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Zhao

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(54) **EXTERIOR MIRROR REFLECTOR SUB-ASSEMBLY WITH AUXILIARY REFLECTOR PORTION**

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CPC ***B60R 1/082*** (2013.01); ***B60R 1/0602*** (2013.01)

(58) **Field of Classification Search**

CPC B60R 1/06; B60R 1/07; B60R 1/074; B60R 1/08; B60R 1/081; B60R 1/082; G02B 7/182; G02B 5/10

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See application file for complete search history.

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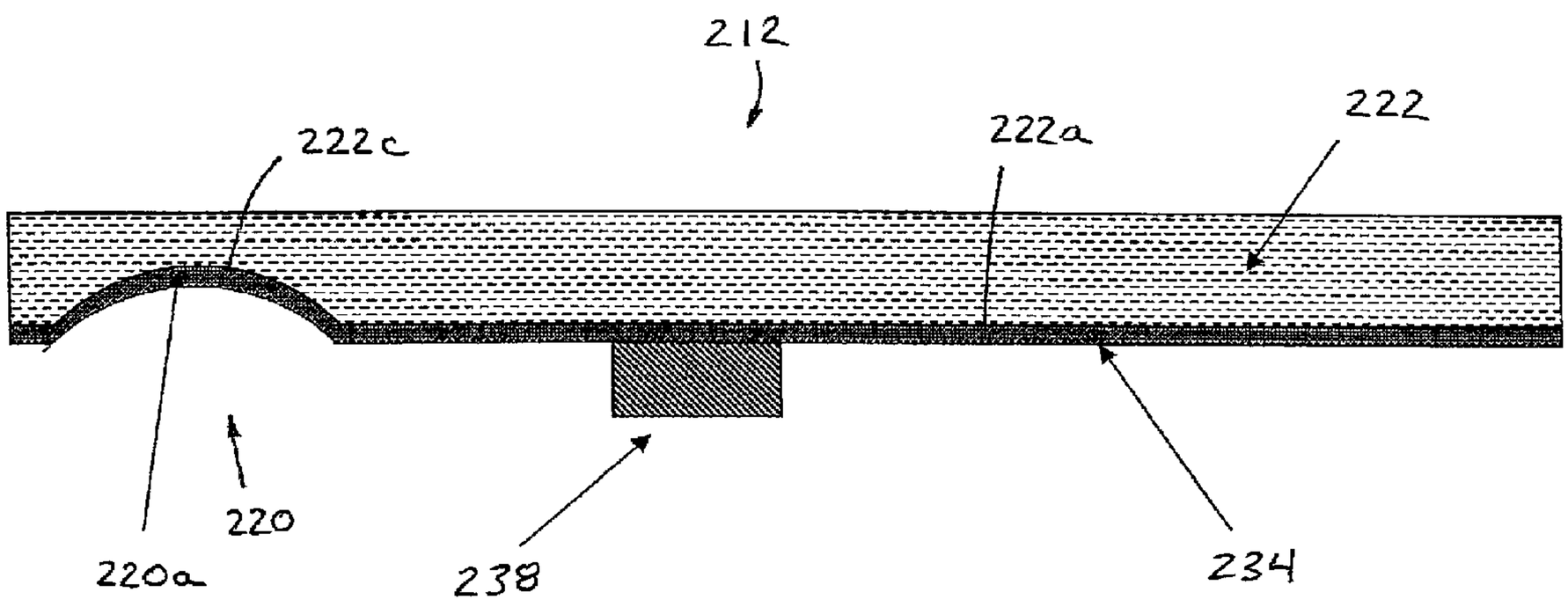
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(57) **ABSTRACT**

A mirror reflector sub-assembly for a vehicular exterior rearview mirror assembly includes a mirror reflective element having a glass substrate. A principal reflector portion has a first radius of curvature and an auxiliary reflector portion includes a curved recess having a second radius of curvature smaller than the first radius of curvature. The curved recess is established at the second surface of the glass substrate by physical removal of glass from a portion of the substrate. The mirror reflective element is supported at a side of a mirror back plate and an opposing side of the mirror back plate is adapted for attaching the mirror back plate to a mirror actuator of an exterior rearview mirror assembly equipped with the mirror reflector sub-assembly. A heater pad is disposed at the second surface of the glass substrate between the mirror reflective element and the mirror back plate.

20 Claims, 6 Drawing Sheets



Related U.S. Application Data

continuation of application No. 13/908,457, filed on Jun. 3, 2013, now Pat. No. 8,608,326, which is a continuation of application No. 13/621,388, filed on Sep. 17, 2012, now Pat. No. 8,459,809, which is a continuation of application No. 13/290,640, filed on Nov. 7, 2011, now Pat. No. 8,267,535, which is a continuation of application No. 13/191,772, filed on Jul. 27, 2011, now Pat. No. 8,061,859, which is a continuation of application No. 13/097,570, filed on Apr. 29, 2011, now Pat. No. 8,021,005, which is a continuation of application No. 12/971,228, filed on Dec. 17, 2010, now Pat. No. 7,934,844, which is a continuation of application No. 12/893,242, filed on Sep. 29, 2010, now Pat. No. 7,887,204, which is a continuation of application No. 12/776,780, filed on May 10, 2010, now Pat. No. 7,824,045, which is a continuation of application No. 12/124,297, filed on May 21, 2008, now Pat. No. 7,748,856.

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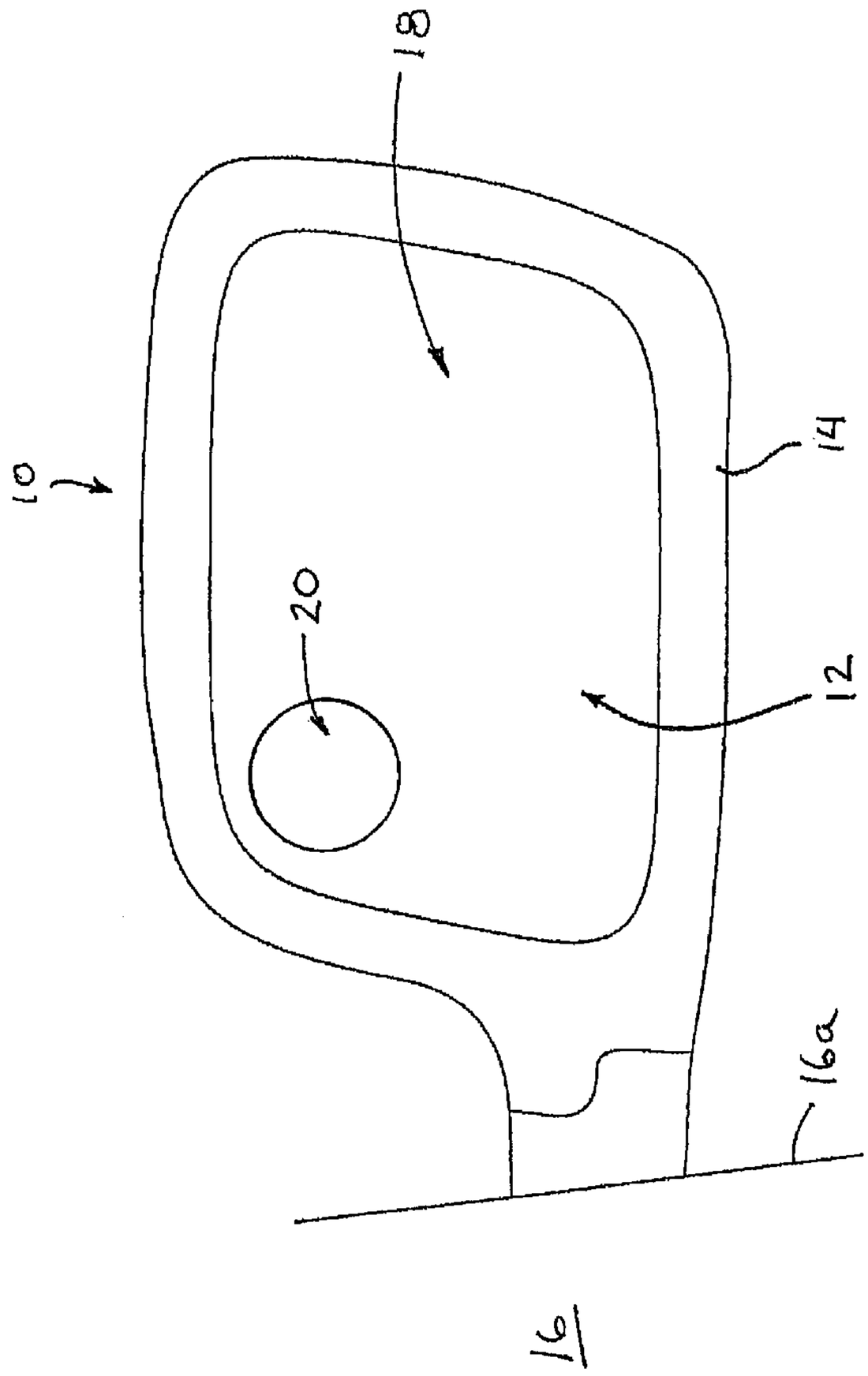


