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Lemelson

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[54] **DISPLAY SHEET MATERIAL AND METHOD**

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[21] Appl. No.: **238,570**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 849,117, Aug. 11, 1969, Pat. No. 3,684,614.

[52] **U.S. Cl.** **350/164;** 350/106; 40/106.51; 40/136; 40/137; 428/29; 428/34; 428/203

[51] **Int. Cl.** **B44f 1/06**

[58] **Field of Search** 161/1, 2, 3.5, 116, 14, 161/122, 130, 131, 139, 413, 410, 146, 148; 350/100, 104, 106, 109; 117/38; 156/156, 290, 219; 40/137, 136, 106.51, 135

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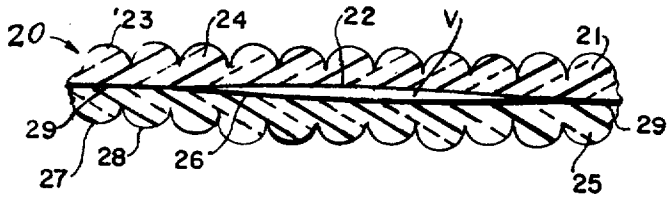
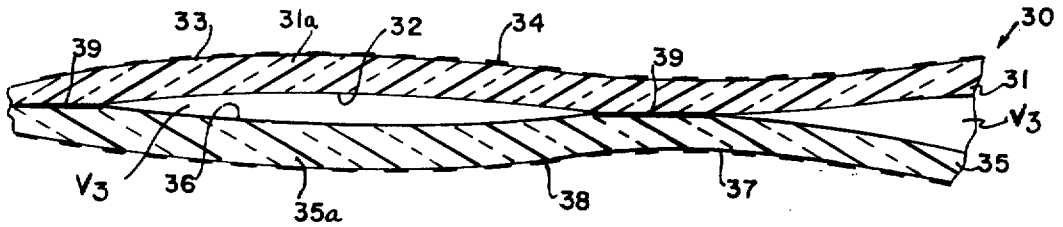
Assistant Examiner—Stanley S. Silverman

[57] **ABSTRACT**

A display sheet material is provided which generates interference fringe patterns which appear to move to an observer upon relative movement of the sheet and the observer. In one form, lenticular formations or parallel printed lines on respective surfaces of different transparent sheets generate fringe patterns. The sheets are secured together in a manner to permit some degree of movement between portions of both sheets to permit variation in the shape and configuration of the fringe patterns.

