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LIGHT MODULATING SCREEN
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354,771

FIG. 1

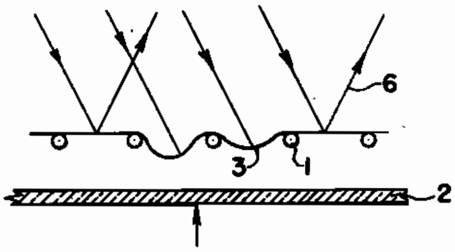


FIG. 2

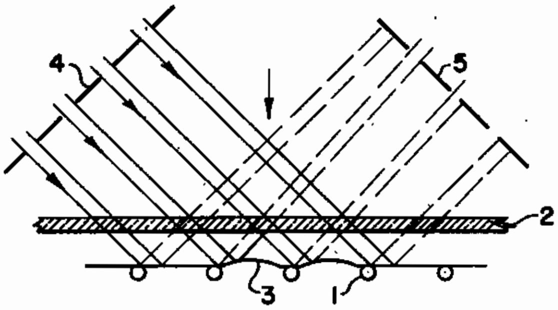


FIG. 3

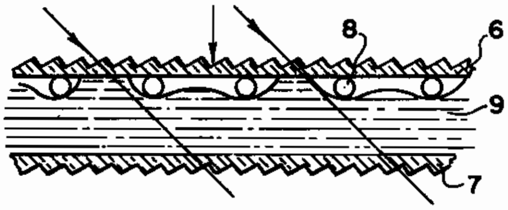


FIG. 4

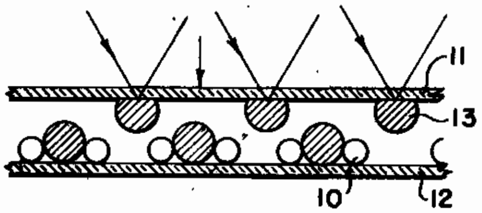
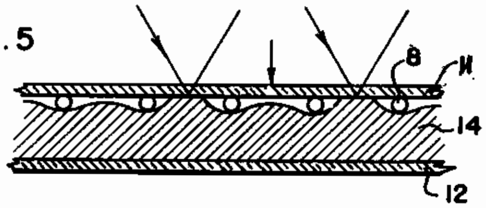


FIG. 5



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ALIEN PROPERTY CUSTODIAN

LIGHT MODULATING SCREEN

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Application filed August 29, 1940

This invention relates to a light modulating screen, particularly to a screen for television use which allows modulation of the spatial intensity distribution of a local light source of constant intensity, and is a refiling of application Serial No. 209,931 filed May 25, 1938.

Screens of this type are known in the art, particularly such screens which make use of a multitude of so-called flippers, which actuate light valves or change the optical path of the light in accordance with picture signals. These screens are extremely difficult to produce and are sluggish in operation.

It is the object of this invention to provide a new screen which can be readily produced without difficulty; to provide a screen which is not sluggish; to provide a screen which may be directly viewed or projected in an enlarged scale; and to provide a screen rendering a brilliant image of high definition. Other advantages may be seen from the following description of the invention.

Considered broadly, the screen according to this invention consists of a deformable surface capable of varying the optical path of light through the screen, when deformed, and a matrix. This matrix may consist of a screen whose openings are smaller than or equal to the size of a picture element. Means are provided to press individual regions of the matrix against the deformable surface, or alternatively to press individual regions of the deformable surface against the matrix, in accordance with the incoming picture signals, resulting in a deformation of the deformable surface compared with its position when no picture signals are received. The matrix in effect divides the deformable surface into a multitude of individual picture elements. There is also provided a local light source of constant high intensity, whose light is directed upon the deformable surface. The degree of deformation of individual regions of the surface is used to alter the path of incident light rays. This in turn results in a modulation of the spatial distribution of light intensity. To this end, the deformation of the deformable surface may be used to alter the optical path of light through the screen in two different ways. First, deformation of the surface, if it is reflecting, can be used to alter the angle of incidence and thereby also the angle of reflection of light directed upon the surface. Secondly, deformation of the surface, if it is that of a transparent medium possessing a certain predetermined refractive index, can be used to alter the angle of refraction to which light passing through the screen is subjected.

The outgoing light stream, thus modulated in its spatial intensity distribution, can be directed upon a screen of ground glass, thereupon producing an image, or may be gathered in a projection lens and projected in an enlarged scale upon a viewing screen.

In order to explain the nature of this invention in detail, several embodiments are shown in the drawings, where Figures 1 to 5 are fragmentary diagrammatic cross-sectional views of screens embodying the present invention.

Referring to Figure 1, there is shown a matrix 1, which may consist of a screen of any suitable material. The flat portion of the bottom wall of a cathode ray tube is indicated by 2, and the vertical arrow touching wall 2 from the bottom illustrates the cathode ray beam which is modulated by incoming picture signals and scanned across wall 2. The deformable surface 3 may consist of a thin metal foil which is spaced from wall 2 by matrix 1. The cathode ray beam produces local charges on wall 2, according to its intensity. Individual regions of the deformable surface 3 will then be attracted toward wall 2 by virtue of and to an extent corresponding to the magnitude of the local charges. If a beam of light is incident upon a portion of surface 3 which has not been deformed but has remained flat, it will be entirely reflected in a new direction. If the region of surface 3 upon which the beam is incident has been deformed and shows a curvature of the surface, the incident beam will be reflected in various directions, that is, it will be dispersed. Thus, if the screen is observed from the direction of the emanating light rays themselves, the screen will appear bright at spots where the surface has remained flat; spots which have been more or less curved will appear less brilliant, according to the degree of curvature. This distribution of brightness, representing the new image, may be directly viewed or projected upon a screen by means of a lens system.

