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Huynh

(54) **GEMSTONE SETTING INCLUDING A GEM FACETED TO DISPLAY A PLURALITY OF IMAGES FROM AN OUTER FOCAL REGION**

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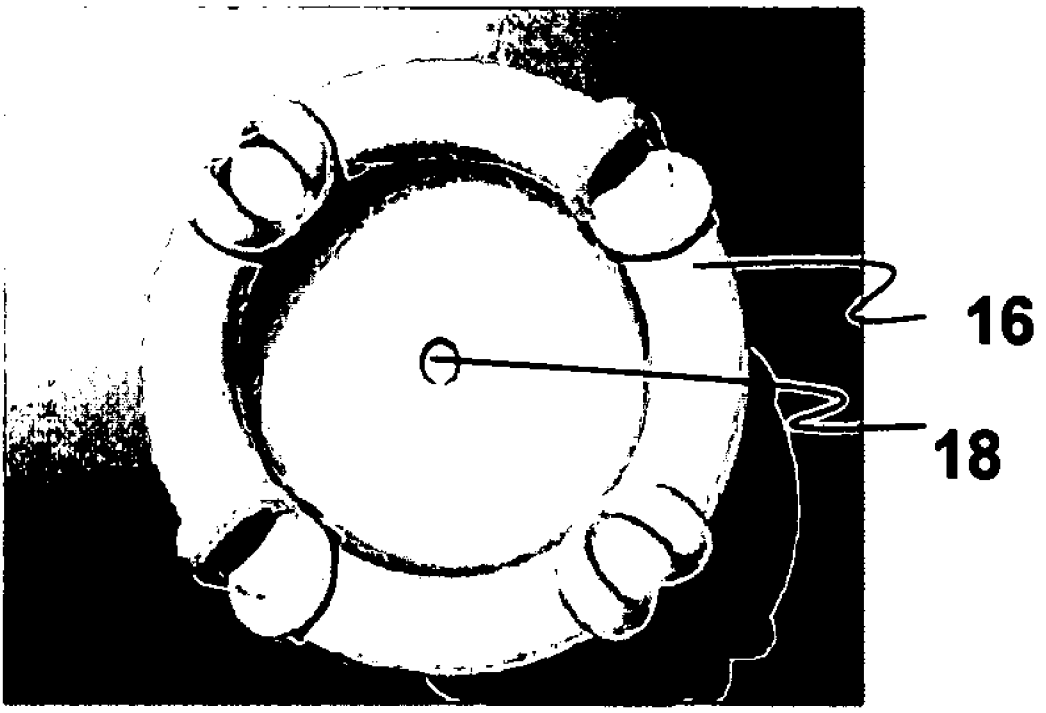
Publication Classification

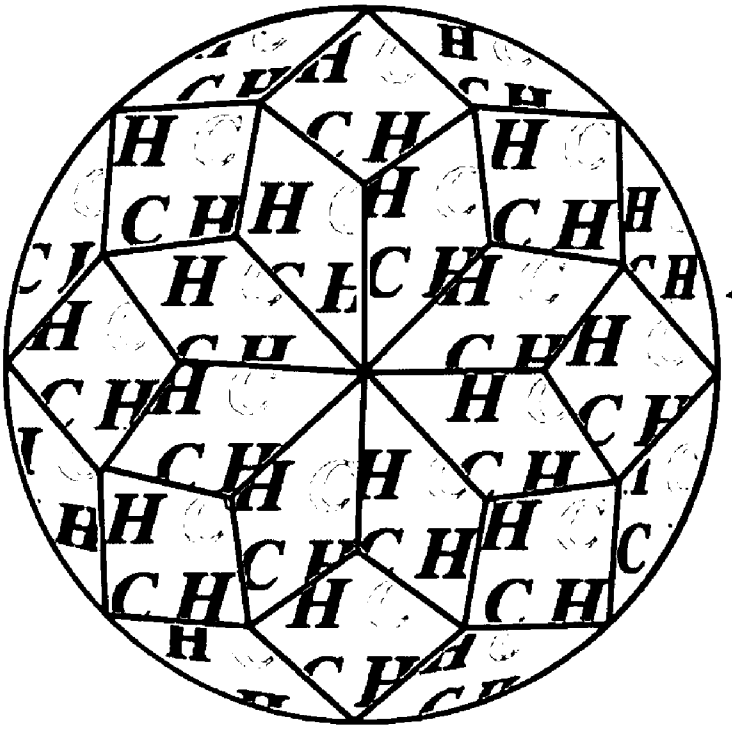
(51) **Int. Cl.**
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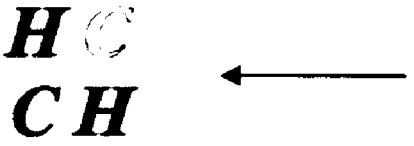
(57) **ABSTRACT**

