United States Patent [19]

Nathanson et al.

[11] **3,746,911**

[45] **July 17, 1973**

[54] **ELECTROSTATICALLY DEFLECTABLE LIGHT VALVES FOR PROJECTION DISPLAYS**

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[73] Assignee: **Westinghouse Electric Corporation**, Pittsburgh, Pa.

[22] Filed: **Apr. 13, 1971**

[21] Appl. No.: **133,608**

[52] **U.S. Cl.** .... **315/21 R**, 178/7.5 D
[51] **Int. Cl.** **H01j 29/70**
[58] **Field of Search** .... 178/5.4 BD, 7.5 D; 315/21; 313/91

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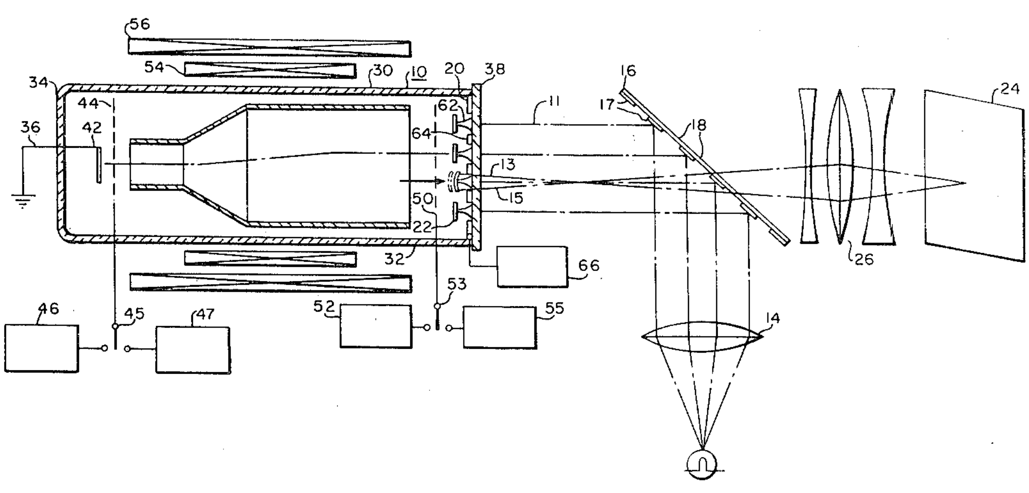
Primary Examiner—Benjamin R. Padgett
Assistant Examiner—J. M. Potenza
Attorney—F. H. Henson and C. F. Renz

[57] **ABSTRACT**

An electrostatically deflectable light valve for use in large area projection display. The system utilizes an array of electrostatically deflectable reflective elements lying in a plane which provides modulation of a light source directed thereon so as to spatially modulate and produce a display of brightness analogous to the amplitude of the deformation of the reflective elements. The elements of the array are comprised of a centrally located post supporting the reflective element. A common ground plane electrode is provided beneath the reflective elements and is capacitively associated therewith. This ground plane electrode in the cathode ray tube embodiment intercepts the electrons that are not intercepted by the reflective elements. The materials and the processes used in the fabrication particularly adapt themselves to the fabrication of large area devices having a resolution capability similar to that of television.