FIG. 1

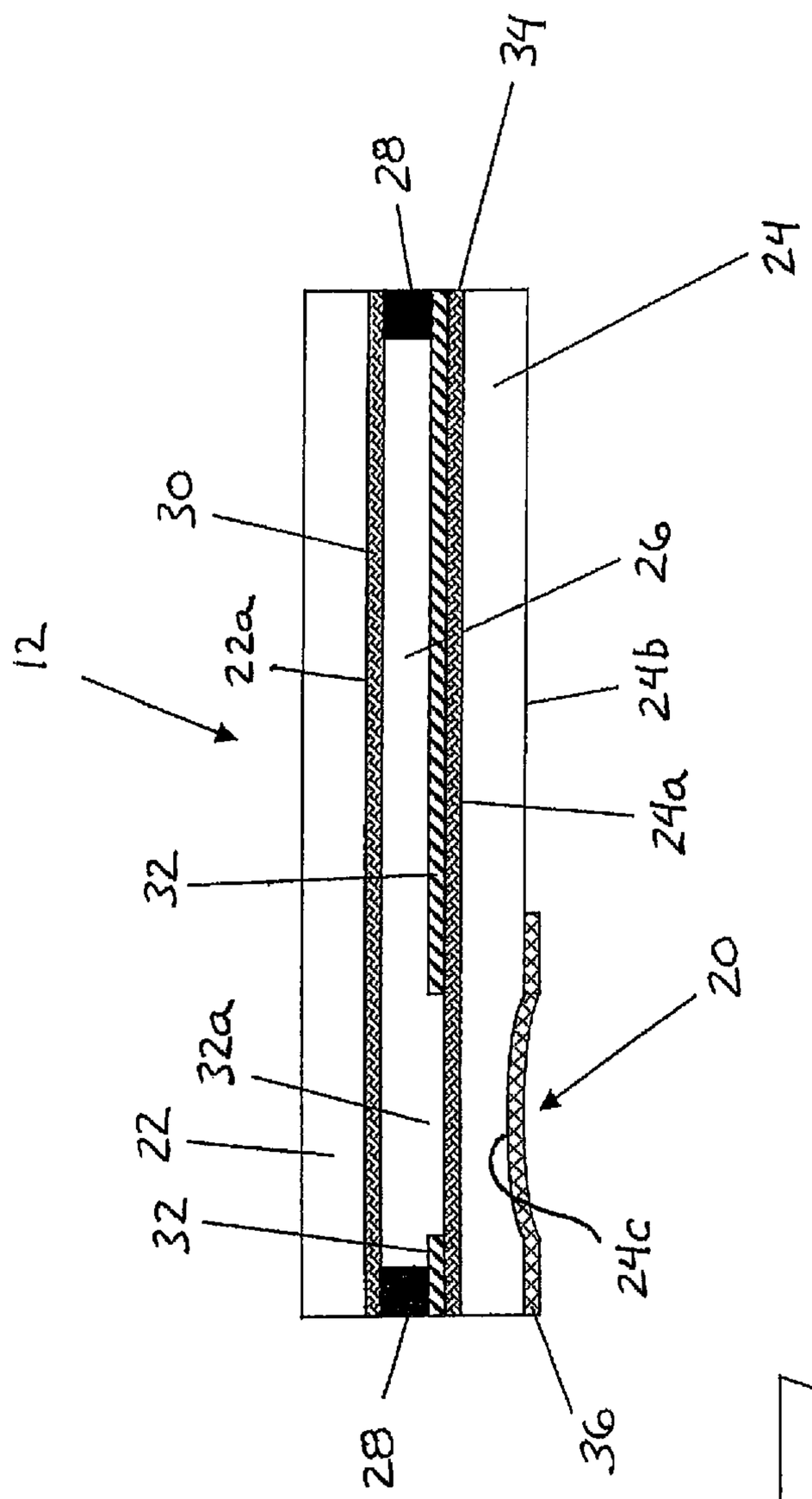


FIG. 3

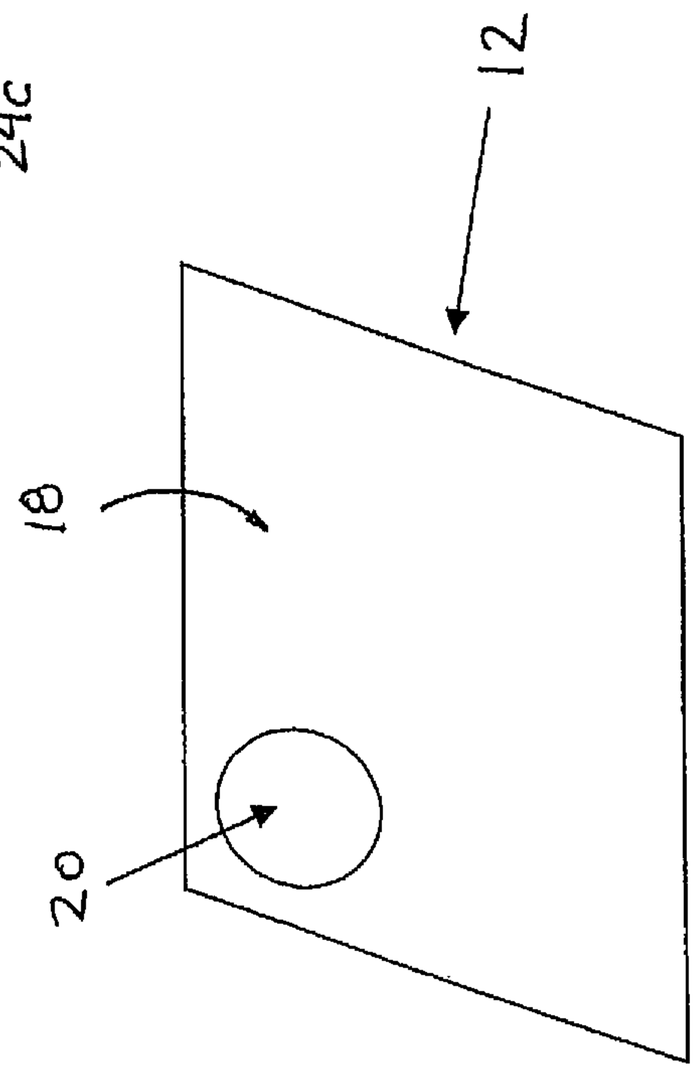


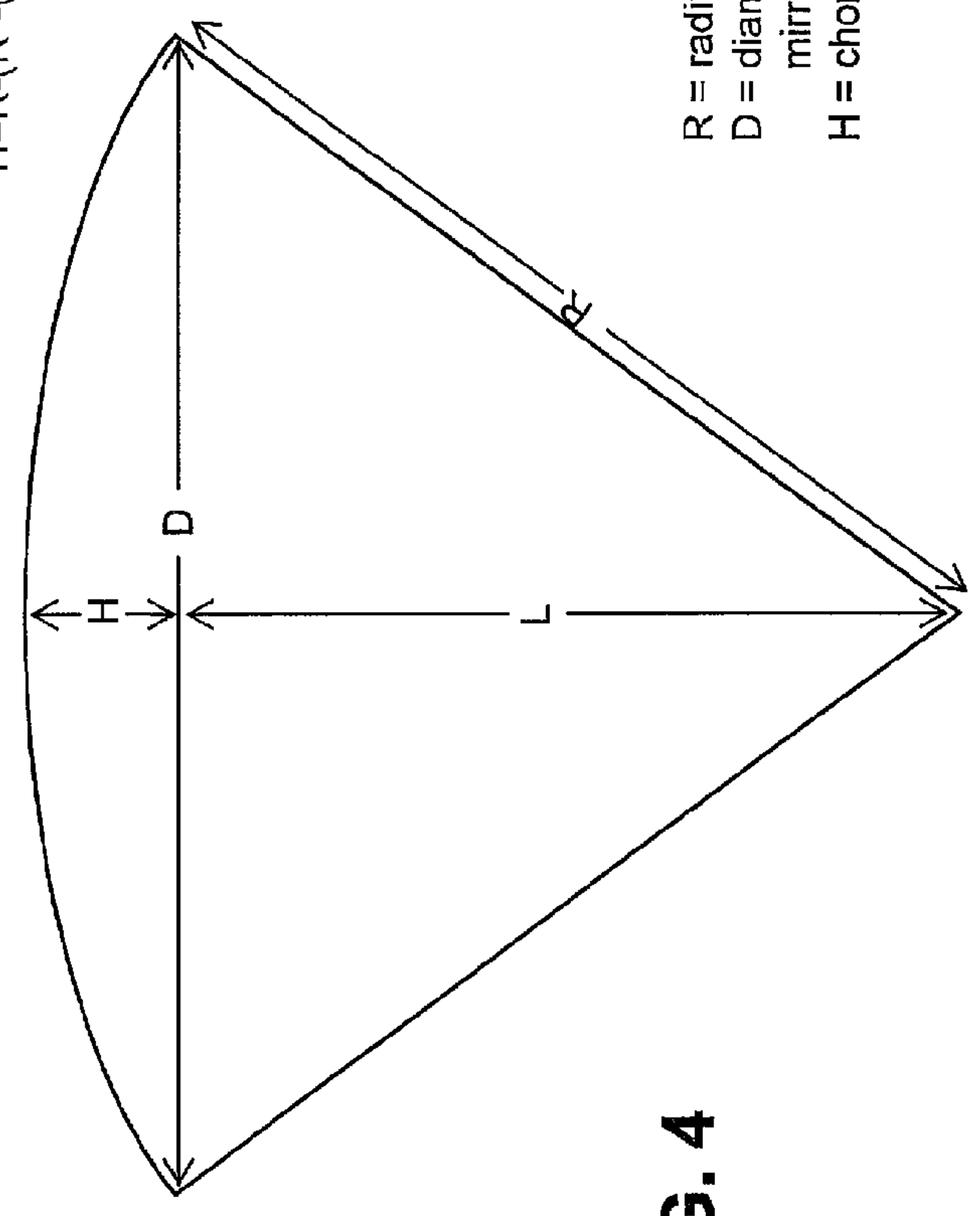
FIG. 2

Chord Height Vs. Radius of Curvature & Diameter

Radius (mm)	Chord Height* (mm)	Diameter (mm)					
		30	40	50	60	70	80
1000		0.11	0.20	0.31	0.45	0.61	0.80
800		0.14	0.25	0.39	0.56	0.77	1.00
600		0.19	0.33	0.52	0.75	1.02	1.33
400		0.28	0.50	0.78	1.13	1.53	2.01
200		0.56	1.00	1.57	2.26	3.09	4.04

Formula:

$H=R-(R^2-(D/2)^2)^{0.5}$



R = radius of curvature
D = diameter of auxiliary convex mirror reflective element
H = chord height

