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Altman

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[45] **Sept. 24, 1974**

[54] **LOW PROFILE EPISCOPIC PROJECTOR AND OPAQUE MATERIALS THEREFOR**

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[22] Filed: **Feb. 5, 1973**

[21] Appl. No.: **329,574**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 81,987, Oct. 19, 1970, Pat. No. 3,778,142.

[52] **U.S. Cl.** **353/66,** 156/4, 156/22, 264/1, 353/44, 353/120, 353/121

[51] **Int. Cl.** **G03b 21/32,** G03b 21/06

[58] **Field of Search** 353/44, 45, 65, 66, 120, 353/121; 156/4, 22; 350/105, 109; 117/8, 8.5; 264/1

[56] **References Cited**

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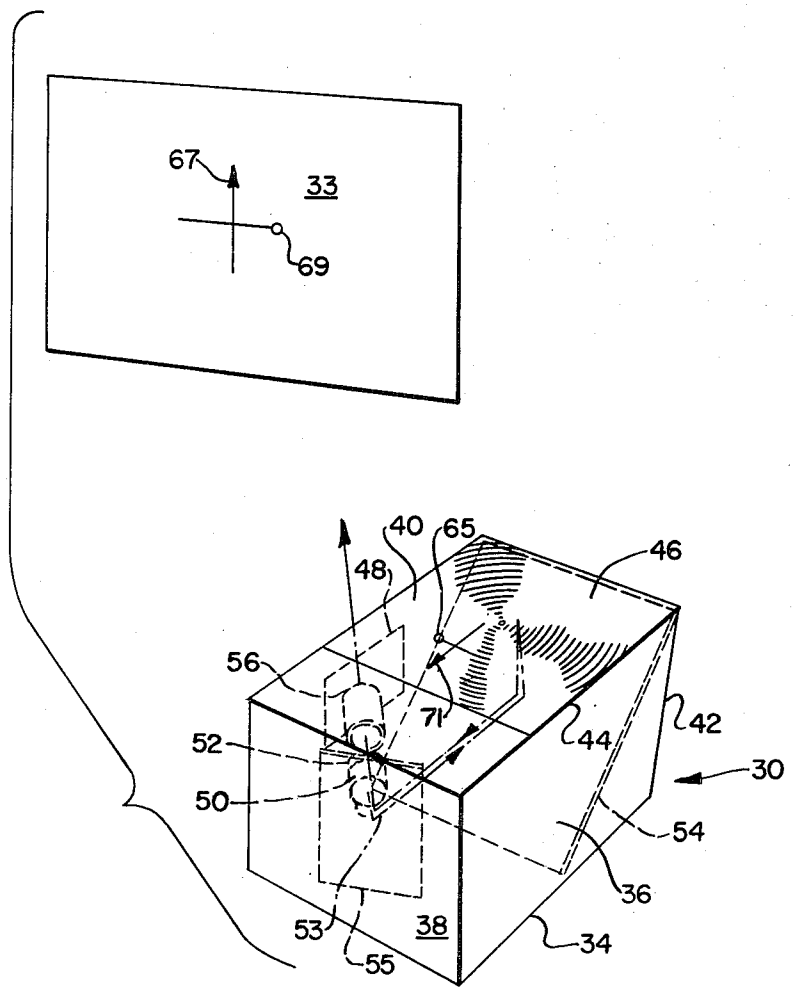
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Primary Examiner—Louis R. Prince
Assistant Examiner—Steven L. Stephan
Attorney, Agent, or Firm—Morse, Altman, Oates & Bello

[57] **ABSTRACT**

A large copy projector, in which the presence of elevated optics in front of the screen is avoided, uses opaque sheeting that is adapted to receive related graphic matter on its upper and lower faces. Simultaneously, the upper face is unobstructedly available for direct observation and manual access, and the lower face is unobtrusively available for image projection through a folded optical path below the opaque sheeting and a projection lens positioned elsewhere than directly over the copy. The copy is characterized by a lower specularly reflecting face that is accessible to the optical system from below but that can be marked from above by chemical etching from a user's pen or the like.