15 Claims, 29 Drawing Figures



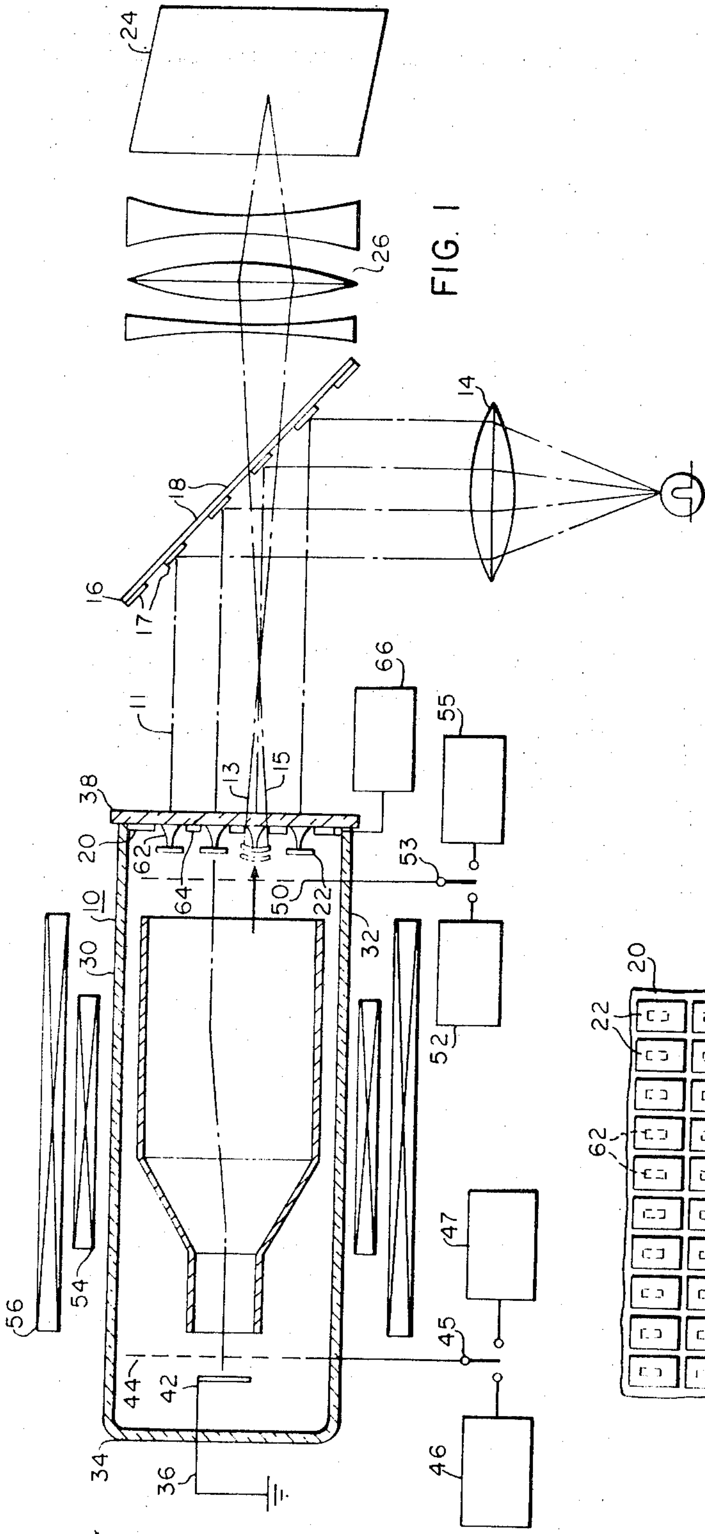


FIG. 1

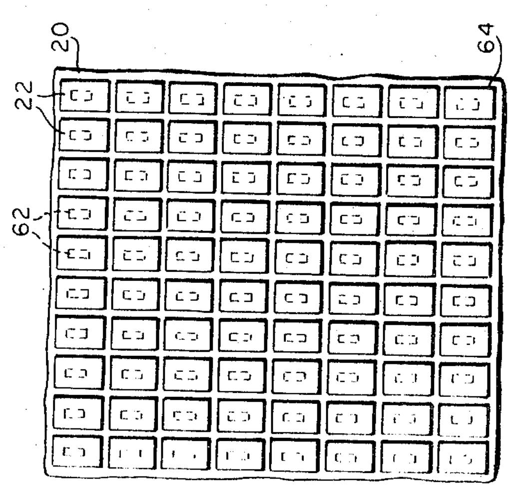


FIG. 2

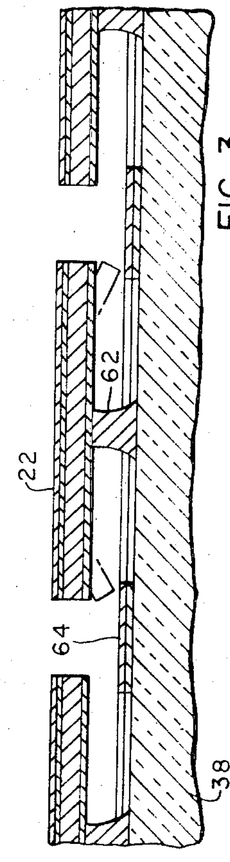


FIG. 3

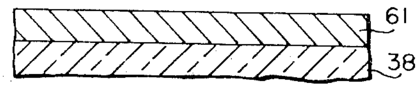


FIG. 4

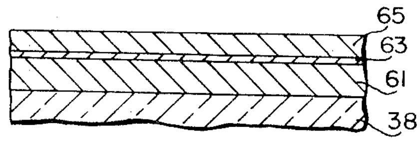


FIG. 5

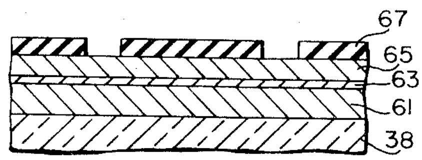


FIG. 6

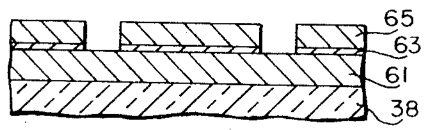


FIG. 7

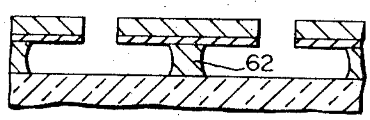


FIG. 8

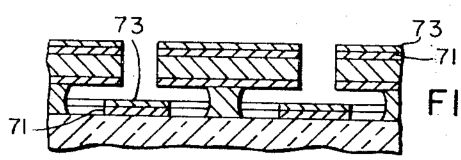


FIG. 9