FIG. 4

FIG. 5

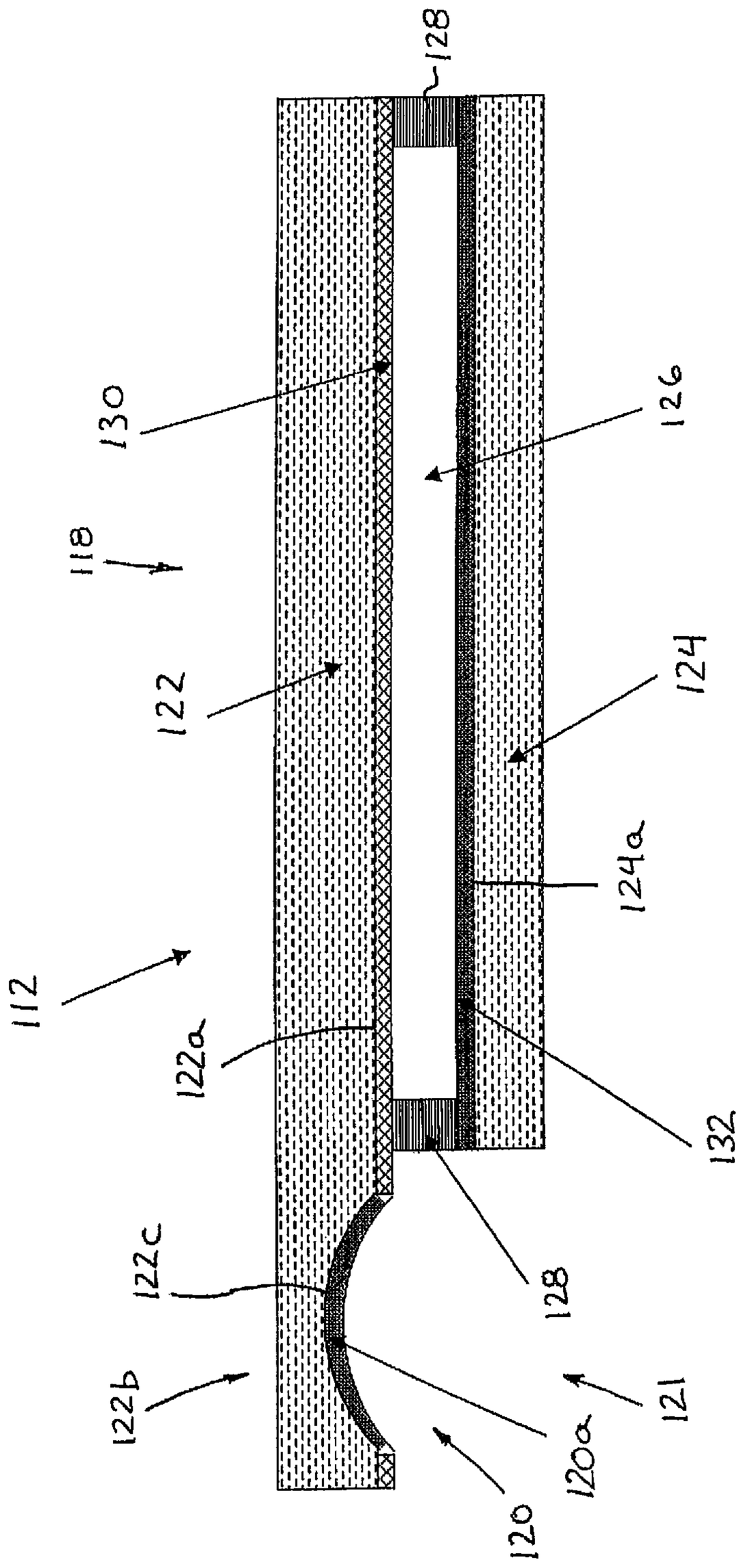

128
130
126
118
122
124
124a
112
122a
132
122c
128
122b
120a
121
120

FIG. 6

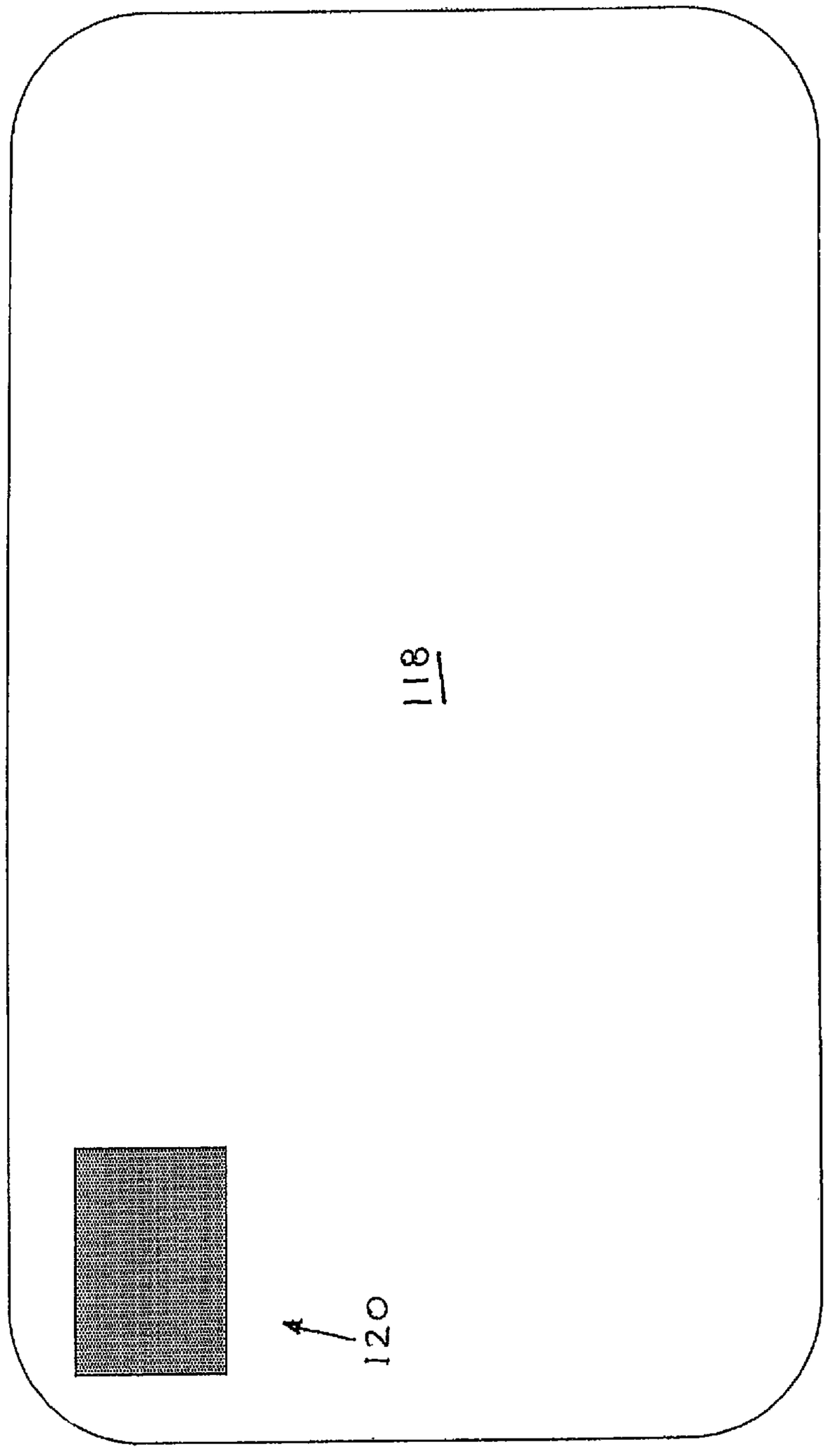


FIG. 7

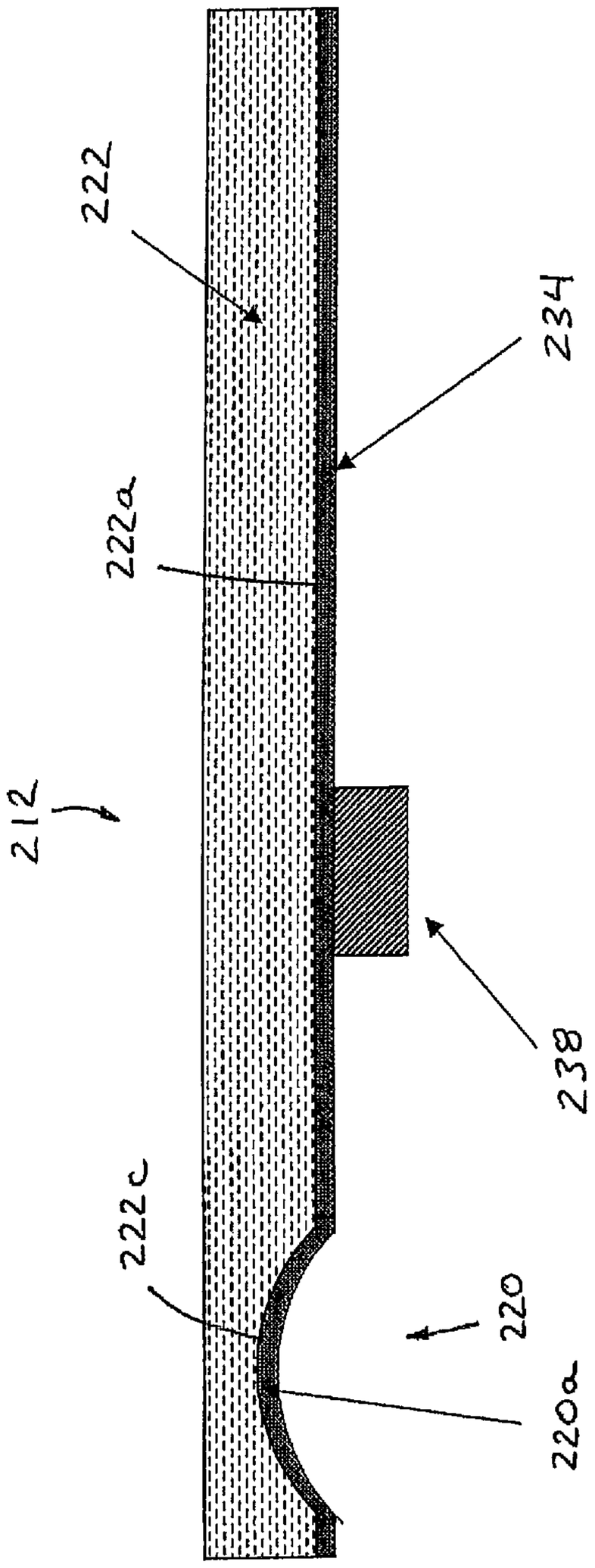


FIG. 8

EXTERIOR MIRROR REFLECTOR SUB-ASSEMBLY WITH AUXILIARY REFLECTOR PORTION

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 14/319,165, filed Jun. 30, 2014, now U.S. Pat. No. 8,939,589, which is a continuation of U.S. patent application Ser. No. 14/107,625, filed Dec. 16, 2013, now U.S. Pat. No. 8,777,430, which is a continuation of U.S. patent application Ser. No. 13/908,457, filed Jun. 3, 2013, now U.S. Pat. No. 8,608,326, which is a continuation of U.S. patent application Ser. No. 13/621,388, filed Sep. 17, 2012, now U.S. Pat. No. 8,459,809, which is a continuation of U.S. patent application Ser. No. 13/290,640, filed Nov. 7, 2011, now U.S. Pat. No. 8,267,535, which is a continuation of U.S. patent application Ser. No. 13/191,772, filed Jul. 27, 2011, now U.S. Pat. No. 8,061,859, which is a continuation of U.S. patent application Ser. No. 13/097,570, filed Apr. 29, 2011, now U.S. Pat. No. 8,021,005, which is a continuation of U.S. patent application Ser. No. 12/971,228, filed Dec. 17, 2010, now U.S. Pat. No. 7,934,844, which is a continuation of U.S. patent application Ser. No. 12/893,242, filed Sep. 29, 2010, now U.S. Pat. No. 7,887,204, which is a continuation of U.S. patent application Ser. No. 12/776,780, filed May 10, 2010, now U.S. Pat. No. 7,824,045, which is a continuation of U.S. patent application Ser. No. 12/124,297, filed May 21, 2008, now U.S. Pat. No. 7,748,856, which claims the benefit of U.S. provisional application, Ser. No. 60/939,753, filed May 23, 2007, which are hereby incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

The present invention relates to exterior rearview mirror assemblies and, more particularly, to an exterior rearview mirror assembly having an auxiliary wide angle reflector portion or optic for providing the driver with a wider angle rearward field of view as compared to a substantially planar portion of the rearview mirror.

BACKGROUND OF THE INVENTION

It is known to provide a wide angle rearward field of view to a driver of a vehicle via a wide angle reflective element at one or both of the exterior rearview mirror assemblies. Such a wide angle rearward field of view may be provided via a curved mirror reflector, or an auxiliary wide angle reflective element may be provided at a portion of a generally planar mirror reflector, such as via a stick on curved auxiliary reflector element attached to the generally planar mirror reflector. Such add-on curved auxiliary reflectors may be provided at the front surface or first surface (the surface of the mirror reflector that is generally facing rearward and at least partially toward the driver of the vehicle) and provide a reduced image size (as compared to the size of the generally planar reflector) wide angle rearward field of view that is readily viewable by the driver of the vehicle. However, such curved, auxiliary wide angle reflectors are additional components and add to the cost and manufacturing complexity of the mirror assembly. Other auxiliary wide angle reflectors have been proposed, such as those described in U.S. Pat. No. 6,315,419; 7,097,312 and/or 6,522,451, which are hereby incorporated herein by reference in their entireties.

SUMMARY OF THE INVENTION

The present invention provides an exterior rearview mirror reflector or reflective element having a generally planar (or slightly curved) principal reflector portion and an auxiliary wide angle reflector portion integrally formed at the mirror substrate.

According to an aspect of the present invention, an exterior rearview mirror assembly for a vehicle includes a mirror reflective element comprising a mirror substrate having a front surface and a rear surface. The mirror substrate comprises a first reflector portion and a second reflector portion, with the first reflector portion comprising a principal reflector portion of the mirror reflective element. The rear surface of the mirror substrate has a curved recess established thereat, and the second curved reflector portion is established at the curved recess. The curved recess has a radius of curvature that is less than a radius of curvature of the first reflector portion (where the radius of curvature of the first reflector portion may be substantially infinity for a generally flat or planar mirror element or substrate with a generally flat or planar principal reflector portion, or may be a measurable radius for a curved or slightly curved or bent mirror element and/or substrate), whereby the curved recess, when coated by a reflector coating, provides a wide angle auxiliary reflector portion integrally formed with the mirror reflective element (such as by physically removing, such as by grinding or sculpting or physically ablating or the like, a portion of the substrate so as to create or establish a physical dish-shaped convex depression or recess or crater at the surface of the substrate).

The mirror reflective element may comprise an electro-optic mirror reflective element having a first or front mirror substrate and a second or rear mirror substrate and an electro-optic medium disposed therebetween. The curved recess is established at a rear surface of the second or rear mirror substrate. The first reflector portion may comprise a metallic reflector disposed at a front surface of the rear mirror substrate and between the rear mirror substrate and the electro-optic medium. The metallic reflector at the front surface of the rear mirror substrate has a window established thereat, with the window substantially corresponding to a location of the curved recess at the rear surface of the mirror substrate. Optionally, the first reflector portion may comprise a metallic reflector disposed at the rear surface of the rear mirror substrate, with the second reflector portion comprising the metallic reflector disposed at the curved recess.

Therefore, the present invention provides an auxiliary wide angle mirror reflector portion that is integrally formed with the mirror substrate and mirror reflective element. The present invention thus provides an auxiliary wide angle reflector portion without additional components or elements being adhered to the front or rear surface of the reflective element, and thus provides an enhanced mirror reflective element with such an auxiliary wide angle reflector portion. The present invention provides a curved wide angle reflector portion that is behind the first or front surface of the mirror reflective element so that the first or front surface of the mirror reflective element comprises a generally or substantially planar surface with the curved reflector portion established or formed behind and viewable through the generally or substantially planar front surface of the mirror reflective element.