10 Claims, 8 Drawing Figures





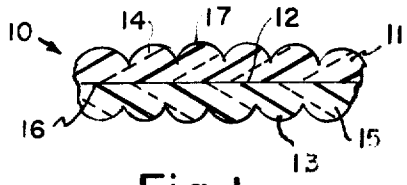


Fig. 1

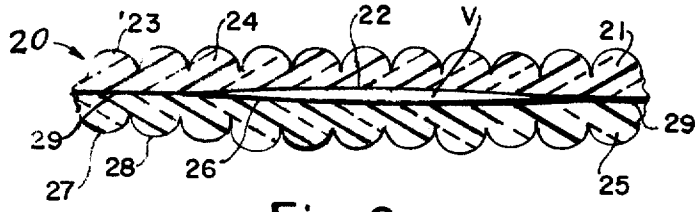


Fig. 2

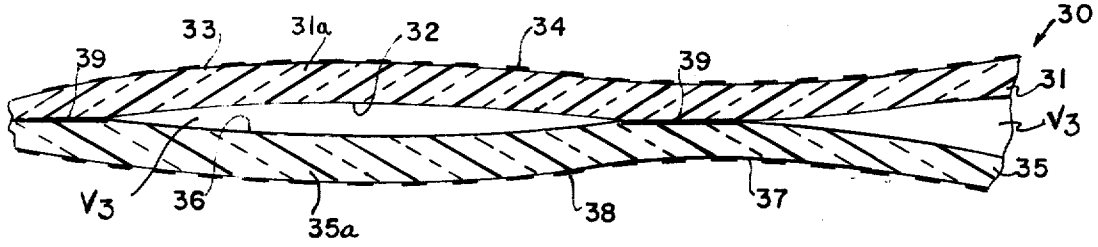


Fig. 3

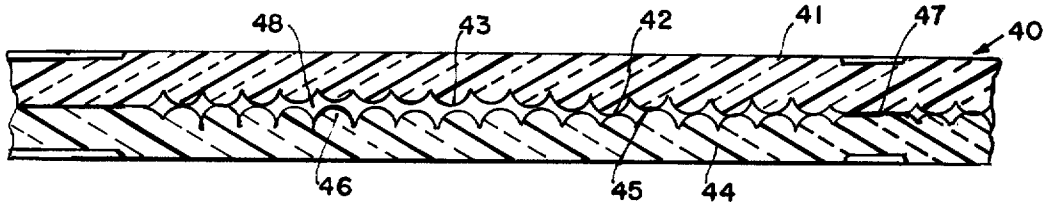


Fig. 4

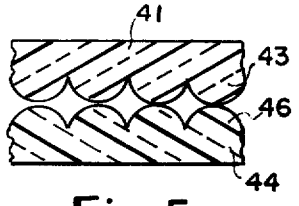


Fig. 5

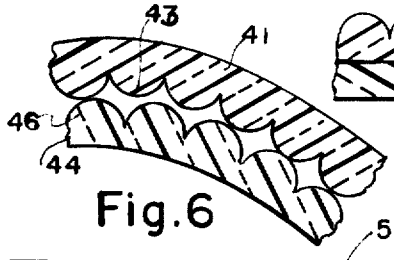


Fig. 6

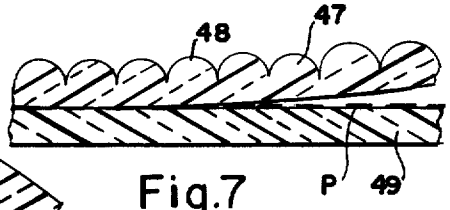


Fig. 7

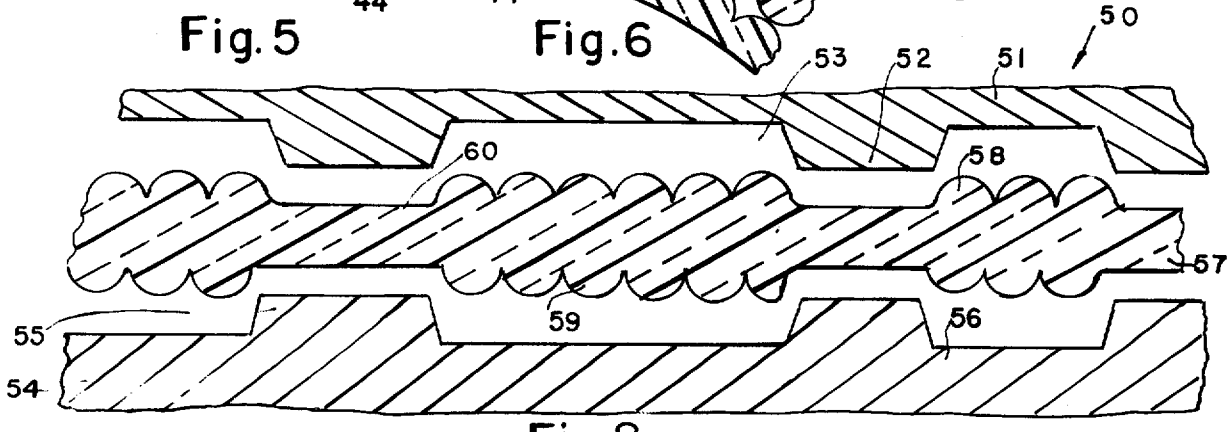


Fig. 8

DISPLAY SHEET MATERIAL AND METHOD

RELATED APPLICATIONS

This is a continuation in part of application Ser. No. 849,117 filed Aug. 11, 1969 for Display and Manufacturing Apparatus now U.S. Pat. No. 3,684,614.