9 Claims, 12 Drawing Figures



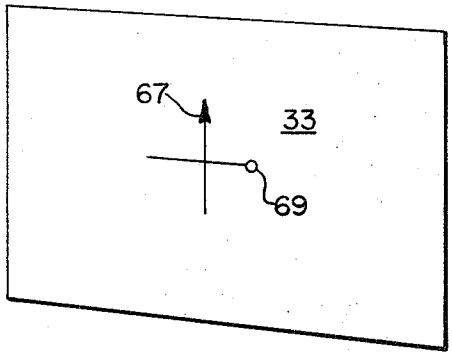


FIG. 1

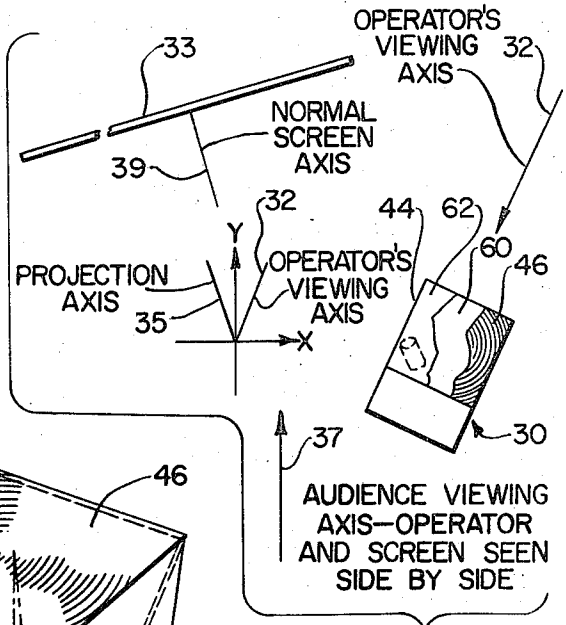
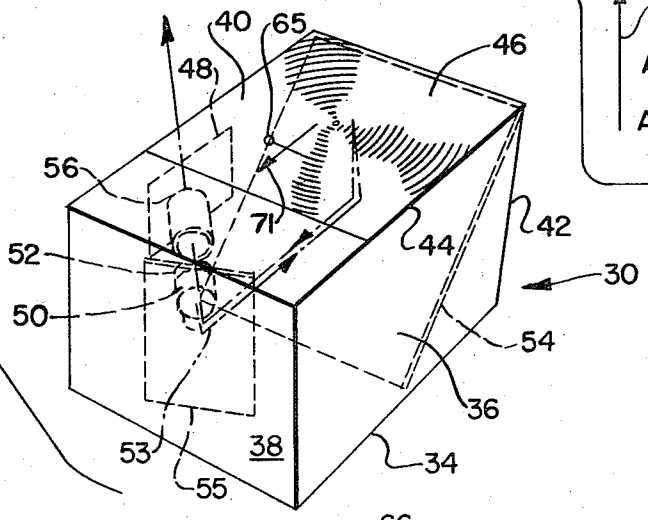