These and other objects, advantages, purposes and features of the present invention will become apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevation of an exterior mirror assembly with an auxiliary wide angle reflector in accordance with the present invention, shown as viewed in the direction of travel of the vehicle;

FIG. **2** is a front elevation of an exterior mirror reflector in accordance with the present invention;

FIG. **3** is a sectional view of the mirror reflector of FIG. **2**;

FIG. **4** is a schematic of the curvature of the auxiliary wide angle reflector of the present invention;

FIG. **5** is a table showing dimensions of the auxiliary wide angle reflector for various applications thereof in accordance with the present invention;

FIG. **6** is a sectional view of another mirror reflector in accordance with the present invention;

FIG. **7** is a plan view of the mirror reflector of FIG. **6**; and

FIG. **8** is a sectional view of another mirror reflector in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and the illustrative embodiments depicted therein, an exterior rearview mirror assembly **10** for a vehicle includes a mirror reflector or reflective element **12** received in and/or supported by a mirror shell or casing **14** (FIG. **1**). Mirror assembly **10** is mounted at the side **16***a* of a host or subject vehicle **16**. Mirror reflector **12** includes a first or principal mirror reflective element portion **18** and a second or auxiliary wide angle reflective element portion or reflective optic **20** integrally formed with the mirror reflector **12**, as discussed below. The auxiliary wide angle optic may be integrally formed such as by physically removing, such as by grinding or sculpting or physical ablation or the like, a portion of the substrate so as to create or establish a physical dish-shaped generally convex-shaped depression or recess or crater at the surface of the substrate, and coating the formed depression or recess with a reflector coating or element or the like, as also discussed below.

In the illustrated embodiment, and as shown in FIG. **3**, mirror reflector **12** comprises an electro-optic reflective element (but could comprise a non-electro-optic reflective element) having a front substrate **22**, a rear substrate **24** and an electro-optic medium **26** (such as a solid polymer matrix electrochromic medium or the like) sandwiched therebetween and sealed via a perimeter seal **28**. Front substrate **22** has a transparent conductor coating **30** (such as an indium tin oxide (ITO) coating or layer) disposed at its rear surface **22***a*, while rear substrate **24** has a mirror reflector or coating **32** (such as a non-dichroic transflector, such as an ITO/Ag/ITO stack of layers or coatings or the like) and a transparent conductor layer **34** (such as an ITO or F-doped or As-doped tin oxide layer or the like) disposed at its front surface **24***a*. The mirror reflector **12** thus comprises a third surface electro-optic mirror element (such as an electrochromic mirror element). The front and rear substrates **22**, **24** may comprise generally planar mirror substrates or may have a slight radius of curvature to provide a wider angle field of view across the principal reflector portion **18** depending on the particular application of the mirror reflective element and exterior rearview mirror assembly.

As shown in FIG. **3**, the transparent conductor layer **34** is established or disposed at substantially the entire principal reflecting portion of the reflective element, while the mirror reflector **32** is disposed at the transparent conductor layer **34** and with a window **32***a* masked or formed through the mirror reflector **32** (such that a window area **32***a* of the rear substrate is substantially devoid of the mirror reflector coating, while the mirror reflector or coating is present at the other regions of the principal reflecting area of the rear substrate of the reflective element). The window **32***a* may be formed via any suitable means, such as via masking of the window area during sputter deposition of the mirror reflector **32** or the like, such as via utilizing aspects of the coating processes described in U.S. patent application Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451, which is hereby incorporated herein by reference in its entirety. The transparent conductor **34** is disposed over substantially the entire front surface **24***a* of the rear substrate and at the window region so as to provide a conductive layer or surface at the electro-optic medium **26** and over substantially the entire interface between the rear substrate and the electro-optic medium. Thus, electrical conductivity is preserved between the glass substrate and the electro-optic medium across the interface surface of the substrate including at the window region, so as to provide substantially uniform dimming of the mirror reflective element (i.e. darkening of the electro-optic medium) when an electrical voltage is applied to the conductive coatings at the opposed surfaces of the front and rear substrates.

As shown in FIG. **3**, rear substrate **24** has the curved auxiliary wide angle mirror reflector portion **20** integrally formed therewith. In the illustrated embodiment, the auxiliary wide angle mirror reflector portion **20** or spotter element comprises a curved (such as convex or spherical or aspherical) formation or depression or recess **24***c* formed or established (such as via grinding of the rear surface of the glass substrate or other suitable means) at the rear surface **24***b* of rear substrate **24**. The curved recess **24***c* is integrally formed as part of the rear substrate and is formed at a rear surface location that is generally opposite or generally aligned with the window **32***a* formed at the mirror reflector **32** at the front surface **24***a* of the rear substrate **24**. A mirror reflector or reflective coating **36** (such as a metallic reflector coating, such as aluminum or silver or chromium or alloys thereof or the like) is disposed or established (such as via sputter deposition or chemical deposition or other establishing means) at the rear or fourth surface **24***b* of rear substrate **24** and at least at encompassing the curved recess **24***c* to form the curved spotter or auxiliary wide angle mirror reflector portion **20**. Optionally, such as if the reflector coating **36** is environmentally fragile or non-robust, a sealing or protective layer (not shown), such as a lacquer or paint or ink or the like, may be established over the reflector coating to substantially seal the reflector coating and/or to protect the reflector coating.

As shown in FIG. **3**, the rear reflector coating **36** may be established substantially only at the curved recess and the region substantially immediately surrounding the curved recess, or the rear reflector coating may cover more of the rear surface of the rear substrate. Optionally, if the mirror reflective element is a transflective display-on-demand type of mirror reflective element, a window or aperture may be formed through the rear reflector coating (such as in applications where the rear reflector coating extends at least partially or substantially over the rear surface of the substrate and at the principal reflecting portion of the mirror reflective element) for a display element or illumination source to project illumination therethrough.

Thus, the auxiliary wide angle mirror reflector portion **20** provides a wide angle rearward field of view to the driver of the vehicle as compared to the field of view provided by the generally planar or slightly curved principal reflecting area or portion **18** of the mirror reflective element **12**. The diameter or

cross dimension of the wide angle mirror reflector portion and the radius of curvature (with a smaller radius of curvature providing a wider angle rearward field of view) of the wide angle mirror reflector portion **20** are selected to provide the desired wide angle rearward field of view, while being established at a desired or appropriate depth at the rear surface of the rear substrate. The curved recess has a radius of curvature that is smaller and preferably substantially smaller than the radius of curvature of the principal reflector portion, which may have a large radius of curvature that may approach infinity, such as for a slightly curved to generally or substantially planar or flat mirror element.

As can be seen with reference to FIGS. **4** and **5**, for a spherical or convex construction, the diameter or cross dimension or size D (the dimension across the reflective element) of the auxiliary wide angle reflector portion and the radius of curvature R of the wide angle reflector portion determine the depth H of the recess to be formed at the rear surface of the rear substrate. Thus, the thickness of the glass substrate should be selected to have a thickness that allows for the formation of the curved recess at its rear surface while limiting the affect of the curved recess on the structural integrity of the mirror reflective element. If a larger size or cross dimension or diameter (such as about 60 mm to about 80 mm or thereabouts, such as may be used on an exterior rearview mirror for a larger vehicle, such as a truck or the like) of the auxiliary wide angle reflector portion and/or a smaller radius of curvature (such as about 200 mm to about 400 mm or thereabouts) of the auxiliary wide angle reflector portion is/are desired, the glass substrate should be thick enough to have such a recess formed at its rear surface (with the recess possibly being about 1 mm deep to about 4 mm deep or thereabouts) without adversely effecting the structural integrity of the reflective element. For example, and with reference to FIGS. **4** and **5**, if a 2 mm thick glass substrate is selected for the reflective element, an auxiliary wide angle reflector having a diameter or cross dimension D of up to about 70 mm could be achieved with a 400 mm radius of curvature R by grinding a curved recess having a chord height or depth H of about 1.53 mm into the rear surface of the substrate and thus leaving about 0.47 mm of glass at the apex of the curved recess.

Although several radii of curvature and diameters/cross dimensions are shown in the table of FIG. **5**, clearly other sizes and/or radii of curvature or multiple radii of curvature and/or combinations thereof may be implemented without affecting the scope of the present invention. Optionally, for a given size or diameter of the auxiliary wide angle reflector portion, it may be desirable to provide the smallest radius of curvature of the curved recess (while maintaining the desired structural integrity of the glass substrate and/or reflective element) so as to provide a wider angle rearward field of view to the driver of the vehicle via the auxiliary wide angle reflector portion. Although the radii of curvature and diameters and chord heights or recess depths are shown for spherical formations or constructions, aspherically formed recesses or constructions may be integrally established at the rear surface of the rear substrate to provide other, aspheric or non-uniform wide angle field of views, without affecting the scope of the present invention. For such applications, the depth of the aspheric curved recess should be determined to ensure that the curved recess is not established too deep into rear surface of the glass substrate for the particular applications. Thus, the auxiliary wide angle reflector optic, as viewed through the front surface of the reflective element by a viewer viewing the front or front surface of the reflective element, can be a spherical or aspherical reflector optic, depending on the particular application of the reflective element and mirror assembly and the desired rearward field of view provided by the auxiliary wide angle reflector optic.

Although shown as a generally circular-shaped auxiliary wide angle mirror reflector portion, the auxiliary wide angle mirror reflector portion of the present invention may comprise other shapes and/or may be otherwise located or established at the mirror reflective element, while remaining within the spirit and scope of the present invention. Optionally, the wide angle reflector may comprise a generally convex-shaped reflector, such as a spherically convex shape, or the wide angle reflector may comprise a generally convex-shaped reflector having a compound curvature convex shape, such as a multi-radius shape or aspherical shape or the like. For example, the auxiliary wide angle mirror reflector portion may be formed or sculpted or drilled or ground at a corner or outboard region, preferably an outboard, upper region of the mirror substrate relative to the side of a vehicle to which the mirror would be mounted and viewed by a driver of that vehicle (or elsewhere depending on the particular application), and may comprise a partial circle or partial spherical depression or recess or other shape (such as multi-radius or non-spherical or aspherical shape or segment or such as a rectangular shape that may be curved as a partial cylindrical-shaped recess or the like). Optionally, the wide angle reflector may be formed or sculpted or drilled at the rear surface of the substrate so that the reflector is effectively canted relative to the mirror substrate so as to reflect the wide angle image toward the driver of the vehicle. The rear surface of the corner region of the mirror substrate may be formed or ground or sculpted or otherwise processed to provide the desired shape and/or contour/curvature of the auxiliary reflector portion, and the rear surface of the mirror substrate may be coated or otherwise processed to provide the mirror reflector at the established curved recess at the corner region of the mirror substrate, such as in a similar manner as described above. The wide angle reflector may utilize aspects of the mirror assemblies described in U.S. Pat. Nos. 6,315,419; 7,097,312 and/or 6,522,451; and/or PCT International Publication WO 01/81956 to George E. Platzer Jr. entitled "Compound Automotive Rearview Mirror"; and/or U.S. patent application Ser. No. 11/226,628, filed Sep. 14, 2005 and published Mar. 23, 2006 as U.S. Publication No. US-2006-0061008; and/or Ser. No. 11/912,576, filed Oct. 25, 2007, now U.S. Pat. No. 7,626,749; and/or U.S. provisional applications, Ser. No. 61/050,810, filed May 6, 2008; and/or Ser. No. 61/050,853, filed May 6, 2008, which are hereby incorporated herein by reference in their entireties.