SUMMARY OF THE INVENTION

This invention relates to improvements in display sheet material, preferably flexible translucent plastic sheet capable of generating interference fringe patterns which appear to move or change configuration as the sheet is moved or deformed.

It is a primary object of this invention to provide a new and improved display sheet material having optical effects which are attention getting and pleasing to observe.

Another object is to provide a display sheet material in which is generated interference fringe patterns which not only may be made to shift position or move as the sheet is handled but will also change in configuration.

Another object is to provide a display material which is low in cost and may be used for a component of various products.

Another object is to provide a display material containing lenticular formations therein for generating a variety of optical effects including interference patterns, which formations are disposed facing each other within the sheet and are therefore protected from damage or contamination.

Another object is to provide a display material capable of generating changing optical effects, which material may also be utilized to heat insulate and protect by shock absorption, an article with which it is assembled.

Another object is to provide an apparatus and method for forming indicia within a transparent plastic sheet which is deliniated from a background of interference patterns by exhibiting a lack or variation in such interference patterns.

With thee above and such other objects in view as may hereafter more fully appear, the invention consists of the novel constructions, combinations and arrangements of parts as will be more fully described and illustrated in the accompanying drawings, but it is to be understood that changes, variations and modifications may be resorted to which fall within the scope of the invention as claimed.

IN THE DRAWINGS:

FIG. 1 is an end cross-sectional view of a fragment of a first form of display sheet material formed of two abutted transparent, embossed sheets;

FIG. 2 is an end view in cross section of a fragment of a display sheet material containing portions of two embossed sheets which are spaced-separated from each other;

FIG. 3 is an end cross-sectional view of a composite display sheet material having printed grid patterns for generating interference effects;

FIG. 4 is an end cross-sectional view of a portion of a display sheet material having lenticular surface formations which face each other;

FIG. 5 shows a fragment of the material of FIG. 4 in a flat condition;

FIG. 6 shows the fragment of FIG. 5 deformed;

FIG. 7 is an end cross-sectional view of a portion of sheet material capable of producing interference optical effects which appear to change in configuration and move when the sheet is deformed, the sheet material being made of a lamination of lenticular material and printed material; and

FIG. 8 is an end cross-sectional view of a portion of display sheet material of the type shown in FIG. 1 and embossing means therefore for changing the content of the image changing or interference pattern display.

FIG. 1 is an end cross sectional view of a display material **10** made of two sheets **11** and **15** of translucent material such as transparent plastic having flat contacting surfaces **12** and **16** and respective outer surfaces **13** and **17** in which are formed respective lenticular formations **14** and **18.** The lenticular formations **14** and **18** are respective parallel arrays of oblong lenses such as semi-cylindrical parallel ribs embossed or molded in the respective faces **13** and **17** of the sheets. I have discovered that if the parallel oblong lens formations in one sheet are angulated between about 3° and 25° to the parallel lens formation in the other sheet, interference bands will develop which are observable through the composite material **10** from either surface thereof which bands will vary in thickness depending on the angle between the lens formations. Furthermore, the interference bands will appear to move to an observer as the angle between the line of sight and the observer and the surface of the composite material **10** changes further, the degree and relative velocity of movement of the interference bands is a function of angle between parallel lens formations which velocity and degree increases as the angle increases until the interference effect substantially disappears at an angle of between 20° and 25°.

If the materials of which two sheets **11** and **15** are made is a flexible plastic such as plasticized polyvinyl chloride, and the total thickness of the composite sheet **10** is less than about 60 mils, and preferably under 25 mils, the sheet may be easily bent or flexed as applied to a substrate or during its handling, and will generate very eyecatching, if not startling, optical effects. The two sheets **11** and **15** may be solvent or adhesive bonded or welded together along their entire flat sides or as described hereafter.