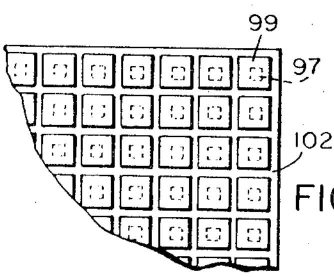


FIG. 11

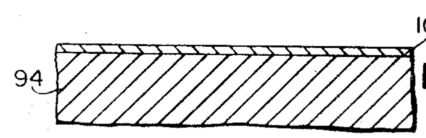


FIG. 13

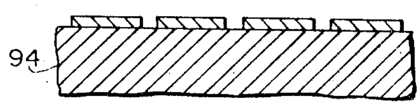


FIG. 14

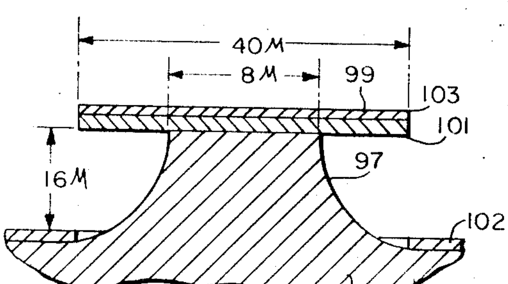


FIG. 12

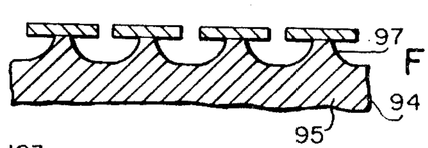


FIG.15

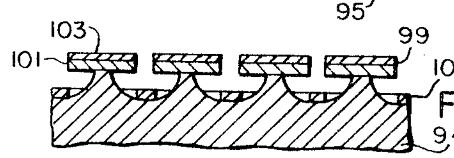


FIG.16

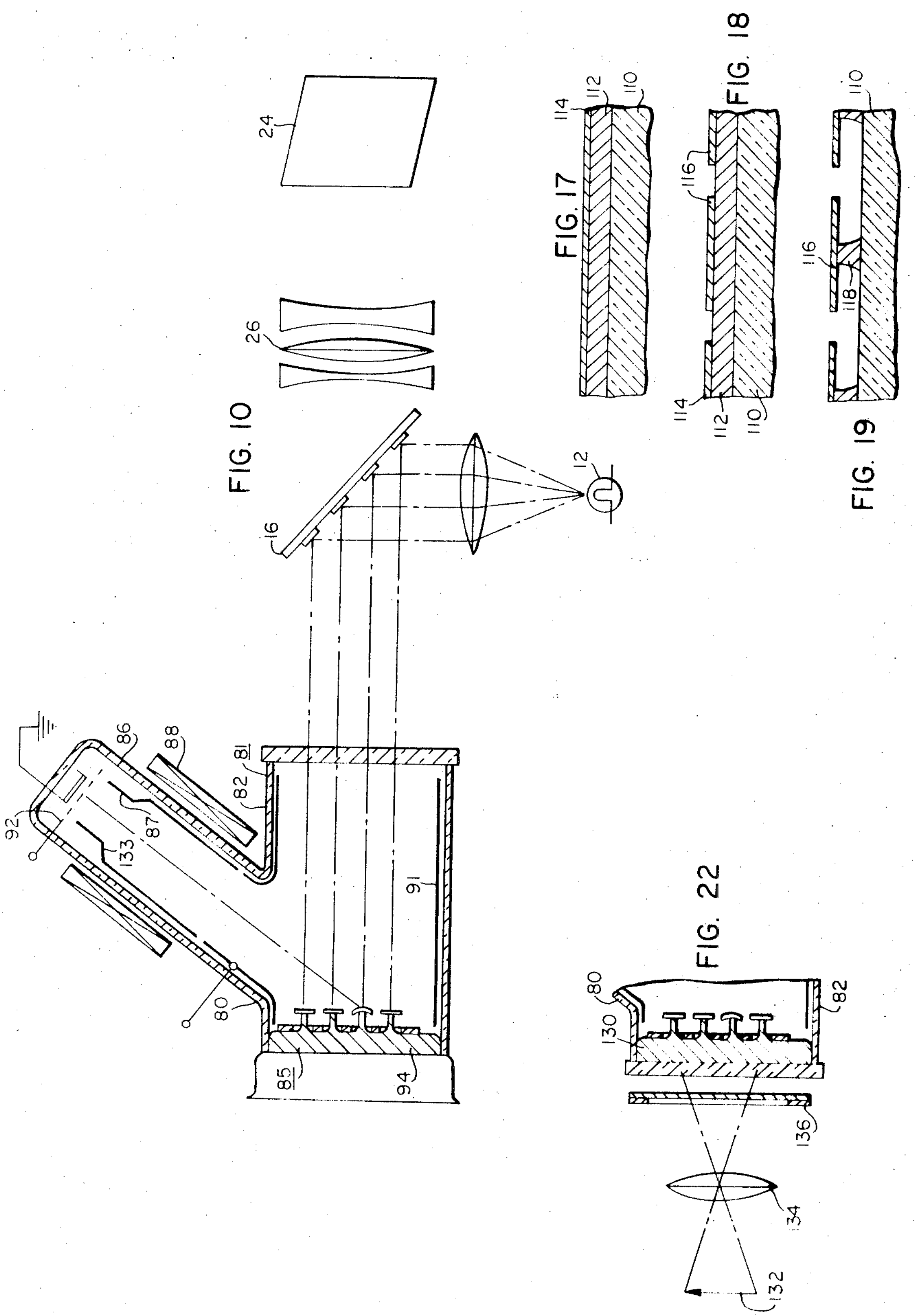


FIG. 10
FIG. 17
FIG. 18
FIG. 19
FIG. 22
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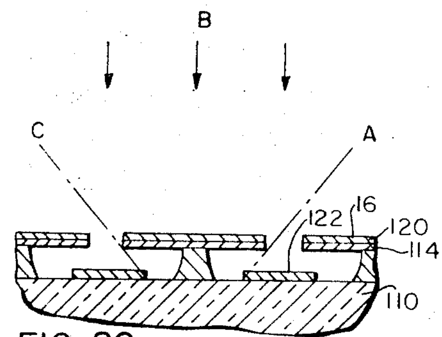