In accordance with what is disclosed in U.S. Pat. No. 6,522,451 (above incorporated herein by reference in its entirety), a plano element and/or a multiradius element can comprise a variable reflectance electro-optic element such as an electrochromic mirror reflector. Thus, both the plano element and the multiradius element can comprise an electrochromic mirror element or either of the plano element and the plano element can comprise an electrochromic mirror element and the other can comprise a fixed reflectance non-variable reflectance mirror element such as a metal reflector coated glass panel such as a chromium coated glass substrate. Also, if both the plano element and the multiradius element comprise an electro-optic element such as an electrochromic mirror element capable of electrically dimmable reflectivity, both elements can dim together and in tandem under control of a common dimming control signal (typically provided by an electro-optic automatic dimming interior mirror assembly mounted in the cabin of the automobile and equipped with photosensors to detect incident glare and ambient light).

Alternately, if both the plano element and the multiradius element comprise an electro-optic element such as an electrochromic mirror element capable of electrically dimmable reflectivity, the plano element can dim independently of the multiradius element (such as is disclosed in U.S. Pat. No. 5,550,677, the entire disclosure of which is hereby incorporated by reference herein). If either or both of the elements comprise an electrochromic element, preferably, the electrochromic reflective element comprises a front substrate and a rear substrate with an electrochromic medium disposed between, such as a solid polymer matrix electrochromic medium such as is disclosed in U.S. patent application Ser. No. 09/350,930, filed Jul. 12, 1999, now U.S. Pat. No. 6,154,306, or such as is disclosed in U.S. Pat. Nos. 5,668,663; 5,724,187; 5,910,854 and 5,239,405, the entire disclosures of which are hereby incorporated by reference herein. Also, although it is preferable to utilize a multiradius or compound curvature reflective element such as an aspherical element or a compound curvature element for the auxiliary mirror element adjacent the plano reflective element (as this enables least discontinuity in image at the joint between the adjacent elements of the assembly), a spherical reflective element (that has substantially only one radius of curvature and, as such, is a section from a sphere) can optionally be used adjacent the plano reflective element instead of, or in addition to, the multiradius reflective element.

In accordance with what is disclosed in U.S. Pat. No. 7,626,749 (above incorporated herein by reference in its entirety), the mirror reflective element may include a wide angle or auxiliary mirror or reflector at a perimeter region or corner region of the reflective element to provide a rearward wide angle view to the driver of the vehicle. The wide angle reflector may be established at the reflective element and behind the fourth surface of the reflective element, such as by utilizing aspects of the reflective elements described in U.S. Pat. No. 6,315,419 and/or U.S. pat. publications, Pub. No. US 2002/0105741, published Aug. 8, 2002; and/or Pub. No. US 2003/0117731, published Jun. 26, 2003; and/or International Pub. No. WO 01/81956, published Nov. 1, 2001, which are all hereby incorporated herein by reference in their entireties. The wide angle reflector may be positioned at a perimeter region of the reflective element so as to provide a wide angle viewing area for viewing the blind spot area at the side and rearward of the vehicle, while the primary or central region of the reflective element provides a generally planar reflective surface for viewing rearward and sideward of the vehicle mirror. The reflective element includes a perimeter band around the perimeter of the reflective element and a perimeter band portion inboard of a wide angle area or region at the reflective element and around an inboard perimeter region of the wide angle reflector. The perimeter band thus separates and/or demarcates the wide angle reflective portion from the generally planar reflective portion of the reflective element, and may conceal or hide the edges of the wide angle reflector. The perimeter band is disposed on the second surface of the front substrate and generally at or along the perimeter seal of the reflective element, while the perimeter band portion is disposed on the second surface and inboard of the seal to generally outline/demarcate an inner perimeter of the wide angle reflector. The perimeter band portion may have generally the same width as the perimeter band, or may have a reduced width or narrow width to reduce the effect on the viewing area of the reflective element. Wide angle reflector is positioned at the rear (or fourth) surface of the rear substrate and may be adhered to the rear surface and generally behind the wide angle area defined by the perimeter band and the perimeter band portion.

In accordance with what is disclosed in PCT International Publication WO 01/81956 (above incorporated herein by reference in its entirety), the auxiliary wide angle mirror portion may be disposed at the second surface of the front substrate of an exterior electrochromic mirror reflective element, and with the electrochromic medium containing electrochromic-active material contacting the auxiliary wide angle mirror portion and disposed between the auxiliary wide angle mirror portion/second surface and a reflector coated rear substrate of the exterior electrochromic mirror reflective element.

Therefore, the mirror reflector or reflective element or transflective electro-optic mirror element of the present invention has an auxiliary wide angle mirror reflector portion established integrally into the rear substrate. The auxiliary mirror reflector portion may be formed or established via grinding a portion of the rear surface of the rear substrate and coating the ground area. The rear surface reflector coating may be established or disposed substantially only at the ground area or curved recess, or may be established or disposed substantially over the entire rear surface of the rear substrate (particularly for applications of the integrally formed wide angle auxiliary mirror reflector portion in fourth surface reflector mirror elements, as discussed below).

Optionally, the integrally formed auxiliary wide angle mirror reflector portion of the present invention may be integrally formed at a rear surface of a fourth surface reflecting electro-optic mirror reflective element, whereby the rear surface mirror reflector disposed at the auxiliary wide angle mirror reflector portion may be established or disposed over substantially the entire rear surface of the rear substrate, with the front surface of the rear substrate having only the transparent conductor layer established thereat. Optionally, the integrally formed auxiliary wide angle mirror reflector portion of the present invention may be integrally formed at a rear surface of non-electro-optic or non-electrochromic reflective element, such as a single substrate mirror reflective element. In such an embodiment, the single substrate may have a mirror reflector or coating established or disposed at its rear surface and at the integrally formed recess of the wide angle mirror reflector portion, such that the rear surface reflector of the mirror reflective element is established over the entire rear surface to form the principal reflector portion of the mirror element and the auxiliary wide angle reflector portion of the mirror element. The single substrate may comprise a generally flat or planar substrate or a slightly curved substrate or a prismatic element or substrate, while remaining within the spirit and scope of the present invention.

Optionally, and as shown in FIGS. **6** and **7**, a mirror reflector **112** may comprise an electro-optic reflective element (but could comprise a non-electro-optic reflective element) having a front substrate **122**, a rear substrate **124** and an electro-optic medium **126** (such as a solid polymer matrix electrochromic medium or the like) sandwiched therebetween and sealed via a perimeter seal **128**. The electrochromic reflective element **112** includes the electrochromic medium **126** sandwiched between the front and rear substrates and at a principal reflecting region **118** of the reflective element **112**. In the illustrated embodiment, the rear substrate **124** is cut away or formed to accommodate the wide angle element **120** at a cut-away region **121** (such as in a similar manner as described in U.S. provisional applications, Ser. No. 61/050,810, filed May 6, 2008; and/or Ser. No. 61/050,853, filed May 6, 2008, which are hereby incorporated herein by reference in their entireties) so that the wide angle element **120** is established at the rear surface **122***a* of the front substrate **122** and at the cut-away region **121** and at a wide angle reflector region **122***b* of front substrate **122**. Thus, the wide angle element may be

established at a cutaway region and rearward of the front substrate and adjacent to the electrochromic medium and rear substrate, such that the mirror reflector assembly does not provide a dimming function at the wide angle reflecting region.

In the illustrated embodiment, front substrate **122** has a transparent conductor coating **130** (such as an indium tin oxide (ITO) coating or layer) disposed at its rear surface **122***a*, while rear substrate **124** has a mirror reflector or coating **132** (such as a non-dichroic transflector, such as an ITO/Ag/ITO stack of layers or coatings or the like, which may include a transparent conductor layer such as an ITO or F-doped or As-doped tin oxide layer or the like) disposed at its front surface **124***a*. The mirror reflector **112** thus comprises a third surface electro-optic mirror element (such as an electrochromic mirror element) at the principal reflecting region of the reflector that is bounded by the seal **128**. The front and rear substrates **122**, **124** may comprise generally planar mirror substrates or may have a slight radius of curvature to provide a wider angle field of view across the principal reflector portion **118** depending on the particular application of the mirror reflective element and exterior rearview mirror assembly.

As shown in FIG. **6**, front substrate **122** has the curved auxiliary wide angle mirror reflector portion **120** integrally formed therewith. In the illustrated embodiment, the auxiliary wide angle mirror reflector portion **120** or spotter element comprises a curved (such as convex or spherical or aspherical) formation or depression or recess **122***c* formed or established (such as via grinding of the rear surface of the glass substrate or other suitable physical material removal means) at the rear surface **122***a* of front substrate **122**. The curved recess **122***c* is integrally formed as part of the front substrate and is formed at a rear surface location that is at the cut-away region **121** of the mirror reflective element assembly. The mirror reflector or reflective coating **120***a* (such as a metallic reflector coating, such as aluminum or silver or chromium or alloys thereof or the like, and optionally may be similar in materials and/or reflectance to the mirror reflector **132** at front surface **124***a* of rear substrate **124**, but other coatings could be utilized at the wide angle reflector depression **122***c* at rear surface **122***a* of front substrate **122**) is disposed or established (such as via sputter deposition or chemical deposition or other establishing means) at the rear or second surface **122***a* of rear substrate **122** and at least at encompassing the curved recess **122***c* to form the curved spotter or auxiliary wide angle mirror reflector portion **120**. Optionally, such as if the reflector coating **120***a* is environmentally fragile or non-robust, a sealing or protective layer (not shown), such as a lacquer or paint or ink or the like, may be established over the reflector coating to substantially seal the reflector coating and/or to protect the reflector coating.

Thus, when forming the front substrate **122** and the mirror reflector or reflective element assembly **112**, the rear surface **122***a* of front substrate **122** may be coated with the transparent conductor coating **130** (such as across its entire or substantially its entire rear surface), and the rear surface of the extended portion or wide angle region **122***b* of front substrate **122** may be ground or physically ablated to establish the recess or depression **122***c* at the rear surface **122***a* of front substrate **122** (such as by first physically removing the transparent conductor coating **130** at the wide angle region of the front substrate and then physically removing a portion of the substrate to establish the recess or depression at the rear surface of the front substrate). The recess or depression **122***c* may then be coated with the mirror reflector or coating **120***a* to establish the wide angle reflector **120** at the overhang region or cut-away region or wide angle reflector region **121** of the mirror reflector **112**. Optionally, the wide angle element may utilize aspects of the Platzer-type auxiliary mirrors that follow the teaching of PCT International Publication WO 01/81956 to George E. Platzer Jr. entitled "Compound Automotive Rearview Mirror", the entire disclosure of which is hereby incorporated by reference herein.

Optionally, the front substrate may include a perimeter band and/or demarcating band and/or hiding layer that traverses the front substrate at the wide angle reflecting region to demarcate the wide angle reflecting region from the generally planar or principal reflecting region and optionally to generally circumscribe at least a portion of the wide angle reflector, such as by utilizing aspects of the mirror assemblies described in U.S. Pat. Nos. 7,274,501; 7,184,190; 7,255,451; and/or U.S. patent application Ser. No. 11/226,628, filed Sep. 14, 2005 and published Mar. 23, 2006 as U.S. Publication No. US-2006-0061008; and/or Ser. No. 11/912,576, filed Oct. 25, 2007, now U.S. Pat. No. 7,626,749; and/or U.S. provisional applications, Ser. No. 61/050,853, filed May 6, 2008; and/or Ser. No. 61/050,810, filed May 6, 2008, which are hereby incorporated herein by reference in their entireties. The hiding layer thus may mask or hide from direct view of the driver the seal and/or other components or elements of the mirror reflector assembly construction that are to the rear of the front substrate and in the area of the bordering or hiding layer or element. The hiding layer thus serves as a demarcation element and a hiding or occluding element for the wide angle mirror reflector established at the rear of the glass substrate at the wide angle reflecting region of the mirror reflector assembly. The hiding layer or demarcation element may demarcate or delineate or distinguish or frame the wide angle reflector from the generally planar principal reflecting region of the reflective element to enhance the discernibility of the wide angle reflector at the wide angle reflecting region of the mirror reflector assembly, while hiding the perimeter seal of the electro-optic mirror reflector assembly.