FIG. 2



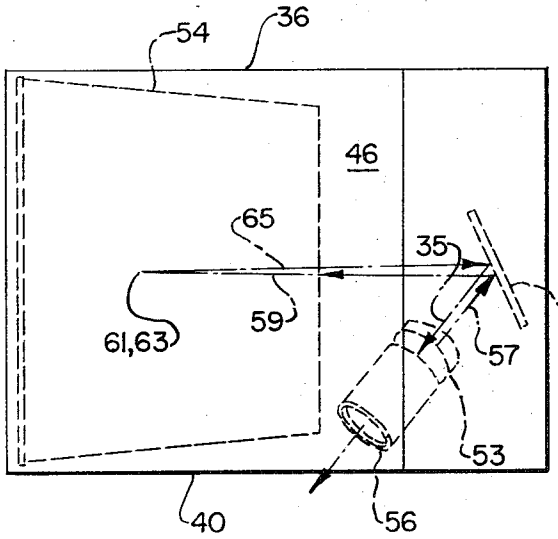


FIG. 3

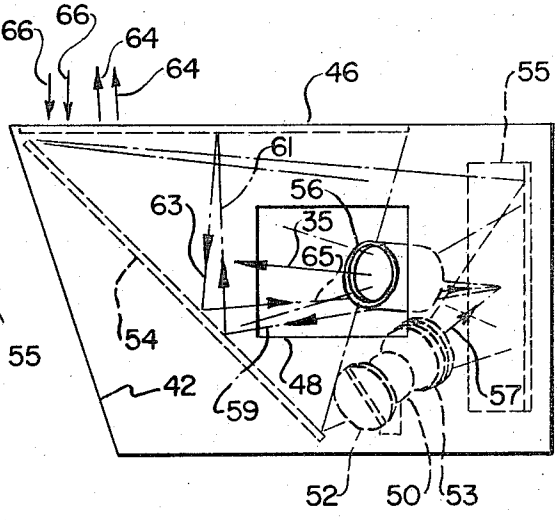


FIG. 4

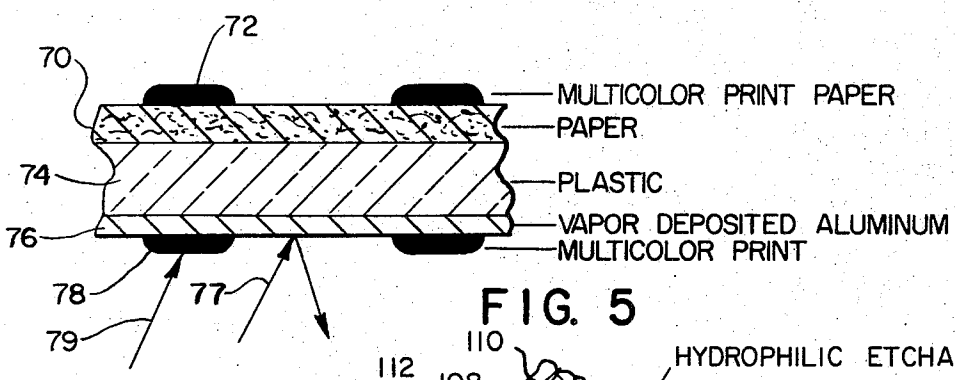


FIG. 5

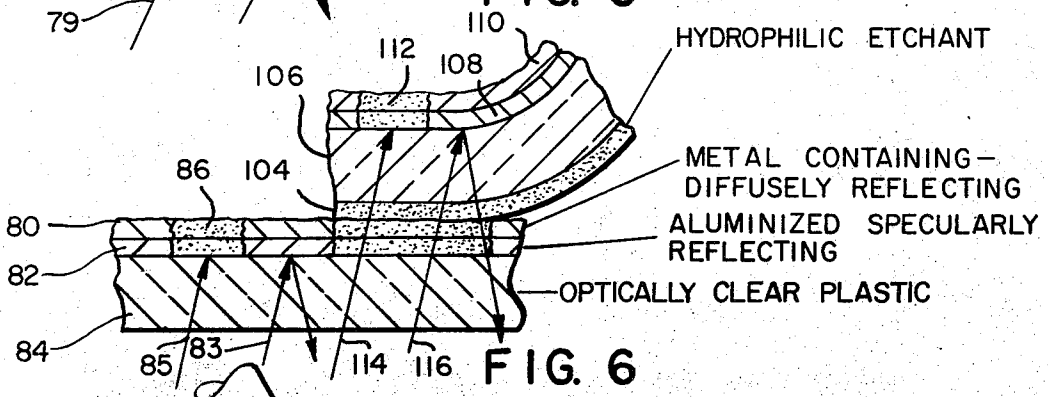


FIG. 6

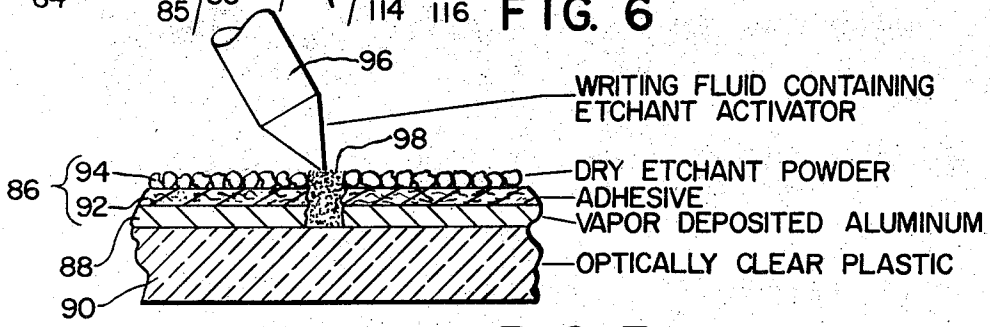


FIG. 7

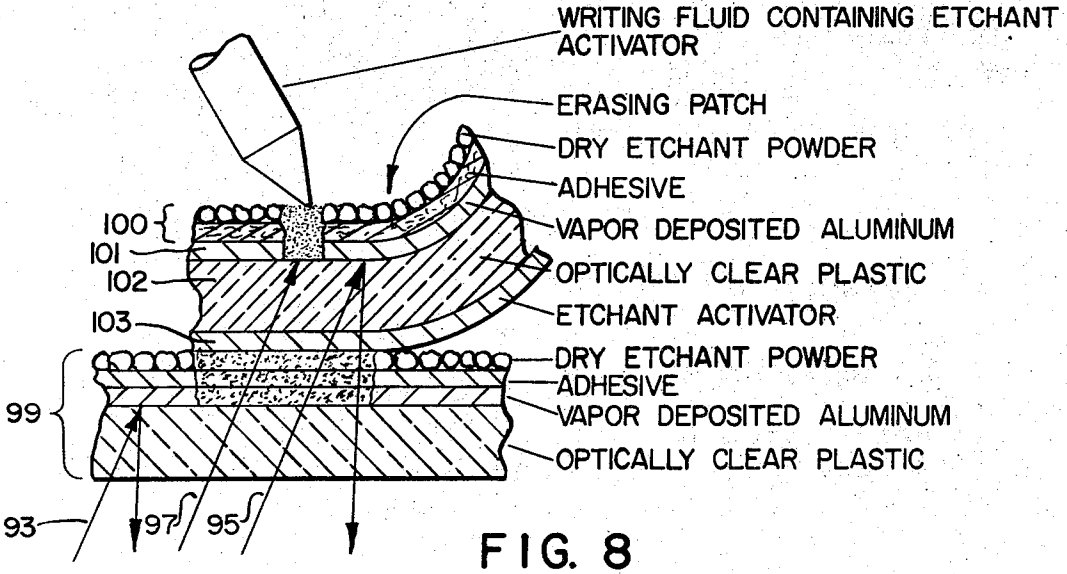


FIG. 8

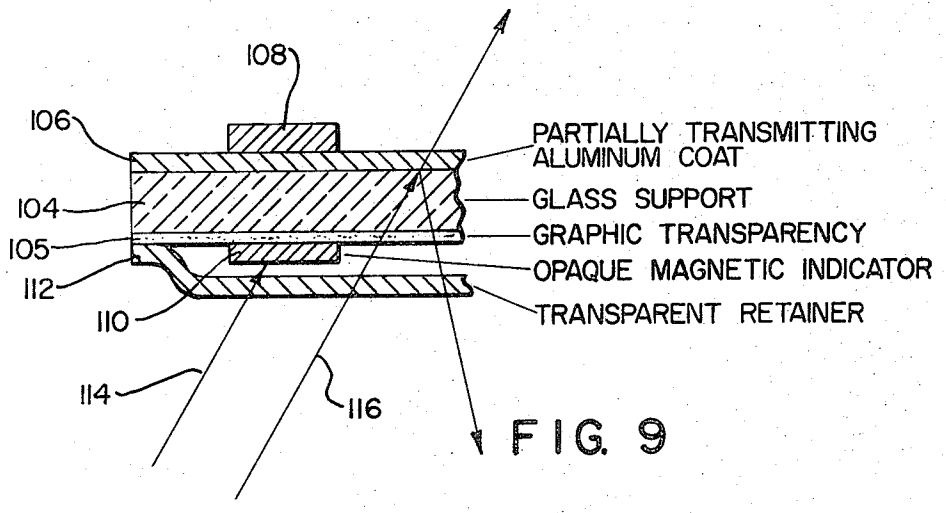


FIG. 9