FIG. 20

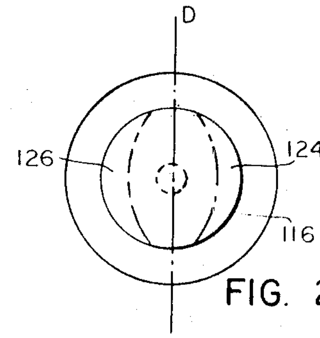

FIG. 21

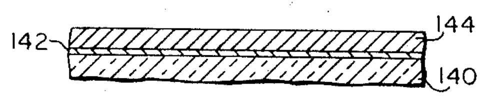

FIG. 23

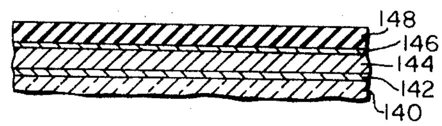

FIG. 24

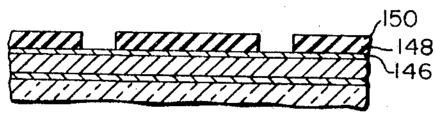

FIG. 25

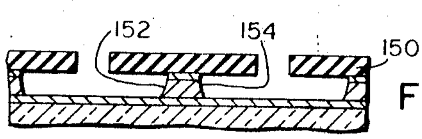

FIG. 26

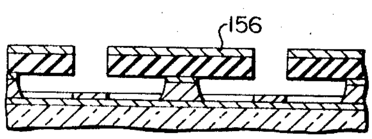

FIG. 27

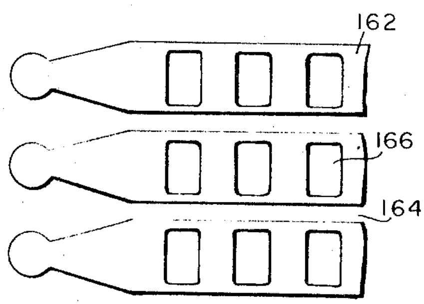

FIG. 28

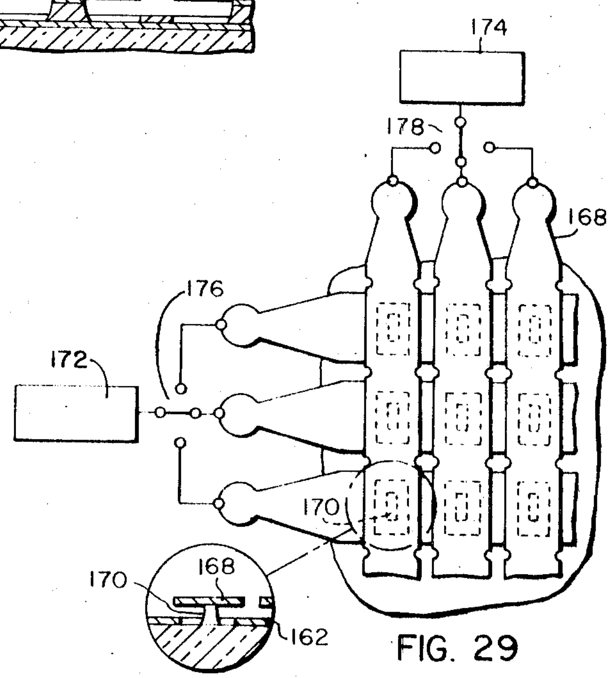

FIG. 29

ELECTROSTATICALLY DEFLECTABLE LIGHT VALVES FOR PROJECTION DISPLAYS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrostatically deflectable light valves for spatially modulating a light beam to produce a high brightness image analogous to the amplitude of deformation of the electrostatically deflectable light waves.

2. Description of the Prior Art

Large area, projection display systems have not found wide usage due to complexity, performance and cost. The standard kinescope is limited in area and also brightness. The oil eidophor system is one of the most successful television projection displays. In this device, an external light source is spatially modulated by an oil film which is rippled by an electron beam within a cathode ray tube. The eidophor system has been plagued by complexity, high cost and cathode deterioration due to the presence of the oil film in the vacuum. Light deformable surfaces fabricated from refractory or high temperature materials have also been suggested in prior art such as found in U.S. Pat. No. 2,644,208 and U.S. Pat. No. 2,682,010. These devices generally disclose the concept of manufacturing electrostatically deflectable light valves utilizing a mosaic of elements. However, these systems suffer from complexity in manufacture and certain operational problems.

More recently an electrostatically deflectable light valve was described by J. A. van Raalte in an article entitled "New Schlieren Light Valve for Television Projection" in the Oct. 1970 issue of "Applied Optics." The structure described therein consists of a taut film provided on a grid support. Another type of device which utilizes a substantially continuous sheet for the entire light valve assembly is described in an article entitled "An Array Optical Spatial Phase Modulator" by K. Preston and found in the ISSCC Digest of Technical Papers, Volume 11, pages 100–101, 1967. These latter devices suffered from a problem in that it was necessary to provide a tautly suspended ultra-thin membrane film over a substantially large area. Difficulty was found in handling such a thin membrane, maintaining even tension over each element in the array, metallic fatigue associated with stretching of the taut membrane, and also in the charging operation where it is necessary that the electron beam penetrate through this film to charge an insulating surface beneath the film. In addition, high film tension requires high operating voltages making storage of signals difficult due to high field leakage effects.

SUMMARY OF THE INVENTION

This invention comprises an electrostatically deflectable light valve comprising an array of elements. Each of these elements consists of a reflective surface supported by a centrally located post or pillar member. The post member may be formed of a suitable material such as silicon and the fabrication thereof consists of controlled etching of the silicon from beneath the reflective surface to provide the reflective element upon the remaining silicon post member. A ground plane electrode common to all of the array elements is provided beneath the reflective element and is capacitively associated with the reflective element to provide the necessary electrostatic forces to deflect the reflective element. The reflective elements are insulated from the ground plane electrode by utilizing an insulating substrate or providing an insulating barrier between the reflective elements and the ground plane electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be had to the preferred embodiments, exemplary of the invention, shown in the accompanying drawings, in which:

FIG. 1 is a schematic showing a projection system incorporating an electrostatically deflectable light valve array in accordance with the teachings of this invention;

FIG. 2 is an enlarged front view of a portion of the target array of FIG. 1 viewed from the electron gun side;

FIG. 3 is an enlarged sectional view of a portion of the target array of FIG. 1;

FIGS. 4, 5, 6, 7, 8 and 9 illustrate steps in the fabrication of the target structure shown in FIG. 1;

FIG. 10 is a schematic optical projection system illustrating another embodiment of the invention;

FIG. 11 is a view of the target viewed from the electron gun of the device shown in FIG. 10;

FIG. 12 is a sectional view of one of the array elements in the target structure of FIG. 10;

FIGS. 13, 14, 15 and 16 illustrate steps in the manufacture of the target structure in FIG. 10;

FIGS. 17, 18, 19 and 20 illustrate another process for manufacture of target for FIG. 1;