In FIG. **2** is shown a composite sheet material **20** made of two sheets **21** and **25** of flexible material of the type defined in FIG. **1** or as otherwise defined hereafter, which sheets are bonded or welded together only along space-separated spot or band-like areas or lines **29** permitting portions of the sheets between the joined portions to become slightly separated and/or shift with respect to each other as the composite assembly **20** is deformed as it is handled, used or otherwise moved. The volume V between the sheets **21** and **25** may be an air space of such thickness as to permit certain portions of the two sheets to contact each other during the handling, bending or folding of the material **20** while other areas adjacent to the contacting areas remain out of contact, and/or to permit variation in the separation distances between the flat faces **22** and **26** of the sheets across the non-bonded portions so as to generate slight interference effects which vary in shape, size and degree of movement as the material is handled or otherwise deformed.

While the lens formations **24** and **28** in the outer faces **23** and **27** of the two sheets may comprise oblong

semi-cylindrical formations, they may also be formed in any other configuration which will generate fringe patterns which will be affected as described, by the separation and relative shifting of those portions of the two sheets which are not joined. Semi-spherical or otherwise formed configurations will also serve to generate suitable fringe patterns which vary as described.

In a modified form of the embodiment of FIG. 2 it is noted that gas under pressure slightly above atmospheric perhaps a pound or two or less may be entrapped between the sheets in the volumes V to expand the sheet portion thereof and maintain them slightly apart.

It is noted that fringe pattern effects which change, as described, may also be generated in the material **20** if the sheets are joined together with surfaces **26** and **27** containing lenticular formations **24** and **28** facing each other.

In FIG. **3** is shown another form of the invention wherein a composite material **30** is made of two sheets **31** and **35** of flexible translucent or transparent plastic, as described, which are welded together along space-separated spot or band-like areas **39** leaving portions **31***a* and **35***a* of the sheets **31** and **35** with their inside faces **32** and **36** which are unjoined and are capable of a slight degree of relative shifting as the sheets are bent or flexed. Printed on the outer faces **33** and **37** of the sheets **31** and **35** are respective indicia **34** and **38** which may comprise respective sets of parallel bands of opaque or translucent colored printing material. Various interference effects may be generated which vary as described, by providing the parallel space separated bands **34** on one face, angulated with respect to those on the other face. The indicia may also be disposed on the inside faces **32** and **36** of the sheets **31** and **35** although the interference effects will not be as prounounced. Depending on the interference effects desired, the indicia arrays composed of elements **34** and **38** may comprise opaque or colored parallel translucent bands which in the range of 0.005 to 0.050 inches wide which are angulated between about 3° and 25° to each other. The bands are preferably equispaced from each other a degree equal to the width of each band although their thickness and separation may vary across the composite sheet. The printed matter on the opposite faces **33** and **37** of the sheets may also comprise spot-like depositions of ink which are of the same shape and equi-spaced from each other to produce interference patterns which vary in shape and appear to move as the material **30** is flexed in handling or use.

The volumes V_3 shown as existing between those portions of the sheets **31** and **35** of FIG. **3** which are disposed between the band-like bonded or welded interfacial areas **39** may vary in thickness from substantially sliding contact between the two sheets which will permit relative shifting of the printed bands **34** and **38** on the outer surfaces of the composite material **30** as said material is handled and deflected or bent during use to a height which is attained as a result of gas pressurizing said volumes to retain the flexible sheet portions of which the composite material is made apart from each other as illustrated. If the printed bands or lines **34** and **38** are relatively narrow, say within the range of 0.005 and 0.030 inches wide, then interference bands may be generated which will appear to move or shift in pattern as the flexible material is deflected or bent during use.