Optionally, and as shown in FIG. **8**, a non-electro-optic mirror element **212** may include a generally planar substrate **222** with a wide angle reflector **220** established at a rear surface **222***a* of substrate **222**. Substrate **222** has the curved auxiliary wide angle mirror reflector portion **220** integrally formed therewith. In the illustrated embodiment, the auxiliary wide angle mirror reflector portion **220** or spotter element comprises a curved (such as convex or spherical or aspherical) formation or depression or recess **222***c* formed or established (such as via grinding of the rear surface of the glass substrate or other suitable physical material removal means) at the rear surface **222***a* of substrate **222**.

The rear surface **222***a* of substrate **222** is coated with a reflector coating **234**, such as a transflective reflector coating that is partially light transmissive. The wide angle reflector coating **220***a* and the principal reflecting coating **234** may comprise the same material (where the substrate may be formed and the depression or recess **222***c* may be established at the rear surface of the substrate prior to the coating process, which may coat the entire rear surface of the substrate) or may be different materials (or applied in different processes), such as for applications where the substrate is coated with the transflective reflector **234** before the depression or recess **222***c* is established (by removing the reflector coating and a portion of the substrate), and then the recess **222***c* is coated with the wide angle reflector coating. In the illustrated embodiment, a display element **238** is disposed to the rear of the substrate **222** and behind the transflective coating **234**, whereby display information or illumination emitted by the display element **238** is viewable through the transflective

coating and the substrate by a person viewing the front surface of the substrate, while the presence of the display element to the rear of the substrate is rendered covert by the transflective coating when the display element is not activated. Optionally, if a transflective reflector coating is disposed at the recess or depression **222***c*, it is envisioned that a display element or illumination element or the like may be disposed to the rear of the wide angle reflector **220** so as to be viewable, when activated, through the substrate by a person viewing the front surface of the substrate, while being substantially covert when deactivated.

Therefore, the present invention provides a mirror reflective element with an integrally formed auxiliary wide angle mirror reflector portion and a method of making such a mirror reflective element. For example, the mirror substrate may cut to the desired shape or form, and the rear surface of the substrate may be ground or otherwise processed to form the desired curvature of the recess (such as a spherical or aspherical curvature). The recess may be formed before or after the front surface of the mirror substrate is coated with the transparent conductor and/or the metallic reflector (with the window established thereat, such as via masking during sputter deposition of the metallic reflector or such as via laser ablation of the metallic reflector coating at the window area or the like). The front surface and/or rear surface of the mirror substrate may be coated with the reflector coatings (and optionally, the surfaces may be coated via a two-side sputter deposition process, such as by utilizing aspects described in U.S. patent application Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451, which is hereby incorporated herein by reference in its entirety) to establish the desired reflector portions of the mirror reflective element. The rear substrate may be assembled to the front substrate (with the electro-optic medium disposed and sealed therebetween) to assemble the mirror reflective element. Optionally, the rear surface of the rear substrate may be ground and/or coated to establish the auxiliary wide angle reflector portion after the mirror reflective element is assembled.

Optionally, conductive electrode coated glass substrates are commercially available from various sources. For example, tin oxide-coated glass substrates, known as "TEC-Glass" products, may be obtained from Libbey-Owens-Ford Co., LOF Glass Division, Toledo, Ohio, and such as described in U.S. Pat. No. 7,004,592, which is hereby incorporated herein by reference in its entirety. Such "TEC-Glass" products are manufactured by an on-line chemical vapor deposition process that pyrolytically deposits onto clear float glass a multi-layer thin film structure, which includes a microscopically thin coating of fluorine-doped tin oxide (having a fine grain uniform structure) with additional undercoating thin film layers disposed between the fluorine-doped tin oxide layer and the underlying glass substrate. The "TEC-Glass" substrates may be available in different thicknesses, such as 2 thick or 3 mm thick glass substrates and/or the like.

Optionally, the mirror assembly and/or mirror reflective element assembly or sub-assembly may include a back plate that includes a perimeter framing portion or bezel portion that extends around the perimeter edges of the reflective element to support the reflective element and frame the reflective element at the mirror assembly (such as by utilizing aspects of the mirror assemblies described in U.S. patent application Ser. No. 11/520,193, filed Sep. 13, 2006, now U.S. Pat. No. 7,581,859, which is hereby incorporated herein by reference in its entirety). The perimeter bezel portion may be narrow or small depending on the particular application of the reflective element and mirror reflector sub-assembly. Optionally, the mirror reflector sub-assembly may comprise a bezelless or frameless reflective element (such as the types described in U.S. Pat. No. 7,184,190; and/or U.S. patent application Ser. No. 11/226,628, filed Sep. 14, 2005 and published Mar. 23, 2006 as U.S. Publication No. US-2006-0061008; and/or Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451, and/or PCT Application No. PCT/US2006/018567, filed May 15, 2006, which are hereby incorporated herein by reference in their entireties), whereby the back plate may not include a perimeter framing portion or bezel portion around the perimeter of the reflective element.

As described in U.S. patent application Ser. No. 11/520,193, filed Sep. 13, 2006, now U.S. Pat. No. 7,581,859 (incorporated above by reference in its entirety), the mirror back plate may comprise a plastic molding, such as a plastic molding formed by injection molding or co-injection molding or the like. The back plate may be formed with an attaching portion, such as a raised annular ring or annular prongs or annular snaps or the like at its rear surface (opposite from the mounting face or surface that attaches to the mirror reflective element) for attaching the back plate to a mirror actuator (for manually or electrically adjusting an angle of the mirror reflective element relative to the mirror casing).

Optionally, the mirror assembly may include a heater pad or element at the rear surface of the glass substrate to provide an anti-fogging of de-fogging feature to the exterior mirror assembly (such as by utilizing aspects of the heater elements or pads described in U.S. patent application Ser. No. 11/334,139, filed Jan. 18, 2006, now U.S. Pat. No. 7,400,435; and/or U.S. provisional applications, Ser. No. 60/853,850, filed Oct. 24, 2006; Ser. No. 60/918,089, filed Mar. 15, 2007; and/or Ser. No. 60/970,687, filed Sep. 7, 2007; and/or PCT Application No. PCT/US07/82099, filed Oct. 22, 2007, which are hereby incorporated herein by reference in their entireties). The back plate and/or heater pad may include suitable electrical connectors and connections incorporated therein (such as by utilizing aspects of the mirror assembly described in U.S. patent application Ser. No. 11/334,139, filed Jan. 18, 2006, now U.S. Pat. No. 7,400,435, which is hereby incorporated herein by reference in its entirety) for electrically connecting the heater pad and/or display element (or other suitable electrical connectors may be utilized, such as electrical leads or wire harnesses or pigtails or other separate connectors or cables or the like). The heater pad may conform to the rear surface of the rear substrate and thus may provide heating to the auxiliary wide angle mirror reflector portion, and thus may provide substantially uniform heating of the mirror reflective element over substantially the entire reflecting area of the mirror reflective element, including the integrally formed auxiliary wide angle mirror reflector portion.

As disclosed in U.S. patent application Ser. No. 11/334,139, filed Jan. 18, 2006, now U.S. Pat. No. 7,400,435, incorporated above, a heating element or heater pad may comprise a flexible substrate, such as a thin, flexible polymeric element, such as a few thousandths of an inch (mils) thick sheet (such as a thickness of one to fifty mils or greater) of polyester or similar polymeric material, such as Mylar™, commercially available from DuPont, or the like, with a plurality of heater conductive traces disposed thereon. The conductive traces may comprise a pair of electrically isolated traces for the heater function of the heater pad and may comprise a silver frit or the like screened onto a back surface of the flexible substrate, with each trace terminating at or connecting to a respective electrical connector or tab or terminal (such as via metallic pins or posts protruding through the polymeric substrate and between the respective traces and terminals). The conductive traces (such as a silver frit or silver containing or metal containing or graphite containing conductive material,

such as a conductive epoxy or paste or layer or ink or the like) may be disposed on the attaching or first surface of the substrate (the surface that faces/attaches to the rear surface of the reflective element). The heater pad may be similar to known heater pads, and may utilize aspects described in U.S. Pat. No. 4,882,466. The heater pad may include an adhesive layer, such as a pressure sensitive adhesive (PSA), on its first surface for adhering the heater pad to the rear of the reflective element (typically, the pressure sensitive adhesive is covered by a peel away backing, whereby the backing is peeled from the polymeric substrate to expose the adhesive and the heater pad is then laid on or pressed against the rear surface of the reflective element to adhere thereto). The heater pad substrate may also include an adhesive layer (such as double sided tape or a pressure sensitive adhesive or the like) on its second surface, whereby a cover or film may be removed from the surface to expose the adhesive/tape when attaching a back plate to the heater pad and reflective element. Conductive traces may be disposed over substantially the entire heater pad substrate, except in the regions where the electrical connectors are located. The conductive traces generate heat when a current is applied to them via electrical connectors or tabs (such as via electrical connection to a power source or wiring harness of the mirror assembly).

As disclosed in U.S. patent application Ser. No. 11/334,139, conductive traces may terminate in a respective flexible flap, which may overlay a respective bus-bar coating or portion at the rear surface of the reflective element or which may fold or bend at least partially around the respective edge portion of the glass substrate to contact an edge coating or solder at the respective edge portion. A conductive epoxy may be applied to the connection area to ensure a good electrical connection between the traces and the respective conductive coatings/solders/layers at the reflective element.

Optionally, and as disclosed in U.S. patent application Ser. No. 11/334,139, a connecting strip for electrically connecting or establishing conductive continuity between the heater pad or sheet and the wiring harness or circuitry of the mirror assembly may comprise a single strip with four conductive traces thereon, such that a single connection may be made to the mirror assembly. The strip is a flexible ribbon or strip that may be readily flexed or bent to connect to a connector at the mirror assembly or at the end of a wiring harness or ribbon of the mirror assembly. Optionally, the heater pad or sheet may include two or more connector strips, where one strip may include the conductive traces for the heater traces, while the other strip may include the conductive traces for the reflective element traces. The strips may then be flexed or bent to connect to the corresponding connectors at the mirror assembly.

The heater pad or sheet disclosed in U.S. patent application Ser. No. 11/334,139 thus provides a flexible heater pad with the conductive traces and connectors integrally formed thereon, whereby attachment and electrical connection of the heater pad or sheet to the reflective element is made via adhering the heater pad or sheet to the rear surface of the reflective element. The heating elements or traces and the cell powering elements or traces are provided on the heater pad or substrate and are separate from and isolated from and not contiguous with one another. Each of the traces terminates at an electrical connector or terminal or pin at the rear surface of the heater pad for connecting to respective connectors or terminals of a wiring harness or the like at the mirror assembly. The electrical connection of the heater pad and reflective element assembly may thus be made to a wiring harness or electrical connector or connectors at the mirror assembly via one or more electrical connections.

As stated above, the reflective element of the rearview mirror assembly may comprise an electro-optic or electrochromic reflective element or cell, such as an electrochromic mirror assembly and electrochromic reflective element utilizing principles disclosed in commonly assigned U.S. Pat. No. 7,195,381; 6,690,268; 5,140,455; 5,151,816; 6,178,034; 6,154,306; 6,002,544; 5,567,360; 5,525,264; 5,610,756; 5,406,414; 5,253,109; 5,076,673; 5,073,012; 5,117,346; 5,724,187; 5,668,663; 5,910,854; 5,142,407 and/or 4,712,879, and/or U.S. patent application Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451; and/or Ser. No. 11/226,628, filed Sep. 14, 2005 and published Mar. 23, 2006 as U.S. Publication No. US-2006-0061008; and/or PCT Application No. PCT/US2006/018567, filed May 15, 2006 and published Nov. 23, 2006 as International Publication No. WO 2006/124682, and/or European Patent Application No. EP0728618, filed Dec. 8, 1995 and published Aug. 28, 1996; and/or European Patent Application EP0729864, filed Dec. 11, 1995 and published Sep. 4, 1996; and/or Australian Patent Application AU4031795, filed Dec. 11, 1995 and published Feb. 8, 1996, and/or Australian Patent Application AU4031895, filed Dec. 11, 1995 and published Aug. 29, 1996, which are all hereby incorporated herein by reference in their entireties, and/or as disclosed in the following publications: N. R. Lynam, "Electrochromic Automotive Day/Night Mirrors", SAE Technical Paper Series 870636 (1987); N. R. Lynam, "Smart Windows for Automobiles", SAE Technical Paper Series 900419 (1990); N. R. Lynam and A. Agrawal, "Automotive Applications of Chromogenic Materials", Large Area Chromogenics: Materials and Devices for Transmittance Control, C. M. Lampert and C. G. Granquist, EDS., Optical Engineering Press, Wash. (1990), which are hereby incorporated by reference herein in their entireties. The thicknesses and materials of the coatings on the substrates of the electrochromic reflective element, such as on the third surface of the reflective element assembly, may be selected to provide a desired color or tint to the mirror reflective element, such as a blue colored reflector, such as is known in the art and/or such as described in U.S. Pat. Nos. 7,274,501; 5,910,854 and 6,420,036, and in PCT Application No. PCT/US03/29776, filed Sep. 9, 2003, which are all hereby incorporated herein by reference in their entireties.

