



[54] REFLECTIVE POLARIZER DISPLAY

[75] Inventors: Andrew J. Ouderkirk; Olester Benson, Jr., both of Woodbury; Sanford Cobb, Jr., St. Mary's Point, all of Minn.; James M. Jonza, Round Rock, Tex.; Michael F. Weber, Shoreview, Minn.; David L. Wortman; Carl A. Stover, both of St. Paul, Minn.

[73] Assignee: Minnesota Mining and Manufacturing Co., St. Paul, Minn.

[21] Appl. No.: 402,349

[22] Filed: Mar. 10, 1995

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 171,239, Dec. 21, 1993, abandoned, Ser. No. 172,593, Dec. 21, 1993, abandoned, Ser. No. 359,436, Dec. 20, 1994, abandoned, and a continuation-in-part of Ser. No. 360,204, Dec. 20, 1994, abandoned.

[51] Int. Cl.⁶ G02B 5/30; G02B 27/28

[52] U.S. Cl. 359/487; 359/495; 359/497; 359/498; 349/62; 349/96; 362/19

[58] Field of Search 359/485, 486, 359/487, 488, 490, 491, 492, 493, 494, 495, 496, 497, 498, 837; 362/19; 349/62, 96

[56] References Cited

U.S. PATENT DOCUMENTS

Re. 34,605	5/1994	Schrenk et al.	359/359
1,610,423	12/1926	Cawley	353/20
2,492,809	12/1949	Marks	88/65
2,776,598	1/1957	Dreyer	88/105
2,887,566	5/1959	Marks	240/9.5
3,213,753	10/1965	Rogers	88/65
3,423,498	1/1969	Lefevre	264/171
3,480,502	11/1969	Schrenk	156/271
3,498,873	3/1970	Schrenk	161/109
3,528,723	9/1970	Rogers	350/157
3,556,635	1/1971	Schrenk et al.	350/96

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

1327286	3/1994	Canada	G02B 6/00
218041	12/1993	China	G02F 1/1335
056843	8/1982	European Pat. Off.	G02F 1/33
062751	10/1982	European Pat. Off.	G02B 1/08
0 460 241 A1	12/1991	European Pat. Off.	G02B 27/28
0 469 732 A3	2/1992	European Pat. Off.	G02B 1/04
0 488 544 A1	6/1992	European Pat. Off.	G02B 5/30
0 492 636 A1	7/1992	European Pat. Off.	H04N 9/31
0 514 223	11/1992	European Pat. Off.	G02B 5/08
0 552 725 A1	7/1993	European Pat. Off.	G02B 27/28
0 573 905 A1	12/1993	European Pat. Off.	G02B 27/28
0 597 261 A1	5/1994	European Pat. Off.	G02F 1/1335
0 606 939	7/1994	European Pat. Off.	G02F 1/1335
0 606 940	7/1994	European Pat. Off.	G02B 5/30
41 21 861 A1	1/1992	Germany	G02B 5/30
181201	7/1988	Japan	F21V 5/02

(List continued on next page.)

OTHER PUBLICATIONS

"Light Duffusing Film", Optical Systems, 3M 1993.
 Im et al, "Coextruded Microlayer Film and Sheet", *Journal of Plastic Film and Sheeting*, vol. 4, pp. 104-115 (Apr., 1988).
 MacLeod, H.A. *Thin Film Optical Filters*, Adam Hilger, London, 1969.
 Schrenk et al, "Coextruded Iridescent Film", TAPPI Paper Synthetics Conference, Atlanta, Georgia, pp. 141-145 (Sep. 27-29, 1976).
 Schrenk et al, "Coextruded Multilayer Polymer Films and Sheet", *Polymer Blends*, vol. 2, 129, Ch. 15, pp. 129-165, Academic Press, Inc. (1978).
 Schrenk et al, "Interfacial Flow Instability in Multilayer Coextrusion", *Polymer Engineering and Science*, vol. 18(8): pp. 620-623 (Jun. 1978).

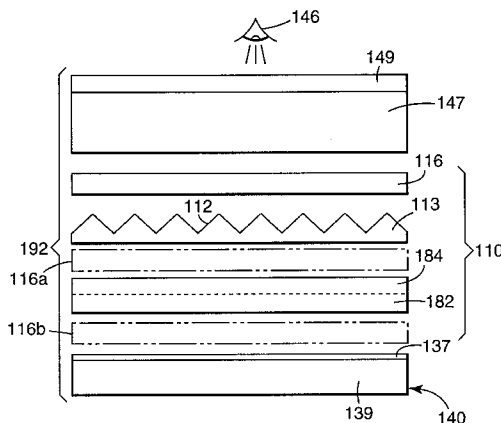
(List continued on next page.)