Figure 2 shows a modification of the above embodiment. Again 2 may be the flat portion of the bottom wall of a cathode ray tube, which is scanned by the modulated cathode ray beam indicated by the vertical arrow. Spaced from wall 2 is the matrix 1, upon which a thin metal foil 3 may be attached in a suitable manner. Light from a constant source is directed through a latticework 4 upon foil 3 so that it is incident only upon certain portions of the individual regions of the deformable surface. If the elemental regions of the surface are deformed, the angle of reflection of the incident light will be changed. A second latticework 5, which is identical with latticework 4, is located in the path of the reflected light. If the reflecting surface is not deformed at all, the reflected light beams impinge on the solid portions of latticework 5 so that no light will go through the latter. If individual regions of the reflecting surface are deformed, this will to a certain degree change the angle of reflection and a certain portion of the light reflected by such an individual region will be allowed to pass through an opening in latticework 5. The variation in angle of reflection, and thereby the amount of light passing through an opening in latticework 5, can thus be varied in accordance with incoming picture signals. It is, of course, also possible to allow all light to pass through latticework 5 when the surface is not deformed and to blank out portions thereof with increasing deformation.

A modification in the construction of the screen is possible inasmuch as the thin foil 3 can be spot-welded along lines or at certain points to a base plate, thus eliminating matrix 1. Alternatively, it is possible to combine matrix 1 and wall 2 into one unit, as may readily be seen.

The charges conveyed to wall 2 can be neutralized by giving a certain amount of conductivity to this wall, or neutralization can be accomplished by a second cathode ray beam which scans wall 2 simultaneously with the charging cathode ray beam but leading the latter.

Figure 3 shows another embodiment of this invention. A liquid 3 is disposed in a glass container possessing two plane walls 6 and 7. A screen-shaped matrix 8 is in contact with the liquid. Wall 6 constitues the flat bottom of a cathode ray tube, scanned by the modulated cathode ray beam illustrated by the vertical arrow from the top. The cathode ray beam conveys charges to wall 6 in accordance with incoming picture signals. For conditions of no charges on wall 6, the liquid does not touch glass wall 6. However, if charges are conveyed to glass wall 6, the liquid, which may be conductive and held at a definite potential, is atracted towards glass wall 6. The attracting force is proportional to the charge, and thereby the area of contact between liquid and glass wall will correspond to the magnitude of the charge. In this case, parallel light rays from a constant source are directed upon the screen. In such spots where liquid 9 is in contact with wall 6, the beam passes through the screen unimpeded. In regions, however, where no contact exists, and where wall 6 and the surface of liquid 9 are spaced from each other, incident light beams will suffer total reflection. Water, for instance, can be used as the required liquid. If the refractive indices of wall 6 and liquid 9 are identical, permeating light rays will not suffer any deflection.

As it is necessary in this case that the light from the constant source be incident upon wall 6 under a constant angle, parallel light rays are preferably used, and the upper surface of wall 6, as well as the bottom surface of wall 7, is provided with grooves so that the incident and emanating light rays form an angle of 90 degrees with the respective surfaces. In order to avoid wetting of wall 6 by liquid 9, it may be preferable to prevent this by providing the inner surface of wall 6 with a film of oil, or to take any other measure to this end.

Figure 4 is a further embodiment of the invention. In Figure 4 a matrix 10 is again located between two plane walls 11 and 12. The wall 11 is the flat portion of the bottom of a cathode ray tube, scanned by the modulated cathode ray beam illustrated by the vertical arrow from above. Matrix 10 is in close contact with wall 12, and each of its apertures contains a droplet of mercury 13. When the screen is not being actuated, these droplets rest upon wall 12. When, however, the cathode ray beam conveys local charges to wall 11, these droplets are attracted towards wall 11 thereby, so that they press themselves against this wall, whereby the area of contact corresponds with the magnitude of the individual local charge. Light rays incident upon wall 11 are reflected from regions where mercury droplets are in contact with wall 11. The amount of light reflected is proportional to the area of contact.

Figure 5 is a further embodiment of the invention, and represents a modification of that shown in Figure 4. In this case, the screen contains a continuous layer of mercury 14 instead of individual droplets. Matrix 8 is closely adjacent to wall 11. The mode of operation is essentially the same as described in connection with Figure 4.

In the cases of Figures 4 and 5, it may be preferable to fill the space between walls 11 and 12, which is not taken up by the mercury and the matrix, with an electrically isolating liquid of substantially the same refractive index as that of wall 11. This may be done in order to avoid adhesion of the mercury droplets to the wall, and to decrease the reflection from the lower surface of wall 11. Preferably, a liquid of low density is used.

From the foregoing it may be seen that the use of separate members for defining picture elements and for light modulation has inherent advantages over other screens known in the prior art.

While I have described embodiments of my invention using a separate screen-like member, referred to as the matrix, I do not limit myself to this particular embodiment.

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