Optionally, use of an elemental semiconductor mirror, such as a silicon metal mirror, such as disclosed in U.S. Pat. Nos. 6,286,965; 6,196,688; 5,535,056; 5,751,489 and 6,065,840, and/or in U.S. patent application Ser. No. 10/993,302, filed Nov. 19, 2004, now U.S. Pat. No. 7,338,177, which are all hereby incorporated herein by reference in their entireties, can be advantageous because such elemental semiconductor mirrors (such as can be formed by depositing a thin film of silicon) can be greater than 50 percent reflecting in the photopic (SAE J964a measured), while being also substantially transmitting of light (up to 20 percent or even more). Such silicon mirrors also have the advantage of being able to be deposited onto a flat glass substrate and to be bent into a curved (such as a convex or aspheric) curvature, which is also advantageous since many passenger-side exterior rearview mirrors are bent or curved.

Optionally, the reflective element may include a perimeter metallic band, such as the types described in U.S. Pat. No. 7,184,190; and/or PCT Application No. PCT/US03/29776, filed Sep. 19, 2003; and/or PCT Application No. PCT/US03/35381, filed Nov. 5, 2003; and/or U.S. patent application Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451; Ser. No. 11/226,628, filed Sep. 14, 2005 and published Mar. 23, 2006 as U.S. Publication No. US-2006-0061008, which are all hereby incorporated herein by reference in their

entireties. Optionally, the reflective element may include indicia formed at and viewable at the reflective element, such as by utilizing aspects of the reflective elements described in PCT Application No. PCT/US2006/018567, filed May 15, 2006; and U.S. provisional applications, Ser. No. 60/681,250, filed May 16, 2005; Ser. No. 60/690,400, filed Jun. 14, 2005; Ser. No. 60/695,149, filed Jun. 29, 2005; Ser. No. 60/730,334, filed Oct. 26, 2005; Ser. No. 60/750,199, filed Dec. 14, 2005; Ser. No. 60/774,449, filed Feb. 17, 2006; and Ser. No. 60/783,496, filed Mar. 18, 2006, which are all hereby incorporated herein by reference in their entireties.

Optionally, the reflective element may comprise a single substrate with a reflective coating at its rear surface. The mirror assembly thus may comprise a prismatic mirror assembly or planar or non-planar mirror or other mirror having a single substrate reflective element, such as a mirror assembly utilizing aspects of the mirror assemblies described in U.S. Pat. Nos. 6,318,870; 6,598,980; 5,327,288; 4,948,242; 4,826,289; 4,436,371 and 4,435,042; and PCT Application No. PCT/US04/015424, filed May 18, 2004; and U.S. patent application Ser. No. 10/933,842, filed Sep. 3, 2004, now U.S. Pat. No. 7,249,860, which are hereby incorporated herein by reference in their entireties. Optionally, the reflective element may comprise a conventional prismatic or flat reflective element or prism, or may comprise a prismatic or flat reflective element of the types described in PCT Application No. PCT/US03/29776, filed Sep. 19, 2003; U.S. patent application Ser. No. 10/709,434, filed May 5, 2004, now U.S. Pat. No. 7,420,756; Ser. No. 10/933,842, filed Sep. 3, 2004, now U.S. Pat. No. 7,249,860; Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451; and/or Ser. No. 10/993,302, filed Nov. 19, 2004, now U.S. Pat. No. 7,338,177, and/or PCT Application No. PCT/US2004/015424, filed May 18, 2004, which are all hereby incorporated herein by reference in their entireties.

Optionally, the mirror assembly may include one or more displays, such as the types disclosed in U.S. Pat. No. 5,530,240 and/or 6,329,925, which are hereby incorporated herein by reference in their entireties, and/or display-on-demand or transflective type displays, such as the types disclosed in U.S. Pat. Nos. 7,184,190; 7,195,381; 6,690,268; 5,668,663 and/or 5,724,187, and/or in U.S. patent application Ser. No. 10/528,269, filed Mar. 17, 2005, now U.S. Pat. No. 7,274,501; Ser. No. 10/538,724, filed Jun. 13, 2005 and published Mar. 9, 2006 as U.S. Publication No. US-2006-0050018; Ser. No. 11/284,543, filed Nov. 22, 2005, now U.S. Pat. No. 7,370,983; and/or Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451; and/or PCT Application No. PCT/US03/29776, filed Sep. 9, 2003; and/or PCT Application No. PCT/US03/35381, filed Nov. 5, 2003; and/or PCT Application No. PCT/US03/40611, filed Dec. 19, 2003, which are all hereby incorporated herein by reference in their entireties, or may include or incorporate video displays or the like, such as the types described in PCT Application No. PCT/US03/40611, filed Dec. 19, 2003, and/or U.S. patent application Ser. No. 10/538,724, filed Jun. 13, 2005 and published Mar. 9, 2006 as U.S. Publication No. US-2006-0050018; and/or Ser. No. 11/284,543, filed Nov. 22, 2005, now U.S. Pat. No. 7,370,983; and/or U.S. provisional applications, Ser. No. 60/630,061, filed Nov. 22, 2004; and Ser. No. 60/667,048, filed Mar. 31, 2005, which are hereby incorporated herein by reference in their entireties.

Optionally, the mirror reflective element may comprise a transflective display on demand reflective element that is partially transmissive and partially reflective, so that the light emanating from the display element may be transmitted through the reflective element when an illumination source is activated, but the display is substantially non-visible or viewable when the illumination source is deactivated. Optionally, the mirror reflective element may comprise a single substrate or non-electro-optic reflective element, with the auxiliary wide angle reflector portion being integrally formed or established at a rear surface of the reflective element, while remaining within the spirit and scope of the present invention. For example, the reflective element may utilize aspects of the reflective elements described in U.S. Pat. Nos. 7,184,190; 6,690,268; 5,668,663 and/or 5,724,187, and/or in U.S. patent application Ser. No. 10/993,302, filed Nov. 19, 2004, now U.S. Pat. No. 7,338,177; Ser. No. 10/528,269, filed Mar. 17, 2005, now U.S. Pat. No. 7,274,501; and/or Ser. No. 11/021,065, filed Dec. 23, 2004, now U.S. Pat. No. 7,255,451, which are all hereby incorporated herein by reference in their entireties.

Optionally, the mirror assembly may include a blind spot indicator and/or a turn signal indicator, such as an indicator or indicators of the types described in U.S. provisional applications, Ser. No. 60/853,850, filed Oct. 24, 2006; and/or Ser. No. 60/918,089, filed Mar. 15, 2007; and/or Ser. No. 60/970,687, filed Sep. 7, 2007; and/or PCT Application No. PCT/US07/82099, filed Oct. 22, 2007; and/or U.S. Pat. Nos. 6,198,409; 5,929,786 and 5,786,772, and/or PCT Application No. PCT/US2006/026148, filed Jul. 5, 2006, which are hereby incorporated herein by reference in their entireties. The signal indicator or indication module may include or utilize aspects of various light modules or systems or devices, such as the types described in U.S. Pat. Nos. 6,227,689; 6,582,109; 5,371,659; 5,497,306; 5,669,699; 5,823,654; 6,176,602 and/or 6,276,821, and/or U.S. patent application Ser. No. 11/520,193, filed Sep. 13, 2006, now U.S. Pat. No. 7,581,859, and/or PCT Application No. PCT/US2006/018567, filed May 16, 2006, which are hereby incorporated herein by reference in their entireties.

Such an indicator or indicators may function as a lane change assist (LCA) indicator or indicators and/or a blind spot indicator or indicators. Such blind spot indicators are typically activated when an object is detected (via a side object or blind spot detection system or the like such as described in U.S. Pat. Nos. 7,038,577; 6,882,287; 6,198,409; 5,929,786 and 5,786,772, and/or U.S. patent application Ser. No. 11/315,675, filed Dec. 22, 2005, now U.S. Pat. No. 7,720,580; and/or PCT Application No. PCT/US2006/026148, filed Jul. 5, 2006, which are hereby incorporated herein by reference in their entireties) at the side and/or rear of the vehicle (at the blind spot) and when the turn signal is also activated, so as to provide an alert to the driver of the host vehicle that there is an object or vehicle in the lane next to the host vehicle at a time when the driver of the host vehicle intends to move over into the adjacent lane. Optionally, and alternately, the indicator or indicators may function as a lane change assist indicator or indicators, where the host vehicle may be detected to be moving into an adjacent lane without the turn signal being activated, and an object or vehicle may be detected at the adjacent lane, whereby the LCA indicator or indicators may be activated to provide an alert to the driver of the lane change to assist the driver in avoiding unintentional lane changes and/or lane changes when a vehicle or object is detected in the adjacent lane.

The blind spot indicators thus may be operable to provide an indication to the driver of the host vehicle that an object or other vehicle has been detected in the lane or area adjacent to the side of the host vehicle. The blind spot indicator may be operable in association with a blind spot detection system, which may include an imaging sensor or sensors, or an ultrasonic sensor or sensors, or a sonar sensor or sensors or the

like. For example, the blind spot detection system may utilize aspects of the blind spot detection and/or imaging systems described in U.S. Pat. Nos. 7,038,577; 6,882,287; 6,198,409; 5,929,786 and/or 5,786,772, and/or U.S. patent application Ser. No. 11/239,980, filed Sep. 30, 2005, now U.S. Pat. No. 7,881,496; and/or Ser. No. 11/315,675, filed Dec. 22, 2005, now U.S. Pat. No. 7,720,580, and/or U.S. provisional applications, Ser. No. 60/638,687, filed Dec. 23, 2004; Ser. No. 60/628,709, filed Nov. 17, 2004; Ser. No. 60/614,644, filed Sep. 30, 2004; and/or Ser. No. 60/618,686, filed Oct. 14, 2004, and/or of the reverse or backup aid systems, such as the rearwardly directed vehicle vision systems described in U.S. Pat. No. 5,550,677; 5,760,962; 5,670,935; 6,201,642; 6,396,397; 6,498,620; 6,717,610 and/or 6,757,109, and/or U.S. patent application Ser. No. 10/418,486, filed Apr. 18, 2003, now U.S. Pat. No. 7,005,974, and/or of the automatic headlamp controls described in U.S. Pat. No. 5,796,094 and/or 5,715,093; and/or U.S. patent application Ser. No. 11/105,757, filed Apr. 14, 2005, now U.S. Pat. No. 7,526,103; and/or U.S. provisional application, Ser. No. 60/607,963, filed Sep. 8, 2004, and/or of the rain sensors described in U.S. Pat. Nos. 6,250,148 and 6,341,523, and/or of other imaging systems, such as the types described in U.S. Pat. Nos. 6,353,392 and 6,313,454, which may utilize various imaging sensors or imaging array sensors or cameras or the like, such as a CMOS imaging array sensor, a CCD sensor or other sensors or the like, such as the types disclosed in commonly assigned, U.S. Pat. Nos. 5,550,677; 5,760,962; 6,097,023 and 5,796,094, and U.S. patent application Ser. No. 09/441,341, filed Nov. 16, 1999, now U.S. Pat. No. 7,339,149, and/or PCT Application No. PCT/US2003/036177 filed Nov. 14, 2003, published Jun. 3, 2004 as PCT Publication No. WO 2004/047421, with all of the above referenced U.S. patents, patent applications and provisional applications and PCT applications being commonly assigned and being hereby incorporated herein by reference in their entireties.