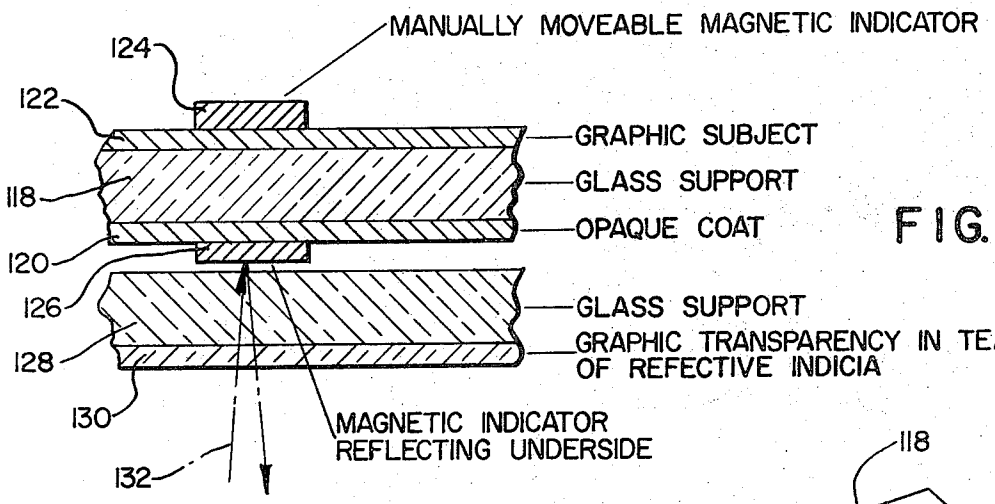


FIG. 10

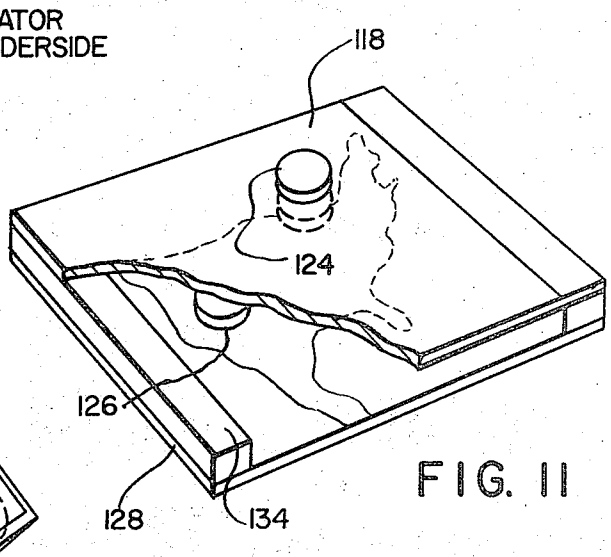


FIG. 11

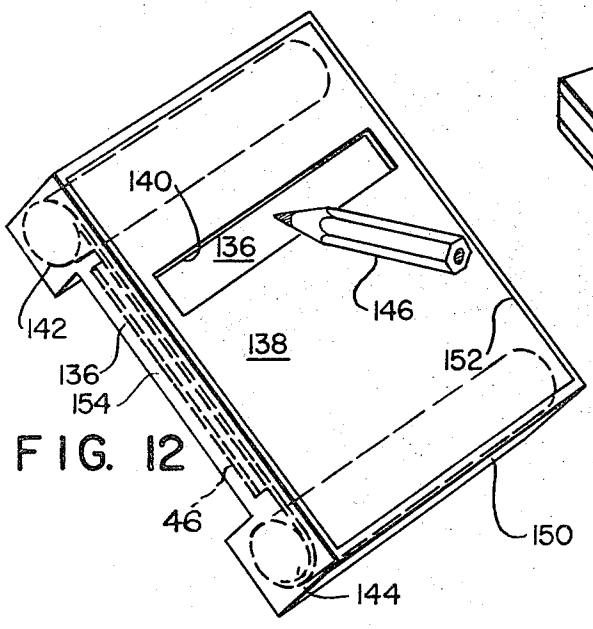


FIG. 12

LOW PROFILE EPISCOPIC PROJECTOR AND OPAQUE MATERIALS THEREFOR

RELATED APPLICATION

The present application is a continuation-in-part of application Ser. No. 81,987, filed Oct. 19, 1970, now U.S. Pat. No. 3,778,142.