If the bands **34** and **38** are relatively wider, in the range of 0.015–0.060 inches and are equally spaced apart with the bands on one face of the composite material angulated with respect to those printed on the other face thereof, and the volume V_3 is greater than the thickness of one of the sheets comprising the composite material and preferably greater than the total thickness of the two sheets, then various dynamic optical effects may be derived which will be eye-catching and striking to an observer. For example, the so-called "picket fence effect" may be derived wherein the illusion of movement of interference bands is effected to an observer looking through the composite material and moving relative thereto.

It is further noted that while the structure shown in FIG. **2** illustrates a volume V having a thickness which is about one third of the thickness of one of the two lenticulated sheets, comprising the composite material, said volume may be larger or smaller in thickness than illustrated depending on the total thickness and stiffness of the two sheets comprising the composite material, whether or not a gas under pressure is disposed between the two sheets and in accordance with the optical effects desired. At one extreme, the volume V may be such as to permit both sliding contact between the two faces **22** and **26** of the sheets **21** and **25** and also separation of said faces depending on the physical deflection or bending of the material, thereby permitting variable optical effects in interference patterns to be created as the material is handled or otherwise deflected.

In FIG. **4** is shown another form of composite material **40** composed of separate sheets **41** and **44** of flexible transparent plastic material, each preferably in the range of 0.003–0.030 inches thick and each provided with respective lenticular formations **43** and **46** formed in surfaces thereof which face or abut each other in the laminated assembly shown and comprising the composite material. The lenticular formations **43** and **46** formed in respective facing surfaces **42** and **45** of the sheets **41** and **44** may be semi-spherical in shape and offset from each other or semi-cylindrical in shape and angulated as described with respect to each other to provide a variety of different interference effects depending on the shape, width and degree of offsetting or angulation between the lenticular formations in the two sheets.

To secure the two sheets **41** and **42** together, a plurality of weld or bond areas **47** which may be in the shape of spot-like areas or lines running parallel to or criss crossing each other are provided and are sufficiently spaced from each other to permit the material of the two sheets between each of the bond areas or welds to contact each other or be separated from each other, as illustrated, to provide an extended interfacial volume **48** therebetween and interference effects which will appear to change and become variably irregular depending upon the shape and deformation or bending of the composite material.

FIGS. **5** and **6** illustrate how the lenticular formations in the sheet portions **41** and **44** of the sheet material of FIG. **4** may shift with respect to each other as the composite material is deflected or bent. In FIG. **5** the lenticular formations **43** in sheet portion **41** are substantially aligned with lenticular formations **46** in sheet portion **44**. In FIG. **6**, the composite material **40** has been bent or curved about a raise such as to cause a slight shifting

of the formations in each sheet portion with respect to those of the other sheet portion. As a result, not only will there be a shifting in the interference pattern formed by the shifting of the lenticular formations but there will also be a variation in the shape of said pattern caused by certain of the lenticular formations of one sheet separating from those of another as illustrated.

In FIG. 7 is shown a modified form of display sheet which is a lamination of two sheets **47** and **49**, the former having its outer surface embossed with semi-cylindrical or semi-spherical lenticulations **48** and the latter (**49**) being provided with indicia P printed on its inside surface which is bonded to the inside surface of sheet **47** only along space separated band or spot-like areas between the two so as to provide portions of the composite sheet which may abut or become separated a distance from each other depending on the degree the two sheets are deflected. If the formations **48** are elongated ribs such as semicylindrical in shape and the indicia P is composed of parallel space separated opaque or transparent colored bands or two or more arrays of colored band which are interposed between each other positioned and configured to generate image changing or color changing effects, by variably separating the two sheets as they are deflected in handling, further variations in such image or color changing effects may be produced as the sheet material composed of the two sheets **47** and **49** is deflected or deformed such as in handling. For example, portions of the image being viewed may disappear or change in content due to lateral shifting of the two sheet portions thereof as shown in FIGS. **5** and **6**.

In FIG. **8** is shown an apparatus and method for varying the shape and interference effects formed in a display sheet material constructed in accordance with the teachings of FIG. 1 although the apparatus may also be utilized to provide indicia or design in material of the type shown in FIG. **4**.