The constructions of the present invention are economical and effective compared to the more complicated and potentially more costly constructions of other mirror assemblies. For example, no additional elements or reflectors need be positioned at the front or rear surface of the reflective element, since the auxiliary reflector portion is integrally formed and/or established at the reflective element during manufacture of the reflective element.

Changes and modifications to the specifically described embodiments may be carried out without departing from the principles of the present invention, which is intended to be limited only by the scope of the appended claims as interpreted according to the principles of patent law.

The invention claimed is:

1. A mirror reflector sub-assembly suitable for use in an exterior rearview mirror assembly of a vehicle, said mirror reflector sub-assembly comprising:

a mirror reflective element;

said mirror reflective element comprising a glass substrate having a first surface and a second surface;

wherein said mirror reflective element has a principal reflector portion and an auxiliary reflector portion;

wherein said principal reflector portion of said mirror reflective element has a first radius of curvature;

wherein said auxiliary reflector portion of said mirror reflective element comprises a curved recess established at said second surface of said glass substrate by physical removal of glass from a portion of said glass substrate so as to create a dish-shaped depression;

wherein said curved recess of said auxiliary reflector portion of said mirror reflective element has a second radius of curvature;

wherein said second radius of curvature is smaller than said first radius of curvature;

wherein said curved recess has a cross-dimension size that is less than about 80 millimeters;

wherein said curved recess has a maximum recess depth that is less than about 2.26 millimeters;

wherein said glass substrate has a thickness between said first surface and said second surface of less than 3 millimeters;

wherein said second radius of curvature of said curved recess comprises a radius of curvature that is less than about 1,000 millimeters;

wherein a reflector is established at said curved recess;

wherein said reflector comprises at least one of (i) a metal and (ii) chromium;

wherein a principal mirror reflector is established at said principal reflector portion;

wherein said principal mirror reflector comprises at least one of (i) a metal and (ii) chromium;

wherein said principal mirror reflector of said principal reflector portion is established at said second surface of said glass substrate via vacuum deposition and wherein said reflector is established at said curved recess via vacuum deposition;

wherein said mirror reflective element is supported at a side of a mirror back plate and wherein an opposing side of said mirror back plate is adapted for attaching said mirror back plate to a mirror actuator of an exterior rearview mirror assembly equipped with said mirror reflector sub-assembly;

wherein said mirror back plate comprises a plastic molding formed by at least one of (i) injection molding and (ii) co-injection molding;

wherein a heater pad is disposed at said second surface of said glass substrate between said mirror reflective element and said mirror back plate;

wherein said mirror reflective element comprises a fixed reflectance non-electro-optic mirror reflective element; and

wherein said principal mirror reflector is established at said second surface of said glass substrate.

2. The mirror reflector sub-assembly of claim **1**, wherein, with said attaching portion of said mirror back plate attached to the mirror actuator of the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly, a perimeter bezel portion of the exterior rearview mirror assembly extends around the perimeter edges of said mirror reflective element.

3. The mirror reflector sub-assembly of claim **1**, wherein said reflector established at said curved recess and said principal mirror reflector of said principal reflector portion comprise the same material and wherein said same material substantially coats the entire second surface of said glass substrate.

4. The mirror reflector sub-assembly of claim **1**, wherein, with said attaching portion of said mirror back plate attached to the mirror actuator of the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly, said mirror reflective element comprises a frameless mirror reflective element.

5. The mirror reflector sub-assembly of claim **1**, wherein said heater pad is secured by an adhesive at least at said principal reflector portion and wherein electrical power for heating said mirror reflective element is provided via at least

one electrically conductive trace of said heater pad that generates heat when passing an electrical current, and wherein said electrical power is applied via at least one electrical connector of said heater pad that is adapted for connection to wiring of the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly for powering of said heater pad by a power source of a vehicle equipped with the exterior rearview mirror assembly.

6. The mirror reflector sub-assembly of claim **5**, wherein said heater pad comprises a flexible heater pad and wherein at least one electrically conductive trace of said flexible heater pad traverses a flexible strip of said flexible heater pad.

7. The mirror reflector sub-assembly of claim **1**, wherein said curved recess comprises a spherically curved recess.

8. The mirror reflector sub-assembly of claim **1**, wherein said first surface of said glass substrate is generally planar and wherein said second surface of said glass substrate is generally planar other than at said curved recess.

9. The mirror reflector sub-assembly of claim **1**, wherein said curved recess is inboard of a perimeter edge of said glass substrate, and wherein said principal reflector portion of said mirror reflective element surrounds said curved recess of said mirror reflective element, and wherein said curved recess is generally circular-shaped, and wherein said mirror reflective element is configured so that, when the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly is normally mounted at a side of a vehicle equipped with the exterior rearview mirror assembly, said curved recess is generally disposed at an outboard region of said mirror reflective element relative to the side of the equipped vehicle.

10. The mirror reflector sub-assembly of claim **1**, wherein said glass substrate is non-planar at said principal reflector portion, and wherein said mirror reflective element comprises a passenger-side exterior mirror reflective element for use in a passenger-side exterior rearview mirror assembly.

11. A mirror reflector sub-assembly suitable for use in an exterior rearview mirror assembly of a vehicle, said mirror reflector sub-assembly comprising:

a mirror reflective element;

said mirror reflective element comprising a glass substrate having a first surface and a second surface;

wherein said mirror reflective element has a principal reflector portion and an auxiliary reflector portion;

wherein said principal reflector portion of said mirror reflective element has a first radius of curvature;

wherein said auxiliary reflector portion of said mirror reflective element comprises a curved recess established at said second surface of said glass substrate by physical removal of glass from a portion of said glass substrate so as to create a dish-shaped depression;

wherein said curved recess of said auxiliary reflector portion of said mirror reflective element has a second radius of curvature;

wherein said second radius of curvature is smaller than said first radius of curvature;

wherein said curved recess has a cross-dimension size that is less than about 80 millimeters;

wherein said curved recess has a maximum recess depth that is less than about 2.26 millimeters;

wherein said glass substrate has a thickness between said first surface and said second surface of less than 3 millimeters;

wherein said second radius of curvature of said curved recess comprises a radius of curvature that is less than about 1,000 millimeters;

wherein a reflector is established at said curved recess;

wherein said reflector comprises at least one of (i) a metal and (ii) chromium;

wherein a principal mirror reflector is established at said principal reflector portion;

wherein said principal mirror reflector comprises at least one of (i) a metal and (ii) chromium;

wherein said principal mirror reflector of said principal reflector portion is established at said second surface of said glass substrate via vacuum deposition and wherein said reflector is established at said curved recess via vacuum deposition;

wherein said mirror reflective element is supported at a side of a mirror back plate and wherein an opposing side of said mirror back plate is adapted for attaching said mirror back plate to a mirror actuator of an exterior rearview mirror assembly equipped with said mirror reflector sub-assembly;

wherein said mirror back plate comprises a plastic molding;

wherein a heater pad is disposed at said second surface of said glass substrate between said mirror reflective element and said mirror back plate; and

wherein said first surface of said glass substrate is generally planar and wherein said second surface of said glass substrate is generally planar other than at said curved recess.

12. The mirror reflector sub-assembly of claim **11**, wherein said curved recess is inboard of a perimeter edge of said glass substrate, and wherein said principal reflector portion of said mirror reflective element surrounds said curved recess of said mirror reflective element, and wherein said curved recess is generally circular-shaped, and wherein said mirror reflective element is configured so that, when the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly is normally mounted at a side of a vehicle equipped with the exterior rearview mirror assembly, said curved recess is generally disposed at an outboard region of said mirror reflective element relative to the side of the equipped vehicle.

13. The mirror reflector sub-assembly of claim **12**, wherein said mirror reflective element comprises a fixed reflectance non-electro-optic mirror reflective element.

14. The mirror reflector sub-assembly of claim **13**, wherein said principal mirror reflector is established at said second surface of said glass substrate.

15. The mirror reflector sub-assembly of claim **14**, wherein said reflector established at said curved recess and said principal mirror reflector of said principal reflector portion comprise the same material and wherein said same material substantially coats the entire second surface of said glass substrate.

16. A mirror reflector sub-assembly suitable for use in an exterior rearview mirror assembly of a vehicle, said mirror reflector sub-assembly comprising:

a mirror reflective element;

said mirror reflective element comprising a glass substrate having a first surface and a second surface;

wherein said mirror reflective element has a principal reflector portion and an auxiliary reflector portion;

wherein said principal reflector portion of said mirror reflective element has a first radius of curvature;

wherein said auxiliary reflector portion of said mirror reflective element comprises a curved recess established at said second surface of said glass substrate by physical removal of glass from a portion of said glass substrate so as to create a dish-shaped depression;

wherein said curved recess of said auxiliary reflector portion of said mirror reflective element has a second radius of curvature;

wherein said second radius of curvature is smaller than said first radius of curvature;

wherein said curved recess has a cross-dimension size that is less than about 80 millimeters;

wherein said curved recess has a maximum recess depth that is less than about 2.26 millimeters;

wherein said glass substrate has a thickness between said first surface and said second surface of less than 3 millimeters;

wherein said second radius of curvature of said curved recess comprises a radius of curvature that is less than about 1,000 millimeters;

wherein a reflector is established at said curved recess;

wherein said reflector comprises at least one of (i) a metal and (ii) chromium;

wherein a principal mirror reflector is established at said principal reflector portion;

wherein said principal mirror reflector comprises at least one of (i) a metal and (ii) chromium;

wherein said principal mirror reflector of said principal reflector portion is established at said second surface of said glass substrate via vacuum deposition and wherein said reflector is established at said curved recess via vacuum deposition;

wherein said mirror reflective element is supported at a side of a mirror back plate and wherein an opposing side of said mirror back plate is adapted for attaching said mirror back plate to a mirror actuator of an exterior rearview mirror assembly equipped with said mirror reflector sub-assembly;

wherein said mirror back plate comprises a plastic molding;

wherein a heater pad is disposed at said second surface of said glass substrate between said mirror reflective element and said mirror back plate;

wherein said heater pad is secured by an adhesive at least at said principal reflector portion and wherein electrical power for heating said mirror reflective element is provided via at least one electrically conductive trace of said heater pad that generates heat when passing an electrical current, and wherein said electrical power is applied via at least one electrical connector of said heater pad that is adapted for connection to wiring of the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly for powering of said heater pad by a power source of a vehicle equipped with the exterior rearview mirror assembly; and

wherein said heater pad comprises a flexible heater pad.

17. The mirror reflector sub-assembly of claim **16**, wherein said glass substrate is non-planar at said principal reflector portion, and wherein said mirror reflective element comprises a passenger-side exterior mirror reflective element for use in a passenger-side exterior rearview mirror assembly.

18. The mirror reflector sub-assembly of claim **17**, wherein said curved recess is inboard of a perimeter edge of said glass substrate, and wherein said principal reflector portion of said mirror reflective element surrounds said curved recess of said mirror reflective element, and wherein said curved recess is generally circular-shaped, and wherein said mirror reflective element is configured so that, when the exterior rearview mirror assembly equipped with said mirror reflector sub-assembly is normally mounted at a side of a vehicle equipped with the exterior rearview mirror assembly, said curved recess is generally disposed at an outboard region of said mirror reflective element relative to the side of the equipped vehicle.

19. The mirror reflector sub-assembly of claim **18**, wherein said mirror reflective element comprises a fixed reflectance non-electro-optic mirror reflective element and wherein said principal mirror reflector is established at said second surface of said glass substrate.

20. The mirror reflector sub-assembly of claim **19**, wherein said reflector established at said curved recess and said principal mirror reflector of said principal reflector portion comprise the same material and wherein said same material substantially coats the entire second surface of said glass substrate.

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