FIG. 21 illustrates a modification of the target of FIG. 1;

FIG. 22 illustrates a modification of FIG. 10;

FIGS. 23, 24, 25, 26 and 27 illustrate the method of manufacture of the target of FIG. 22; and

FIGS. 28 and 29 illustrate another modification of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 illustrates a projection system. The system comprises an electron beam addressed deformable target tube 10. A high intensity light source 12, such as a 500 watt xenon arc lamp, provides the light source for illuminating or flooding the deformable target 20 of the tube 10. The light from the source 12 is collimated by a suitable lens 14 and refracted by a 45° Schlieren striped mirror 16. The mirror 16 contains alternate reflective strips 17 and transmissive strips 18. The light striking the reflective strips 17 is directed onto the target 20 comprised of a plurality of reflective elements 22. In the absence of excitation applied to a reflective array element 22 of the target 20, the light will be reflected back from the array element 22 onto the reflective strip 17 and toward the source 12 as indicated by the ray 11. Excitation of an array element 22 by the electron beam causes the reflective array element 22 to deform and modulate the impinging light as illustrated by the rays 13 and 15 so that they will pass through the transparent strips 18 of the mirror 16 and will be imaged onto a screen 24 by means of a projection lens 26. In this manner, a light image will be imaged onto the screen 24 corresponding to the deformation of the reflective elements 22 of the target structure 20. The deformation of the reflective elements 22 corresponds to the video signal impressed on the the electron beam of the tube 10 so that the image projected on the screen

24 will correspond to the video information impressed on the tube **10**. Different optical systems may be utilized.

Referring now in detail to the electron addressed electrostatically deflectable light valve array device **10**, the device **10** includes an envelope **30**. The envelope **30** is comprised of a tubular body portion **32** with a base portion **34**. The base portion **34** is provided with lead-in members **36** for applying potentials to electrodes within the envelope **30**. A faceplate **38** is sealed to the opposite end of the body portion **32** to provide an evacuated envelope **30**. A target structure **20** is mounted on the inner surface of the face-plate **38**.

The target **20** is scanned by means of a suitable pencil-like electron beam generated by an electron gun **40** comprised of at least a cathode **42**, a control grid **44** and an anode **48**. In one application, the cathode **42** may operate at about ground potential. A video signal from a video source **46** is applied through a switch **45** to the control grid **44** to modulate the electron beam generated by the electron gun **40** with the video information. The anode electrode **48** is for accelerating and providing focusing of the electron beam from the gun **40**. An accelerating grid **50** is provided adjacent the target **20** and is connected through a switching means **53** to a write potential source **52** or to an erase potential source **55**. The source **52** may be about 550 to 700 volts positive with respect to ground. The source **55** is at about 500 volts with respect to ground. Electromagnetic deflection and focusing means illustrated as coils **54** and **56** may be provided on the exterior portion of the envelope for providing deflection and focusing of the electron beam in response to suitable voltages applied thereto in a well-known manner. The device **10** described above is generally similar to a conven-tional vidicon pickup tube with the exception of the structure of the target assembly **20**.

The target structure **20** illustrated in FIG. **1** illustrates only a few of the reflective array elements **22**. In a practical device, the target structure **20** might include as high as two million reflective array elements **22**. FIG. **2** is a view of the target **20** from the side facing the electron gun **40** and illustrates the arrangement of the target array elements **22**. In the specific embodiment shown the array elements **22** are illustrated as a rectangular configuration. It is, however, obvious that the configuration may be of any type described such as circular, elliptical or hexagonal, with proper change of the optics.

The reflective array elements **22** as illustrated in FIG. **3**, in the unchanged state, will all lie in the same plane. The reflective elements **22** have a surface of a suitable electrical conductive material and reflective to light and may be of a suitable material such as gold, silver, nickel, platinum or silicon dioxide covered with a thin reflecting material such as aluminum. The thickness of the reflective element **22** may be 800 to 1,500 Angstrom units, with a dimension of 45 microns by 70 microns. The reflective element **22** is supported by means of a central post **62** of a suitable material such as silicon. The post **62** may have a cross-sectional dimension of about 9 microns by 30 microns and a height of about 1.5 to 4 microns.

The faceplate **38** may be a suitable light transmissive material such as quartz, sapphire or spinel and supports the target array **20**. An electrical conductive grid **64**, which is referred to as the ground plane electrode, is provided on the inner surface of the window **38**. The grid **64** may be a thin metal film of a suitable material such as gold or aluminum and may be transmissive to light radiations. The ground plane electrode **64** is connected to an external potential source **66** which may provide a suitable operating potential to the ground plane electrode **64** of about 500 volts.

Referring now to FIGS. **4** through **9**, a process of fabricating the target **20** is illustrated. A 3 millimeter thick quartz faceplate member 38 having a diameter of at least 1-½ inch is provided. The faceplate **38** is cleaned and degreased and a coating of silicon **61** is deposited as illustrated in FIG. **4** to a thickness of about 3 microns by a process such as sputtering. After the silicon coating **61** has been applied, a coating **63** of about 200 A in thickness of chromium is provided as illustrated in FIG. **5**. A coating **65** of a thickness of about 1,000 A of gold is then provided on the coating **63**. This process may be accomplished by evaporation or plating. The chromium coating **63** provides an adherence layer to the silicon layer **61**.