Primary Examiner—Ricky D. Shafer
Attorney, Agent, or Firm—William D. Miller

[57] ABSTRACT

A brightness enhanced reflective polarizer includes a reflective polarizer and a structured surface material.

92 Claims, 32 Drawing Sheets



U.S. PATENT DOCUMENTS

3,565,985	2/1971	Schrenk et al.	264/171
3,600,587	8/1971	Smith	250/199
3,610,729	10/1971	Rogers	350/157
3,647,612	3/1972	Schrenk et al.	161/165
3,711,176	1/1973	Alfrey, Jr. et al.	350/1
3,746,485	7/1973	Schrenk	425/131
3,759,647	9/1973	Schrenk et al.	425/131
3,773,882	11/1973	Schrenk	264/171
3,801,429	4/1974	Schrenk et al.	161/181
3,847,585	11/1974	Chisholm	65/99 A
4,025,688	5/1977	Nagy et al.	428/350
4,094,947	6/1978	Alfrey, Jr. et al.	264/171
4,190,832	2/1980	Mohler	340/705
4,212,048	7/1980	Castleberry	362/19
4,254,002	3/1981	Sperling et al.	260/23 ST
4,268,127	5/1981	Oshima et al.	350/337
4,310,584	1/1982	Cooper et al.	428/212
4,315,258	2/1982	McKnight et al.	340/784
4,427,741	1/1984	Aizawa et al.	428/332
4,446,305	5/1984	Rogers et al.	528/348
4,520,189	5/1985	Rogers et al.	528/331
4,521,588	6/1985	Rogers et al.	528/363
4,525,413	6/1985	Rogers et al.	428/212
4,540,623	9/1985	Im et al.	428/220
4,542,449	9/1985	Whitehead	362/330
4,586,790	5/1986	Umeda et al.	350/337
4,590,119	5/1986	Kawakami et al.	428/216
4,643,529	2/1987	Hosonuma et al.	350/337
4,659,523	4/1987	Rogers et al.	264/1.3
4,660,936	4/1987	Nosker	350/339 D
4,678,285	7/1987	Ohta et al.	350/345
4,756,953	7/1988	Utsumi	428/220
4,791,540	12/1988	Dreyer, Jr. et al.	362/331
4,796,978	1/1989	Tanaka et al.	350/337
4,798,448	1/1989	van Raalte	350/345
4,799,772	1/1989	Utsumi	350/339 R
4,805,984	2/1989	Cobb, Jr.	350/96.28
4,824,882	4/1989	Nakamura et al.	524/89
4,840,463	6/1989	Clark et al.	350/350 S
4,883,341	11/1989	Whitehead	350/276 R
4,896,942	1/1990	Onstott et al.	350/96.33
4,896,946	1/1990	Suzuki et al.	350/336
4,906,068	3/1990	Olson et al.	350/96.3
4,917,465	4/1990	Conner et al.	350/335
4,937,134	6/1990	Schrenk et al.	428/213
4,952,023	8/1990	Bradshaw et al.	350/102
4,974,946	12/1990	Solomon	350/399
4,989,076	1/1991	Owada et al.	358/61
5,009,472	4/1991	Morimoto	350/6.5
5,042,921	8/1991	Sato et al.	359/40
5,056,888	10/1991	Messerly et al.	385/123
5,056,892	10/1991	Cobb, Jr.	359/831
5,059,356	10/1991	Nakamura et al.	252/585
5,061,050	10/1991	Ogura	359/490
5,089,318	2/1992	Shetty et al.	428/212
5,093,739	3/1992	Aida et al.	359/73
5,094,788	3/1992	Schrenk et al.	264/171
5,094,793	3/1992	Schrenk et al.	264/171
5,095,210	3/1992	Wheatley et al.	250/339
5,103,337	4/1992	Schrenk et al.	359/359
5,122,905	6/1992	Wheatley et al.	359/586
5,122,906	6/1992	Wheatley	359/586
5,124,841	6/1992	Oishi	359/487
5,126,880	6/1992	Wheatley et al.	359/587
5,134,516	7/1992	Lehureau et al.	350/301
5,138,474	8/1992	Arakawa	350/73
5,139,340	8/1992	Okumura	359/63
5,149,578	9/1992	Wheatley et al.	428/213
5,157,526	10/1992	Kondo et al.	359/63
5,159,478	10/1992	Akiyama et al.	359/69
5,166,817	11/1992	Ota et al.	359/73
5,189,538	2/1993	Arakawa	359/73
5,194,975	3/1993	Akatsuka et al.	359/73
5,200,843	4/1993	Karasawa et al.	359/40
5,202,074	4/1993	Schrenk et al.	264/241
5,202,950	4/1993	Arego et al.	385/146
5,217,794	6/1993	Schrenk	428/220
5,221,982	6/1993	Faris	359/93
5,233,465	8/1993	Wheatley et al.	359/359
5,234,729	8/1993	Wheatley et al.	428/30
5,237,446	8/1993	Takahashi	350/359
5,238,738	8/1993	Miller	428/333
5,245,456	9/1993	Yoshimi et al.	359/73
5,255,029	10/1993	Vogeley et al.	353/122
5,262,894	11/1993	Wheatley et al.	359/586
5,269,995	12/1993	Ramanathan et al.	264/171
5,278,680	1/1994	Karasawa et al.	359/40
5,278,694	1/1994	Wheatley et al.	359/359
5,286,418	2/1994	Nakamura et al.	252/585
5,295,018	3/1994	Konuma et al.	359/487
5,303,083	4/1994	Blanchard et al.	359/495
5,309,422	5/1994	Kuroki et al.	369/110
5,316,703	5/1994	Schrenk	264/1.3
5,325,218	6/1994	Willett et al.	359/53
5,333,072	7/1994	Willett	359/41
5,337,174	8/1994	Wada et al.	359/73
5,339,179	8/1994	Rudisill et al.	359/49
5,339,198	8/1994	Wheatley et al.	359/359
5,345,146	9/1994	Koenck et al.	315/169.3
5,359,691	10/1994	Tai et al.	385/146
5,360,659	11/1994	Arends et al.	428/216
5,381,309	1/1995	Borchardt	362/31
5,389,324	2/1995	Lewis et al.	264/171
5,422,756	6/1995	Weber	359/487
5,448,404	9/1995	Schrenk et al.	359/584
5,451,449	9/1995	Shetty et al.	428/195
5,486,949	1/1996	Schrenk et al.	359/498
5,540,978	7/1996	Schrenk	428/212
5,552,927	9/1996	Wheatley et al.	359/359
5,559,634	9/1996	Weber	359/638
5,568,316	10/1996	Schrenk et al.	359/584
B1 4,660,936	1/1990	Nosker	350/339 D

