glass}, of the glass substrate **120** as shown in equation (1):

$$\Theta_c = \mathrm{Sin}^{-1}(1/n_{glass}) \quad (1)$$

[0081] In the exemplary embodiment of the invention, n_{glass}=1.55 and Θ_c~40°.

[0082] A tiled display is made of tiles that are placed in an array so that the spacing between pixels across the gap between tiles is substantially the same as the pitch between pixels within the display tiles. Thus, the display tile edge is one-half pitch distance (or slightly less) from the center of the last pixel. Because of the critical angle, light emitted from a point within a sheet of glass can travel at most a lateral distance of $d_c = t_{glass}$ Tan (Θ_c), where t_{glass} is the thickness of glass. Therefore, light from any part of a gap region may be blocked by putting a black stripe of width $W_m \geqq 2\ d_c$ over the gap region. Such a black stripe is shown in **FIG. 16** as the top of the mullion **1310**. Because of the symmetry of optics, the same black stripe blocks any external rays from making the gap region visible. Thus this black stripe makes the gap region invisible to an observer. In practice, the black stripe or the top bar of the mullion may need to be slightly wider than 2 d_c to account for any finite width of the gap.

[0083] Referring, again, to the structure shown in **FIGS. 12 and 12A**, the individual tiles do not need to be joined by discrete mullions. Instead, the tiles may be assembled directly on the back surface of the optical integrating structure **1220** such that the gaps are positioned directly over black stripes having a width W_m. As shown in **FIGS. 12 and 12A**, the exemplary optical integrating structure **1220** is positioned on top of the array of tiles, with the black lines on the surface of the structure in contact with the glass substrates **120** of tiles. The centers of the black lines are aligned with the gaps between the tiles so that the gap regions can not be seen by an observer. Although this embodiment of the invention does not need discrete mullions, if the tiles are connected by mullions **1310**, the integrating structure **1220** may include black lines that cover the top surfaces **1410** of the mullions. In this instance it would be desirable for the top bar of the mullion to be as thin