The next step is to provide a coating **67** of a suitable photoresist material. The photoresist layer **67** is then exposed to light through a clear grid and the exposed portions are removed to provide the mosaic layer **67** as illustrated in FIG. **6**. The next step is to etch the surface with a suitable etch such as AQUA REGIA followed by 10:1 H_2O/HF to etch through the unprotected portions of layers **63** and **65** to the silicon layer **61** without affecting the layer **61**. The layer **67** is removed and the resulting structure is shown in FIG. **7**. The next step is to use a suitable etch such as nitric:acetic:HF 10:25:9 to undercut and etch the silicon layer **61** evenly from all sides of the elements **22** formed by layers **63** and **65** to remove a substantial portion of the layer **61** and provide the pillar member **62** as illustrated in FIG. **8**. The etch does not affect the spectular surface layers **63** and **65** or the faceplate **38**. The next step in the fabrication is to deposit the ground plane electrode **64** and this may be accomplished by evaporating through the structure so as to provide the conductive grid **64** as illustrated in FIG. **9** on the face plate **38**. The electrode **64** may be formed by depositing a coating **71** of about 100 A in thickness of titanium and a coating **73** of 100 A in thickness of gold. The coatings **71** and **73** are substantially transparent. The coatings **71** and **73** will also deposit on the layer **63**. By evaporating the ground electrode **64** at a glancing angle relative to the reflective surfaces **22**, preferential directions of mirror bending can be obtained.

It is of course obvious that other suitable materials may be utilized for the faceplate **38** such as optical glass, spinel and sapphire as long as they are transmissive to the input radiations. In the case of spinel, such as $MgAl_2O_4$, or sapphire an epitaxial layer **61** is grown. This process is described in an article entitled "Thin-Film Silicon: Preparation, Properties and Device Application" on page 1,490 of the Sept. 1969 issue of the Proceedings of the IEEE. In addition, the posts **62** may be of other materials such as nickel, silver, copper, aluminum and dielectrics such as silicon dioxide. The reflective elements **22** may be of other suitable materials such as aluminum and platinum. It is also possible to fabricate the reflective elements **22** of insulating materials such as silicon dioxide or silicon nitride. In the case of the insulating materials, it would be desirable to evaporate reflective materials onto the insulating support.

Because the array elements 22 are provided on the transparent quartz faceplate 38 in FIG. 1, a system may be utilized wherein the electron beams strike the upper side of the reflective array element 22, whereas the light is reflected from the underside of the array element 22. It is also of course obvious that different optical systems might be utilized for projection of the light onto the target 20 and projection of the reflected light onto the screen 24.

The operation of the device shown in FIG. 1 may be described by first assuming that the reflective elements 22 are uncharged and are in one plane. The grid 50 is connected by the switch 53 to the write potential source 52 of about 550 to 700 volts positive with respect to ground. The ground plane electrode is at about 500 volts positive with respect to ground. The electron beam from the electron gun 40 is scanned over the target 20. The electron beam is modulated by connecting the video source 46 through the switch 45 to the control grid 44. The potential on the reflective element 22 is about 500 volts positive with respect to ground. Bombardment by the electron beam will charge the reflective elements 22 in a positive direction. The maximum potential that the reflective elements 22 might be charged to is the potential of the grid 50. The amount of charge on each reflective element 22 corresponds to the video information. In this manner, a charge image is spatially written on the array of reflective elements 22 corresponding to video input. The amplitude of deflection of the reflective element 22 corresponds to the video input. One of the elements 22 in FIG.1 is shown as deflected in response to the video input. The more the deflection, the more light is reflected onto the image 24. This image may be projected for as long as desired.

To erase the image, the switch 45 is connected to a DC bias source 47 and the switch 53 is connected to DC source 55. The electron beam then charges the elements 22 in a negative direction and returns them to the potential of the grid 50, namely 500 volts. The tube is now in condition to write again.

FIG. 10 illustrates a projection system similar to that illustrated in FIG. 1 but a modified electron beam address target device 80 is substituted for the target 20 in FIG. 1. The device 80 includes an envelope 81 having a body portion 82 which is closed at one end with a transparent face-plate 84. A target assembly 85 closes the opposite end of the body portion 82. A tubular neck portion 86 extends from the body portion 82 at an angle of about 45° to the axis of the body portion 82 and an electron gun 87 is provided therein for directing a pencil-like electron beam onto the target 85. Deflection means, shown as a coil 88, is provided for deflection of the electron beam over the target 85 in a suitable raster.

The target 85 is comprised of a substrate 94 of silicon. The substrate 94 is comprised of a base portion 95 and a plurality of pillar members 97 extending from the base portion 95. Each pillar member 97 supports a reflective member 99. The reflective member 99 is comprised of a layer 101 of silicon dioxide secured to the top of the pillar 97 and a layer 103 of reflective material such as aluminum deposited on the upper surface of the layer 101. An electrical conductive ground plane electrode 102 is provided on the base portion 95 between the bases of the pillar members 97.

The operation of the device is similar to that described in FIG. 1. A collector electrode 91 is provided on the interior surface of the envelope and provides the same function as the grid 50 in FIG. 1. Voltages are applied to control grid 92 and the collector electrode 91 as applied respectively to the control grid 44 and the grid 50 in FIG.1. Light is reflected from the same surface of the reflective member 99 as that bombarded by the electron beam.

FIGS. 13, 14 and 15 illustrate a process for manufacture of the target 80. A wafer 94 of silicon is provided. The wafer 94 is heated to a temperature of about 1,000° C for a few hours to form a silicon dioxide layer 101 on one surface as shown in FIG. 13. A photoresist coating is applied to the layer 101, exposed to light and the undesired portions removed. The undesired portion of the silicon dioxide layer 101 may be removed by suitable etchants such as buffered HF to provide a matrix configuration such as illustrated in FIG. 11 and shown in FIG. 14. The next step is to provide a suitable etch for the silicon substrate 94 so as to etch the silicon both between and beneath a portion of the reflective element 99 to provide the structure illustrated in FIG. 15. If the photoresist coating has not been removed from the silicon oxide layer 101, it is removed at this time and then a coating of electrically conducting material such as aluminum is evaporated onto the target assembly so as to provide a reflective coating 103 on the upper surface of the silicon dioxide layer 101 and also provide the ground potential electrode 102 on the base portion 95 of the substrate 94 at the base of the silicon pillars 97.