FOREIGN PATENT DOCUMENTS

4-141603	5/1992	Japan	B02B 5/30
4-184429	7/1992	Japan	G03B 21/14
5-288910	11/1993	Japan	G02B 5/18
6-11607	1/1994	Japan	G02B 5/18
6-222207	8/1994	Japan	G02B 5/02
2 052 779	1/1981	United Kingdom	G02F 1/133
WO 91/09719	7/1991	WIPO	B29C 43/20
WO 94/11776	5/1994	WIPO	G02F 1/1335
WO 94/29765	12/1994	WIPO	G02F 1/1335
WO 95/17303	6/1995	WIPO	B32B 7/02
WO 95/17691	6/1995	WIPO	G02B 5/30
WO 95/17692	6/1995	WIPO	G02B 5/30
WO 95/17699	6/1995	WIPO	G02F 1/1335

OTHER PUBLICATIONS

Schrenk et al, "Coextruded Elastomeric Optical Interference Film", SPE Annual Technical Conference, Atlanta, Georgia, 1703-7 (1988).

Schenk et al, "Coextruder Infrared Reflecting Films", 7th Annual Meeting Polymer Processing Society Hamilton, Ontario, Canada (Apr. 1991).

Schrenk, "New Developments in Coextrusion", Advances In Polymer Processing, New Orleans, Louisiana, (Apr., 1991).

Wu et al, "High Transparent Sheet Polarizer Made with Birefringent Materials", *Jpn. J. App. Phys.*, vol. 34, part 2, No. 8A, pp. L997-999, Aug. 1995.