BACKGROUND AND SUMMARY

The present invention relates to optical imaging and, more particularly, to systems, processes and products involving episcopic imaging, i.e., imaging utilizing light generally reflected from or at a copy sheet or other visual subject, as distinguished from diascopic imaging, i.e., imaging utilizing light generally directed through a copy sheet. The present invention is directed primarily to large copy projectors, exemplified by so-called "overhead" and "opaque" projectors. Diascopic overhead porjectors have been characterized by: bulky headware that obtrudes between the audience and the projected image and causes the operator to assume an unnatural posture in order not to obtrude between the projection lens and the screen; and transparencies that are uncomfortable for the operator to view, handle and store, Episcopic overhead projectors theoretically are more compact than diascopic overhead projectors because illuminating source and imaging lens are at the same side of the copy sheet, whereby vertical dimensions are reduced. But, in practice, episcopic overhead projectors also have been obtrusive because either (1) the light source and imaging lens are positioned by a post in a sizeable casing above the copy sheet or (2) a bulky housing envelops the light paths to and from the copy sheet in order to control glare. Episcopic copy, when composed of paper or sheeting of equivalent appearance, has not been adapted for brilliant imaging because of its optical diffusivity.

The primary objects of the present invention are the provision of systems, processes and products involving a portable projector and a copy sheet assemblage that are particularly interrelated to achieve, during projection, direct visual and manual access to the copy sheet by the operator, absolute shielding of the operator and the audience from illuminating light, no interposition of the optical projection system above the level of the copy sheet between the audience and the screen, and natural posture of the operator at the projector. The optical projector comprises a low profile housing in which are positioned an upper window for supporting the copy sheet with its front face upward for direct viewing, a source of illuminating light from which the exterior of the housing is absolutely shielded by the copy sheet itself, and a folded optical path below the window to an imaging lens at the side of the projector. The arrangement is such that an unusually powerful illuminating lamp is practicable. The copy sheet is characterized by a lower reflecting face that is accessible to the optical system from below but that can be marked from above by a chemical etching pen which is manually held by an operator. Corrections can be made by a chemical etching patch which can clear sections of the lower reflecting face and present a new reflecting face for marking. Substituting a second copy sheet for a first during projection is achieved by superposing the second upon the first and withdrawing the first from beneath the second so as to maintain a closed optical system. Various kinds of demonstrations are achieved by associating magnetic indicia or the like with a reflective retainer or the like at the copy window.

Other objects of the present invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the systems, processes and products, together with their components, steps, parts and interrelationships, which are exemplified by the present disclosure, the scope of which will be indicated in the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

For a fuller understanding of the nature and objects of the present invention, reference is made to the following detailed description, taken in connection with the accompanying drawings, wherein:

FIG. **1** is a perspective view in use of a large copy projector system embodying the present invention;

FIG. **2** is a top plan view of the system of FIG. **1**, illustrating an exchange of copy sheets in accordance with the present invention;

FIG. **3** is a top plan view of the projector of FIGS. **1** and **2**.

FIG. **4** is a side elevation of the projector of FIG. **3**;

FIG. **5** is an exaggerated cross sectional view of a copy sheet embodying the present invention;

FIG. **6** is an exaggerated, cross-sectional view of another product embodying the present invention;

FIG. **7** is an exaggerated, cross-sectional view of another product embodying the present invention;

FIG. **8** is an exaggerated cross-sectional view of another product embodying the present invention;

FIG. **9** is an exaggerated cross-sectional view of another product useful in the projectors of the present invention;

FIG. **10** is an exaggerated cross-sectional view of another product useful in the projectors of the present invention;

FIG. **11** is an exaggerated perspective view of the product of FIG. **10**; and

FIG. **12** is a perspective view of another product embodying the present invention.

DETAILED DESCRIPTION

A large copy projector embodying the present invention, i.e., for copy greater than 6 × 6 inches in area, is shown in FIG. **1** as including a housing **30**, which mounts and contains the operating optical components. As shown, housing **30** is in the form of a sheet metal enclosure having a flat base panel **34**, a flat side panel **36**, a flat front panel **38**, a flat side panel **40**, and a rear panel **42**. Panel **34** is generally horizontal, panels **36**, **38**, and **40** are generally vertical, and panel **42** is generally oblique, extending from base panel **34** upwardly and outwardly to the top of the housing. At the top of the housing is a periphery **44** which encompasses an optically clear, generally horizontal, glass or plastic window **46**, the upper face of which is flat and the lower face of which has a Fresnel lens configuration. Side panel **40** has a projection window **48**. As shown in FIG. **2**, side panels **36**, **40** are disposed substantially along an operator's viewing axis **32** and projection to a screen **33** occurs along a projection axis **35**. It will be observed that, assuming an audience viewing axis at **37**, screen **33** and projector **30** are viewed by an audience side-by-side. With respect to an X,Y coordinate sys-

tem, operator's viewing axis **32** in the first quadrant intersects the Y axis at less than 45°, projection axis **35** in the second quadrant intersects the Y axis at less than 45°, and screen **33** is normal to some axis **39,** in the third quadrant, that intersects the Y axis at less than 45° and that may or may not be coincident with projection axis **35.**