The target structure illustrated in FIG. 12 has a disadvantage in that since the silicon is used both as the substrate 95 and the pillar 97. The undercutting of the silicon material in a horizontal direction from the edge of the reflective elements 99 also results in an identical etching downwardly into the substrate and determines the distance between the reflective element 99 and the ground electrode 102. If the spacing between the reflective element 99 and the ground plane electrode 102 is large, then the voltage necessary to obtain the necessary deformation may be large. It may be desirable in this environment then to build up the thickness of the ground plane electrode 102 to reduce the spacing between the ground plane electrode 102 and the reflective element 99.

The advantage of the above structures permits the array of reflective elements 22 and 99 to be made with only a mask step in the fabrication operation and no photoresist alignment procedure is necessary. Such a process is consistent with high yield, low defect optical projection printing as used in the industry. An additional advantage is the possibility of depositing the ground plane electrodes 64, 102 in close proximity with the reflective elements 22, 99 to avoid the electron beam writing on a dielectric target material. This is consistent with high writing speeds and high resolution and can be used in the transmission embodiments to omit a separate erase cycle.

Referring to FIGS. 17, 18 and 19, another process for the manufacture of a suitable target for the device shown in FIG. 1 is illustrated. A wafer 110 of spinel about 0.020 inch thickness is provided and then an epitaxial layer 112 of silicon about 4 microns in thickness is provided in a manner previously described. The device is then treated in an oxygen atmosphere at a temperature of about 1,100° C to provide a thin layer **114** of silicon dioxide of about 6,200 Angstroms in thickness on the silicon layer **112**. This structure is illustrated in FIG. **17**. The next step is to provide a photoresist material on top of the silicon dioxide layer **114** and then expose and remove the undesired portion of the photoresist. The silicon dioxide layer **114** is then subjected to a suitable etch of buffered HF which provides the mosaic coating **114** as illustrated in FIG. **18** comprised of a plurality of elements **116**. The elements **116** of this embodiment are circular. The photoresist layer is then removed and the structure is deep etched in a solution of 25 HNO_3, 10 Acetic, 3 HF, for about 1-½ minutes and then quenched in water and rinsed. The resulting structure is illustrated in FIG. **19**. As can be seen, the epitaxial silicon layer **112** is etched but the spinel layer **110** is not affected. In this manner, the silicon layer **112** can be removed for a substantial distance beneath the element **116** to form a pillar **118** and yet still maintain the desired distance between the element **116** and the spinel substrate **110** on which the ground plane electrode is provided.

The next step in the operation is to evaporate a reflective coating **120** onto the silicon dioxide element **116** and also a conductive coating **122** onto the spinel layer to provide the ground plane electrode. This may be accomplished as illustrated in FIG. **20** by evaporating from at least three different sources. The resulting deposition on the spinel substrate **110** is illustrated in FIG. **21**. The resulting deposition on the spinel member **110** provides a coating area **124** beneath one side of the element **116** from source A. A coating over **126** is provided diametrically opposite from coating **124** from source C. The source A will deposit a coating **128** about the element **116** and will overlap coating **124** and **126**. The result is a relatively thick deposit in the gap between the elements **116** so that if the coating **128** is substantially not transmissive to light it will not provide a problem. The coatings **124** and **126** beneath the reflective elements **116** will be substantially transmissive due to the thin coating. The resulting coating **122** provides a bending axis as indicated by the dotted line D. The axis lies in a plane passing through the center of the pillar **118** and is symmetrical about said plane. Thus direction of the bending of the elements is fixed and simplifies the Schleiren optic system. It is, of course, obvious that the bending axis of the elements **117** should be arranged so as to be parallel to the reflective slits **18** in the Schleiren mirror **16**. If the coatings **124** and **126** from the two sources A and C are about **50** Angstroms, they will be substantially transparent to light. The reflective coating **120** will include coatings from the source A and C as well as source B. The source B may provide a coating of 200 Angstroms which is adequate reflectance from the reflective elements **116**.

The devices previously described are primarily directed to those devices in which the video information is written into the reflective matrix by means of an electron beam. FIG. **22** illustrates schematically a system in which a reflective array **130** is addressed by means of a light image **132** focussed onto the reflective array **130** and which modulates the deformation of reflective array **130** corresponding to the light input. Referring now to FIG. **22**, the light image input **132** is directed through a suitable lens **134** and a shutter means **136** onto a reflective array target **136**. The optics and projection system has been previously described with regard to FIG. **10**.

FIGS. **23, 24, 25, 26** and **27** illustrate the fabrication of the reflective array **130**. A wafer **140** of spinel is provided. A transparent conductive coating **142** is deposited on one surface of the wafer **140** of a suitable material such as a layer of tinoxide and to a thickness of 20 A. Onto this conducting layer **142**, an N-type layer **144** of silicon is grown to a thickness of about **4** microns. The resulting structure is illustrated in FIG. **23**. The next step in the fabrication is to diffuse a suitable material such as Boron into the N silicon layer **144** to provide a P+ region **146** on the surface of the layer **144**. This P+ region **146** may then be oxidized to provide a silicon dioxide coating **148**. This structure is illustrated in FIG. **24**. The next step is to provide a photoresist coating over the coating **148**, expose and then remove the undesired portions of the photoresist coating and then etch the silicon dioxide layer **148** with a suitable material such as buffered HF to form a plurality of rectangular silicon dioxide members **150**. This resulting structure with the photoresist removed is illustrated in FIG. **25**. The next step is to etch the upper surface of the structure with a suitable etch such as 25 HNO_3/10 Acetic/ 3 HF which etches into the silicon layers **144** and **146** to etch away the desired amount of the silicon layers **144** and **146**. The resulting structure is illustrated in FIG. **26**. Pillars **152** are formed which contain a P-N junction **154**. The next step in the operation is to deposit a coating **156** of aluminum onto the silicon dioxide elements **150** to a thickness of 500 Angstroms, this resulting structure is the reflective element **156** of the device. The transparent conductive coating **142** serves as the ground plane electrode.