- Derwent Abstract, JP 63017023.
Abstract, Japan 62-295024, 1987.
Abstract, Japan 63-168626, 1988.
Abstract, Japan 4-356038, 1992.
Alfrey, Jr. et al., "Physical Optics of Iridescent Multilayered Plastic Films", *Polymer Engineering and Science*, vol. 9, No. 6, Nov. 1969, pp. 400-404.
Radford et al., "Reflectivity of Iridescent Coextruded Multilayered Plastic Films", presented at the American Chemical Society Symposium on Coextruded Plastic Films, Fibers, Composites, Apr. 9-14, 1972.
3M IR-Compatible Safelight Kit, Instruction Sheet 78-8063-2625-8, Jan. 1989, pp. 1-7.
3M IR Safelight Brochure, 1991.
Boese et al., "Chain Orientation and Anisotropies in Optical and Dielectric Properties in Thin Films of Stiff Polyimides", *Journal of Polymer Science, Part B: Polymer Physics*, vol. 30, pp. 1321-1327 (1992).
Baba et al., "Optical anisotropy of stretched gold island films: experimental results", *Optics Letters*, vol. 17, No. 8, Apr. 15, 1992.
Weber, "Retroreflecting Sheet Polarizer", SID conf. proceedings, Boston, MA, May 1992, *SID 92 Digest*, pp. 427-429.
Weber, "Retroreflective Sheet Polarizer", SID conf. proceedings, Seattle, WA, May 1993, *SID 93 Digest*, pp. 669-672.
Hodgkinson et al., "Effective principal refractive indices and column angles for periodic stacks of thin birefringent films", *Optical Society of America*, vol. 10, No. 9, pp. 2065-2071, Sep. 1993.
Zang et al., "Giant Anisotropies in the Dielectric Properties of Quasi-Epitaxial Crystalline Organic Semiconductor Thin Films".