The optical components include: an illuminating lamp **50,** associated with a reflecting spherical mirror **52** and a heat absorbinb condensing lens **53,** disposed along an illuminating axis in a plane that includes projection axis **35;** a rearward plane mirror **54** generally underlying Fresnel lens **46** along a plane obliquely intersecting the axis of the Fresnel lens; a forward plane mirror **55** generally forward of Fresnel lens **46** in a plane that is parallel to the axis of the Fresnel lens and oblique with respect to operator's viewing axis **32** and projection axis **35;** and a projection lens **56** that defines and is disposed along projection axis **35.** As shown in FIGS. **3** and **4,** light is directed from lamp **50** along an illuminating axis segment **57** to mirror **55,** is deflected along an illuminating axis segment **59** to rear mirror **54,** is deflected along an illuminating axis segment **61** and through Fresnel lens **46** to a specularly reflective copy sheet thereon; and imaging light is returned from the copy sheet through the Fresnel lens along an imaging axis segment **63** to rear mirror **54,** is deflected along an imaging axis segment **65** to front mirror **55,** and is deflected through lens **56** along projection axis **35.** It will be observed that the illuminating light diverges, that the imaging light converges and that the paths of the illuminating and imaging light overlap at mirror **55.**

As shown at **60** in FIG. **2,** an opaque copy sheet, when superposed on Fresnel lens **46,** presents an upper face for direct observation and a lower face for imaging by lens **56.** As suggested by arrows **64, 64** and **66, 66,** light rays emerging upwardly through Fresnel lens **46** are substantially parallel or collimated and light rays returned by the reflecting under face of copy sheet **60** are substantially parallel or collimated. A suitable vent and fan arrangement draws air through the housing in order to maintain the correct temperature at the Fresnel lens and at the illuminating lamp. Replacing an initial copy sheet **60** by a new copy sheet **62** merely involves superposing copy sheet **62** upon copy sheet **60** and, while copy sheet **62** is held in place above window **46,** withdrawing copy sheet **60** from between copy sheet **62** and Fresnel lens **46.** It will be appreciated that, projector **30** is capable of projecting transparencies which are interposed between Fresnel lens **46** and a plane cover mirror that can be superposed thereon. In one form (not shown) this cover mirror is hinged to housing **30.** From the operator's viewing position, the upward and rightward directions of the copy are indicated at **71, 65.** These directions correspond to the upper and right ward directions of the screen indicated at **67, 69.**

An integrated copy sheet of a type particularly adapted for use with the projector of FIG. **1** is shown in FIG. **5.** This copy sheet comprises an upper print receiving stratum **70** which carries an outer visual medium **72** and an inner support stratum **74** which is coated with a reflecting stratum **76** and carries a visual medium **78.** In one form, print receiving stratum **70** is composed of a porous material such as paper, visual medium **72** is an ink containing a pigment such as carbon in an organic vehicle, support stratum **74** is composed of a dimensionally stable polymer such as polyester ranging in thickness from 3 to 15 mils, reflecting stratum **76** is composed of aluminum or silver that has been vacuum vapor deposited in a thickness ranging from 500 to 2,500 Angstrom units, and visual medium **78** is an ink containing a pigment such as carbon in an organic vehicle. In a specified example of the product of FIG. **5,** the dimensions are approximately as follows: porous paper stratum **70** is 0.001 inch thick; polymeric support stratum **76** is 10 mils thick; and vapor deposited aluminum stratum is 1,200 Angstrom units thick.

The arrangement is such that visual medium **72** may be viewed directly in terms of diffusely reflected light that is ambient to projector **30** and visual image **78** may be projection imaged on a screen in terms of specularly reflected light to which it is subjected through Fresnel lens **46** from within the housing of projector **30.** Thus upwardly incident rays **77** are differentially specularly reflected and upwardly incident rays **79** are differentially specularly absorbed. Since these images are in mirror reversed correspondence, the operator and the audience see the same image at any time.

The graphic product of FIG. **6** is capable of being manually marked to produce, simultaneously, a visual record for direct observation from the front and for optical projection from the rear in conjunction with the projector of FIG. **1.** This product, in laminated sequence, comprises: a visual image receiving, diffusely reflecting stratum **80;** a visual image, specularly reflecting stratum **82;** and an optically clear, transparent, polymeric support stratum **84.** Each of strata **80, 82** ranges in thickness from 500 to 2500 Angstrom units; and stratum **84** ranges in thickness from 3 to 15 mils. In a preferred form, stratum **80** is composed of a metal or metal compound and is in direct contact with stratum **82.** It has been found that a special ink **86,** which may be applied from a fibrous pen, is capable of penetrating through strata **80** and **82** to leave an etched mark through both strata. As above in connection with FIG. **5,** upwardly incident rays **83** are differentially reflected and upwardly incident rays **85** are differentially absorbed. In association with the sheet is an erasing patch comprising, in laminated sequence, a diffusely reflecting stratum **110,** a specularly reflecting stratum **108,** an optically clear transparent, polymeric support stratum **106,** and an optically clear pressure sensitive stratum **104,** containing an etchant composition. The etchant activator serves to clear the region of strata **80,82** with which it comes in contact. The patch itself then may be marked at **112** so as to absorb rays **114** and to reflect rays **116.** The dimensions of the patch and the dimensions of the sheet correspond.

In the product illustrated in FIG. **6,** strata **80** and **110,** which are directly chemically bonded to aluminum strata **82** and **108,** respectively, are in the form of a metal containing deposit that has been produced either by chemical reaction with aluminum strata **82** and **108,** by chemical or electrochemical plating, or by chemical vapor deposition or vacuum vapor deposition. For example, in one form, strata **80** and **110** are composed of diffusely reflecting zinc which has been deposited, at room temperature, from an alkaline aqueous, solution of zinc oxide. In another form, strata **80** and **110** are composed of diffusely reflecting tin which has been deposited, at room temperature, from an alkaline aqueous solution of sodium or potassium stannate.