Light directed onto the reflective array **130** from scene **132** will modify the conductivity of the junction **154** formed between the P and N type regions **144** and **146** resulting in a charge being established on the reflective element **150** and causing deflection thereof. This charge on the reflective element will leak off through the P-N junction to the ground plane electrode **142**. The electron gun **133** may be used to return all the elements **156** to a desired equilibrium potential.

FIGS **28** and **29** illustrate a device in which a reflective array **160** is addressed by an X-Y electrical conductive system. FIG. **28** indicates the X electrodes **162** of conductive material deposited on a glass base with open windows **166** provided as illustrated. The next step in the fabrication is to place a layer of silicon over the X network **162** followed by deposition of a suitable reflective layer, followed by etching this layer in the form of the Y conductive members **168** as illustrated in FIG. **29**. The silicon layer is etched away so as to leave only the supporting pillars **170**. Application of voltage from sources **172** and **174** to a selected X and a selected Y conductor **162** and **168** results in deflection of the portion of the Y member **168** at the crossing point with the X conductor **162**. Switching means **176** and **178** are used for switching voltages to selected conductors. Light from a source similar to **12** and a similar optics as shown in FIG. **1** may be utilized.

We claim as our invention

1. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said reflective elements supported by a spacer post member extending from a base member, said base member providing a potential electrode positioned near the base of said spacer post member said spacer post member having substantially less cross section than said light reflective element and located entirely beneath said light reflective elements.

2. The system set forth in claim 1 in which said base member is selected from materials of the group consisting of silicon, quartz, glass, sapphire and spinel.

3. The system set forth in claim 1 in which the spacer post members are selected from a group of materials consisting of silicon, aluminum, silver, nickel and silicon dioxide.

4. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said refelctive elements supported by a spacer post member extending from the base member, said base member providing a potential electrode positioned near the base of said spacer post member, said light reflective elements selected from materials of the group consisting of aluminum, platinum, titanium, gold and cadmium.

5. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said reflective elements supported by a spacer post member extending from the base member, said base member providing a potential electrode positioned near the base of said spacer post member, said light reflective elements comprising a substrate of silicon dioxide and a reflective coating of a metal.

6. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said reflective elements supported by a spacer post member extending from the base member, said base member providing a potential electrode positioned near the base of said spacer post member, said base member selected from materials of the group consisting of sapphire and spinel, and said spacer post is of silicon material.

7. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said reflective elements supported by a spacer post member extending from the base member, said base member providing a potential electrode positioned near the base of said spacer post member, said spacer post member has a substantially less cross section than said light reflective element and is centrally located with respect to said light reflective element.

8. The system set forth in claim 1 in which said reflective elements are rectangular and said post members are rectangular in cross section.

9. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said reflective elements supported by a spacer post member extending from the base member, said base member providing a potential electrode positioned near the base of said spacer post member, said light reflective elements and said post members are circular in cross section.

10. An electrostatically deflectable light valve system comprising an array of spaced apart deformable light reflective elements, each of said reflective elements supported by a spacer post member extending from the base member, said base member providing a potential

electrode positioned near the base of said spacer post member, said potential electrode extending beneath said light reflective elements to provide a non-uniform distributed coating beneath said reflective element.

11. An electrostatically deflectable light valve system comprising an evacuated envelope having an electron gun and a light valve target structure, said light valve target structure supported upon a light transmissive input window, said light valve target structure comprising an array of spaced deformable light reflective elements lying in a single plane and capable of reflection of light transmitted through said input window, each of said reflective elements supported by a centrally located post member secured to the undersurface of said reflective element and to said input window, a potential electrode common to all of said array of reflective elements positioned on said input window at the base of said post members, said potential electrode operating at a fixed potential, a means for scanning an electron gun over said reflective elements to deposit a charge thereon to effect deformation of said reflective elements in an amount determined by the difference of potential of said reflective elements and the potential of said potential electrode, means for directing light through said input window onto said reflective elements and means for displaying an image representative of the reflective light from said reflective elements corresponding to the deformation thereof.

12. The light valve system set forth in claim 11 in which said potential electrode is provided as a coating on the exposed areas of said substrate to said electron beam and also extending beneath the reflective elements to provide a non-uniform coating beneath the reflective distributed element.

13. The light valve system set forth in claim 12 in which said non-uniform distributed coating beneath said reflective element provides symmetrical deformation about a plane perpendicular to the reflective element and passing through the center of the post member.

14. An electrostatically deflectable light valve system comprising an evacuated envelope having an electron gun and a light valve target structure, said light valve target structure comprising an array of spaced deformable light reflective elements lying in a single plane and capable of reflection of light, said reflective elements supported by a centrally located post member secured to the under-surface of said reflective elements and to said input window, a potential electrode common to all of said array of reflective elements and positioned on said input window at the base of said post members, said potential electrode operating at a fixed potential, means for scanning an electron beam generated by said electron gun over said reflective elements, said centrally located post member including photosensitive means responsive to input radiations to modify the resistance thereof and thereby change the charge on said reflective elements and causing deformation in response to said input radiations and means for directing a flooding radiation onto said reflective elements and means for displaying an image of the reflected flooding radiation from said reflective elements corresponding to the deformation of said reflective elements.

15. The light valve system of claim 14 in which said photosensitive means is a P-N junction.

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