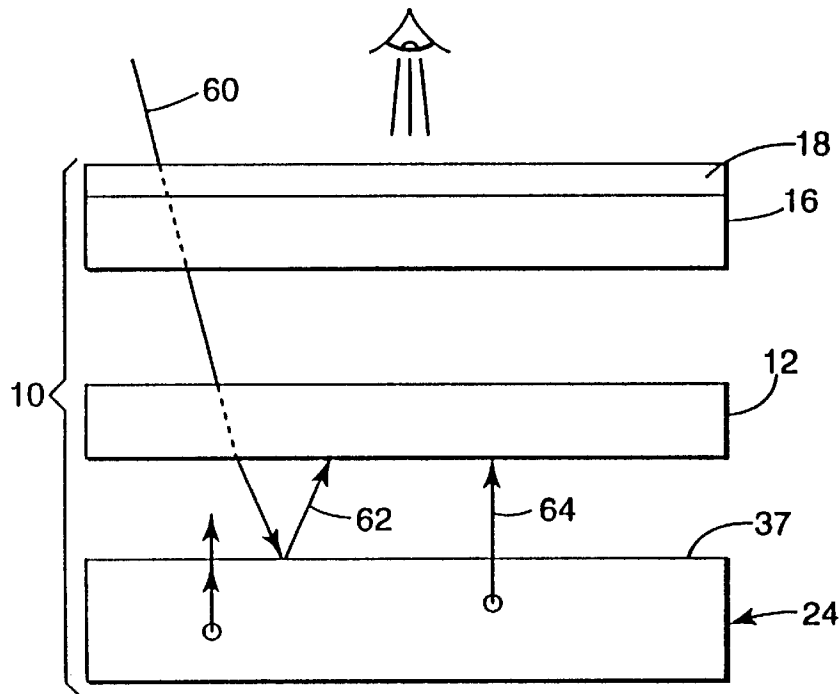


Fig. 1

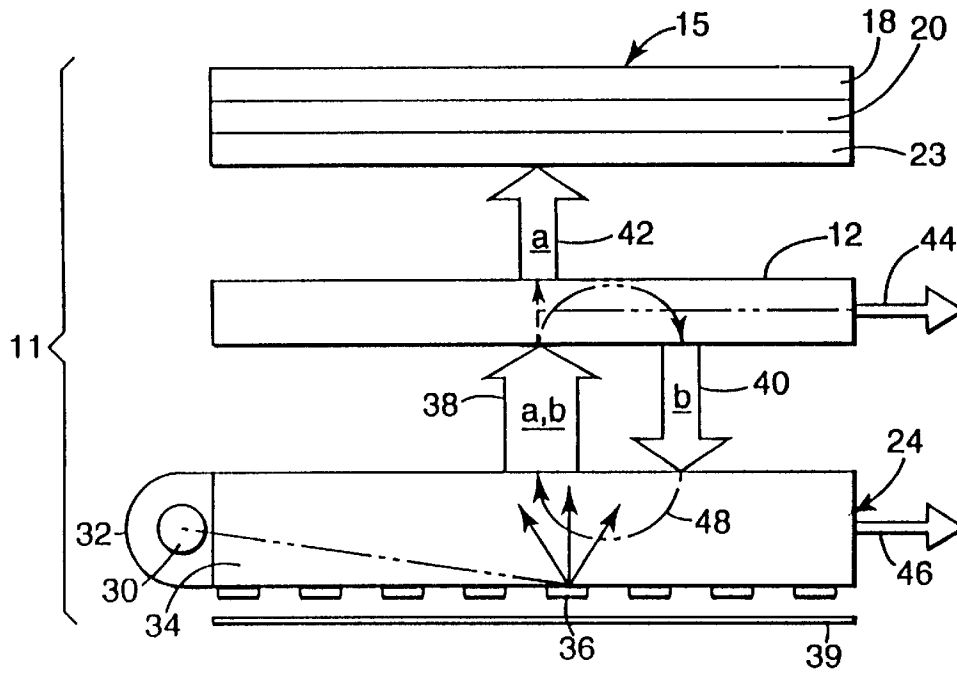


Fig. 2

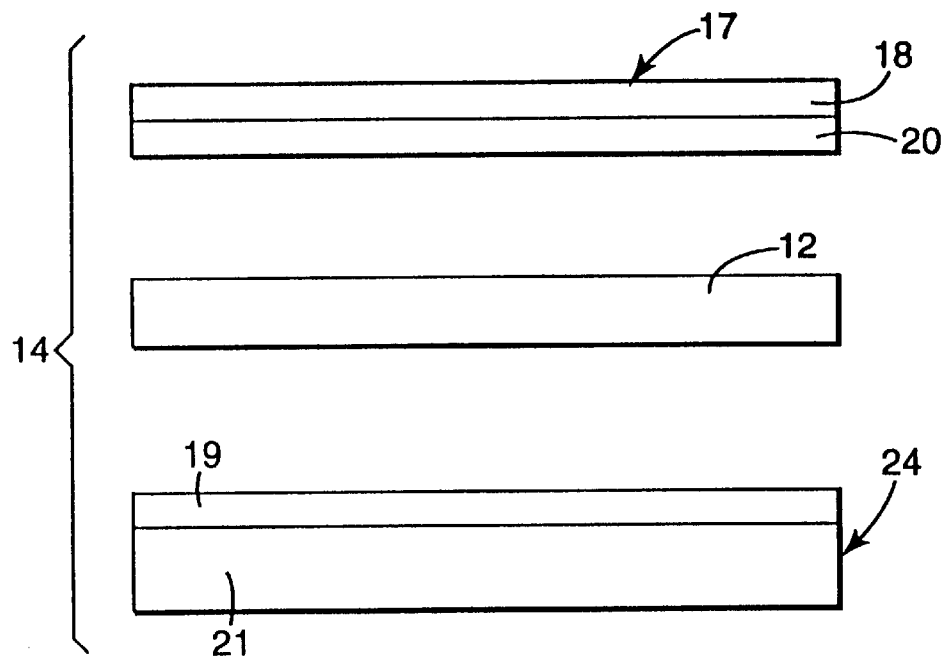


Fig. 3

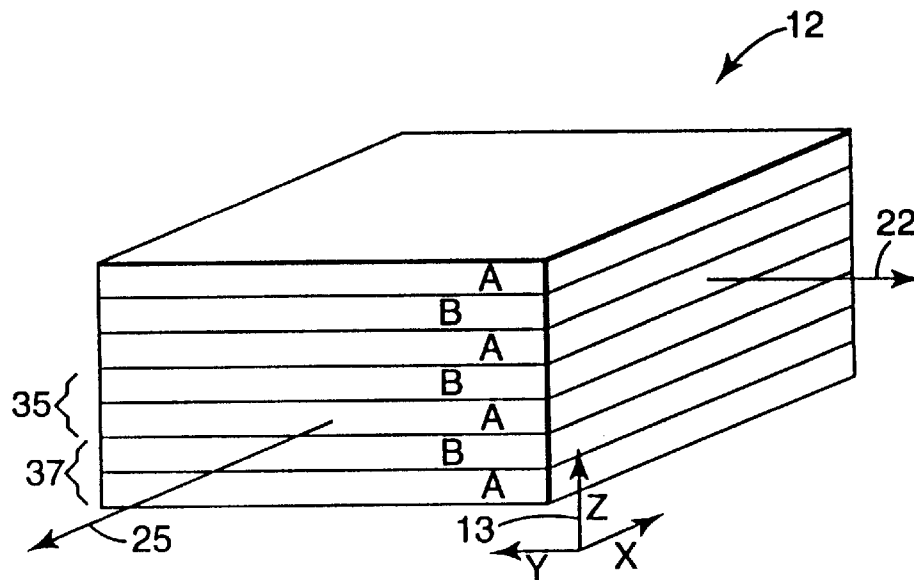


Fig. 4

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.