The lenticular material, denoted **57**, is a sheet having lenticular formations **58** in one surface thereof and cooperating lenticular formations **59** in the opposite surface thereof. The lenticular formations **58** and **59** may comprise semi-spherical or semi-cylindrical formations which are operable to generate interference patterns in the two sheets which appear to move to an observer whose line of sight is shifting with respect to the sheet material. In order to provide indicia such as symbols, trademarks, letters numbers or other designs in the sheet material **57**, certain of the lenticular formations in both surfaces of said sheet are removed by means of an apparatus **50** composed of opposed embossing plates or rolls **51** and **54** having raised portions **52** and **55** and recessed portions **53** and **56**. The raised portions **52** and **55** serve to compress certain portions **60** of the sheet **57** therebetween and if the plates **51** and **54** are properly heated may be used to emboss out the lenticular formations in the outer surfaces of the sheet **57**. The areas in which the lenticular formations are embossed out may be of any suitable configuration and may serve to eliminate the interference effects along said embossed-out areas so as to provide a sheet having interference effects defining certain areas thereof and no such interference effects comprising other areas thereof which are deliniated from the interference areas by the lack of interference bands or other shapes.

I claim:

1. A composite flexible display sheet material made of a plurality of thin light transmitting flexible plastic sheets comprising:

first and second sheets defining different strata of said sheet material,

means for joining said first and second sheets facewise together along a plurality of space-separated portions of said first and second sheets with juxtapositioned portions of said sheets between the joined portions of said sheets being unjoined and capable of some degree of relative shifting movement with respect to each other when the composite sheet material is deformed out of flatness,

each of said first and second sheets containing respective light diffracting means which cooperates with the light diffracting means of the other sheet in generating optical fringe pattern effects to an observer looking through said composite sheet material, and operable whereby, when the sheet material is flexed, said observed fringe pattern effects will appear to the observer to change in shape and to move a degree other than the degree of movement of the display sheet material during the flexure thereof.

2. A composite display sheet material in accordance with claim **1** wherein said light diffracting means of at least one of said sheet layers comprises lenticular formations in at least one surface thereof.

3. A composite display sheet material in accordance with claim **1** wherein said light diffracting means comprises lenticular formations formed in at least one of the major surfaces of each of said sheet layers.

4. A composite display sheet material in accordance with claim **3** wherein said lenticular formation formed in said first and second sheet layers comprise respective parallel rib formations with the parallel rib formations in one sheet layer being angulated to the rib formations formed in the other layer to generate interference fringe patterns which are viewable through said sheet material which fringe patterns vary in shape and positions as said material is flexed.

5. A composite display sheet material in accordance with claim **3** wherein said lenticular formations in said first and second sheet layers are closely spaced short protrusions each defining a respective light diffracting lens and the protrusions of one layer are offset a degree from the protrusions of the other layer a degree to generate an interference fringe pattern effect which will vary in shape as the sheet material is flexed.

6. A composite display sheet material in accordance with claim **1** wherein said light diffracting means comprises lenticular formations in both said sheets formed in the abutting surfaces of said sheets.

7. A composite display sheet material in accordance with claim **1** wherein said light diffracting means comprises rib-like lenticular formations in the outer surface of one of said sheet layers and printed matter on the inside surface of the other of said sheet layers cooperating with said lenticular formations to provide a changing optical effect along abutting portions of the first and second sheet layers.

8. A composite display sheet material in accordance with claim **1** wherein said light diffracting means comprises spaced apart printed formations disposed on both said sheet layers and separated from each other by the thickness of at least one of said sheet layers.

9. A composite display sheet material in accordance with claim 1 wherein the voids between said space-separated portion of said first and second layers of sheet material are gas pressurized.

10. A composite display sheet material in accordance with claim 1 wherein the joined portions of said first and second sheet layers are configured and separated from each other so as to permit relative lateral movement of the unjoined portions of the two layers as the sheet material is flexed to create changing optical effects.

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