Preferably, ink **86** contains (1) a polar solute such as water or methyl alcohol, (2) a pigment for example a dye, and (3) a soluble salt of a metal that is lower in the electromotive series than the metals of strata **80,82** and **108,110,** i.e., is characterized by a readiness to acquire electrons from these metals so as to be reduced in a reaction by which these metals are substituted in the salt. Thus with respect to aluminum, such etchant metals include maganese, zinc, chromium, ion, cadmium, cobalt, nickel, tin, lead, copper, bismuth, antimony, mercury, silver, platinum and gold. For example, when strata **80, 110** are composed of zinc or tin and strata **82, 108** are composed of aluminum, the salt typically is a halide, for example, cupric chloride. In another form, ink **86** contains, in aqueous dispersion, a black pigment composed for example of carbon or iron oxide and a polar reagent, for example, a base such as sodium hydroxide or ammonium hydroxide or an acid such as hydrochloric acid. In one modification, image receptive stratum **80** is impregnated with a catalyst such as an alkali carbonate. Ink **86,** in another form, contains a dye such as a diazo dye or ferric amonium oxalate, by which image receptive stratum **80** is marked from direct observation and aluminum reflecting stratum **82** is colored without etching to produce a specularly reflective colored mark for projection. When the erasing patch of FIG. **6** is used, preferably the dyes in etchant fluid **86, 112** are such as to be cleared by the etchant fluid of adhesive stratum **104.** Otherwise the composition of etchant fluid **104** is analogous to that of etchant fluid **86, 112.**

The graphic product of FIG. **7** is capable of being manually marked to produce, simultaneously, a visual record for direct observation from the front and for optical projection from the rear in conjunction with the projector of FIG. **1.** This product, in laminated sequence, comprises a visual image receiving stratum **86,** a specularly reflecting stratum **88,** and an optically clear, transparent, polymeric support stratum **90.** As shown, specularly reflective stratum is in the form of a vapor deposited aluminum coat on polymeric stratum **90** and visual image receiving stratum is in the form of a pressure sensitive adhesive coat **92** to which has been adhered a coat of reactive power **94.** As shown, a manually held fabric or other marking pen **96** is capable of applying a writing fluid **98** that contains an etchant activator. When etchant activator **98** contacts etchant powder **94,** incremental reaction with aluminum **88** occurs. The result is visual indicia that is accessible at the upper face of the copy to the eye of the operator and accessible at the lower face of the copy to the enclosed specualr illuminating and projecting optics of projector **30** for observation on the screen by the audience.

In one form: (a) the etchant powder includes a soluble salt of a metal that is lower in the electromotive series than aluminum, i.e., a salt of manganese, zinc, chromium, iron, cadmium, cobalt, nickel, tin, lead, copper, bismuth, antimony, mercury, silver, platinum and gold; and (b) the activator ink simply is a regular commercial ink including an aqueous dispersion of a pigment such as iron oxide or carbon or a dye such as a diazo dye. The salt typically is a halide, for example, cupric chloride.

In an alternative embodiment of the product of FIG. **7,** granules **94** are in the form of microcapsules which contain an etchant fluid of the type disclosed in connection with FIG. **6** and marker **96** is simply a pressure applying element capable of rupturing the capsules in order to release the etchant fluid.

FIG. **8** illustrates a graphic product **99** of the type shown in FIG. **7.** In association with sheet **99** is an erasing patch comprising, in laminated sequence, a visual image receiving stratum **100,** a specularly reflecting stratum **101,** an optically clear transparent, polymeric support stratum **102,** and an optically clear pressure sensitive stratum **103** containing an etchant activator of the type shown at **98** in FIG. **7.** The etchant activator serves to clear the aluminized region of sheet **99** with which it comes in contact. The result is that certain upwardly incident rays **93** and **95** are differentially specualrly reflected whereas others **97** are differentially absorbed.

Fig. **9** illustrates an accessory by which a manually controlled indicator can be positioned for observation by an operator at the projector and for observation by an audience on the screen. This accessory includes an upper sheet glass support **104** and a lower sheet plastic retainer **112,** which is secured to and spaced from support **104** by an upwardly and outwardly projecting flange. Glass support **104** and plastic retainer **112,** both, are optically clear and transparent. At the upper face of support **104** is a vapor deposited coat of aluminum, which is partially reflecting and partially transmitting, i.e., sufficiently thin, say less than 1,000 angstrom units thick, to enable observation from above of a graphic subject **105,** which is adhered to the under face of support **104.** A manually controlled slider **108** and follower **110** ride at the upper and lower faces of support **104,** respectively. In one form, slider **108** is a permanent magnet and follower **110** is ferromagnetic element. By virtue of the magnetic coupling between elements **108** and **110,** manual movement of element **108** causes analogous movement of follower **110** in such a way that positioning of element **108** with respect to graphic subject **105** is observable from above by the operator and positioning of element **110** with respect to graphic subject **105** is observable on the screen. It will be observed that illuminating ray **114** is absorbed by the opaque surface of element **110** but that illuminating ray **116,** which is not intercepted by element **110** is partly transmitted and partly reflected by aluminium coat **106.**

FIGS. **10** and **11** illustrate an alternative accessory by which a manually controlled indicator can be positioned for observation by an operator at the projector and for observation by an audience on the screen. This accessory includes an upper sheet glass support **118** and a lower sheet glass support **128,** which are secured to each other in parallel relation by spacers **134.** A graphic subject **122** is laminated to the upper face of support **118.** An opaque stratum **120** is laminated to the lower face of support **118.** Laminated to the lower face of support **128** is a graphic transparency **130,** of which the graphic indicia are in the form of vapor deposited regions. A manually controlled indicator **124** and a magnetically controlled indicator **126** slide at the upper and lower faces of support **118,** respectively. In one form, indicator **124** is a permanent magnet and indicator **126** is a ferromagnetic element with a specularly reflecting lower face. By virtue of the magnetic coupling between elements **124** and **126,** manual movement of element **124** causes analogous movement of follower element **126** in such a way that positioning of element **124** with respect to graphic subject **122** is

observable from above by the operator and positioning of element **126** with respect to graphic subject **130** is observable on the screen. It will be observed that illuminating rays **132** striking either reflecting element **126** or reflecting indicia on graphic subject **130** are projected onto the screen.

The product of FIG. **12** enables a transparency **136** on Fresnel lens **46** to be marked from above by a grease pencil **146** through a slot **140** in a specualrly reflective sheet **138.** The position of the slot is controlled by a pair of rolls **142, 144** and all regions of transparency **136** except for the region in registration with slot **140** are projected onto the screen. Rolls **142, 144** and sheet **138** are held by a suitable casette **150** that is open at its top **152** and bottom **154** to permit manual access from above and optical access from below and that rests on top of projector **30** with opening **154** in registration with Fresnel lens **46.**

The present invention thus provides a variety of systems involving opaque projection, which ensure: simultaneous, direct optical and mechanical access to the subject by the operator; absolute shielding of the operator and the audience from illuminating light; no interposition of the optical system above the level of the subject between the audience and the scree; and natural posture of the operator at the projector. Since certain changes may be made in the foregoing disclosure, without departing from the scope of the invention hereof, it is intended that all matter described in the foregoing specification or shown in the accompanying drawings, be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. A method for optical projection of visual information on a visual sheet, said method comprising the simultaneous steps of applying a chemical reactant to one surface of a vapor deposited metallic coat on one face of said sheet in order to chemically react with said metallic coat to differentially change the reflectivity of portions of the other surface of said metallic coat, directing illuminating light to said other surface of said metallic coat, and focusing imaging light reflected by said other surface to project an optical image.

2. The method of claim **1** wherein said chemical reactant is an etchant that dissolves said portions of said metallic coat.

3. The method of claim **1** wherein said illuminating light is substantially collimated.

4. The method of claim **1** wherein said vapor deposited metallic coat is composed of aluminum and said chemical reactant includes a soluble salt of a metal that is lower in the electromotive series than aluminum.

5. The method of claim **1** wherein said aluminum ranges in thickness from 500 to 2,500 angstrom units.

6. The method of claim **1** wherein said vapor deposited metallic coat is composed of aluminum and said chemical reactant includes (1) a soluble salt of metal selected from the class consisting of manganese, zinc, chromium, iron, cadmium, cobalt, nickel, tin, lead, copper, bismuth, antimony, mercury, silver, platinum and gold, and (2) a light absorbing medium selected from the class consisting of pigments and dyes.

7. The method of claim **1** wherein said imaging light reflected by said other surface is further reflected by a second mirror and a third mirror, said second mirror obliquely underlying said visual sheet for directing said imaging light along a first axis, said third mirror obliquely intersecting said first axis for directing said imaging light along a second axis.

8. In a method for optical projection of visual information on a visual sheet, said visual sheet including a lower optically clear polymeric stratum and an upper specularly reflecting, vapor deposited aluminum stratum, the steps of differentially marking said aluminum stratum with a chemical reagent in order to differentially change the reflectivity of portions thereof, applying an erasing patch to said aluminum stratum, said erasing patch including a lower, optically clear, adhesive stratum containing a chemical reagent for said aluminum stratum, an intermediate, optically clear, polymeric stratum, and an upper, specularly reflecting, vapor deposited aluminum stratum, said erasing patch clearing a portion of said aluminum stratum of said visual sheet with which it is in contiguity, differentially marking said aluminum stratum of said patch with a chemical reagent in order to change the reflectivity of portions thereof, and, simultaneously with all of the foregoing steps, directing illuminating light to the lower surface of said visual sheet and focusing imaging light reflected therefrom.

9. A method of optical projection of a succession of sheets of visual information, said method comprising:

a. the simultaneous steps of applying a chemical reactant to one surface of a vapor deposited aluminum coat on a polymeric stratum of a first graphic sheet in order to chemically react with and differentially change the index of reflection of portions of the other surface of said aluminum coat, directing illuminating light to other surface of said vapor deposited aluminum coat, and focusing imaging light reflected by said other surface to project an optical image; and

b. replacing said first graphic sheet with a second graphic sheet by superposing said second graphic sheet on said first graphic sheet and withdrawing said first graphic sheet from below said second graphic sheet in order to permit repetition of said simultaneous steps on said second graphic sheet.

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