The present invention includes gemstone settings and methods of manufacturing gemstone settings including a primary gem capable of displaying a plurality of images corresponding to one or more objects placed within in a focal region outside of the primary gem. The plurality of images is displayed by flattening the bottom of the primary gem and faceting the crown to specifications that allow light to pass through the gem and not substantially reflect against a faceted pavilion.





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FIG. 1

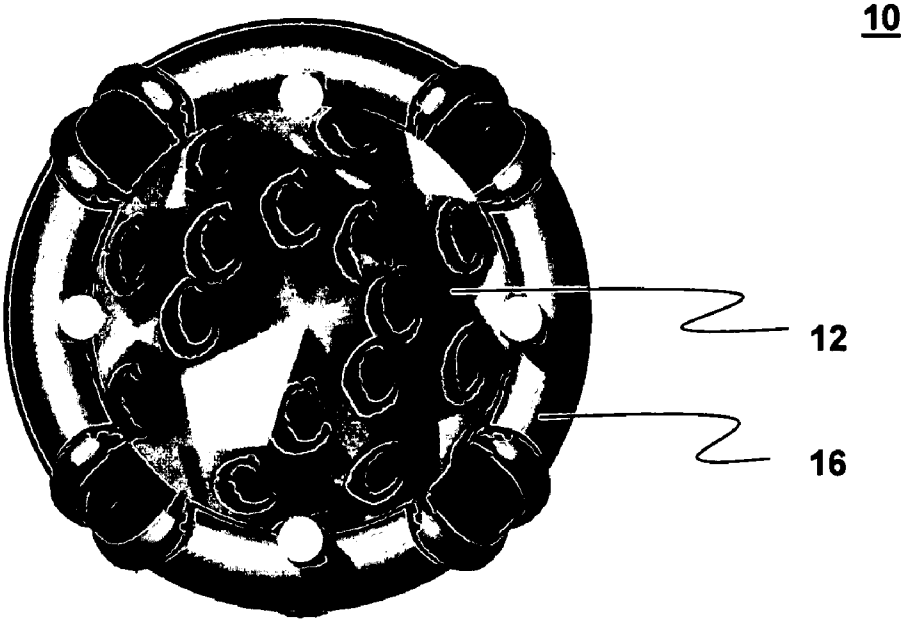


FIG. 2A

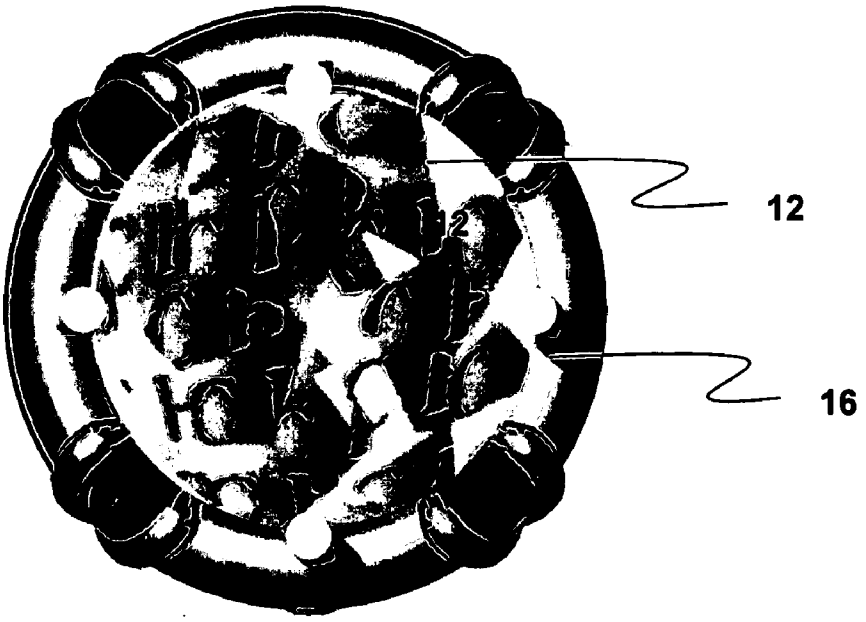


FIG. 2B

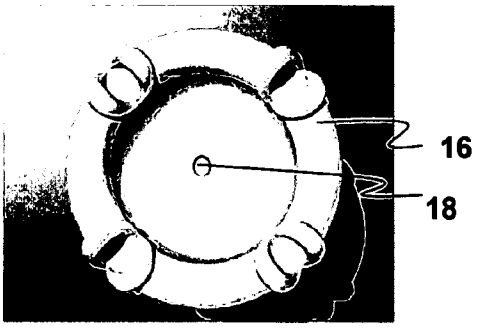


FIG. 3A

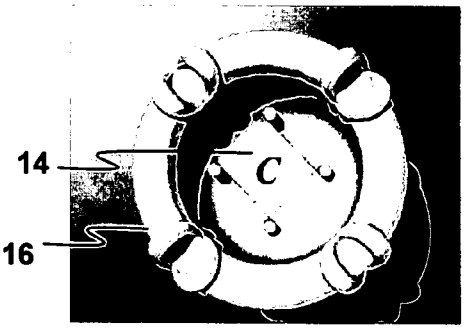


FIG. 3B

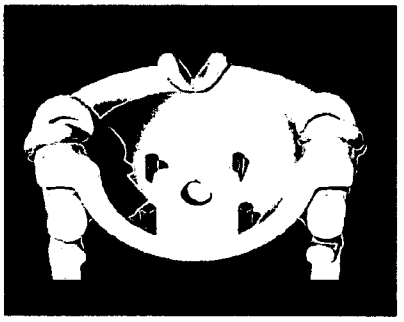


FIG. 3C

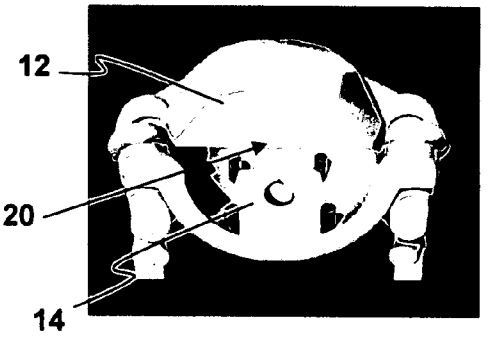


FIG. 3D

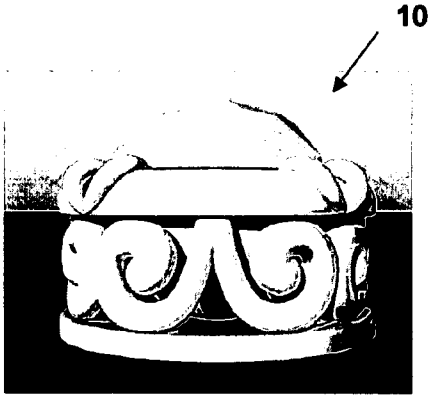


FIG. 3E

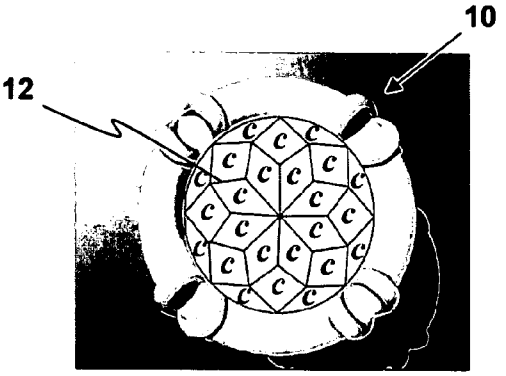


FIG. 3F

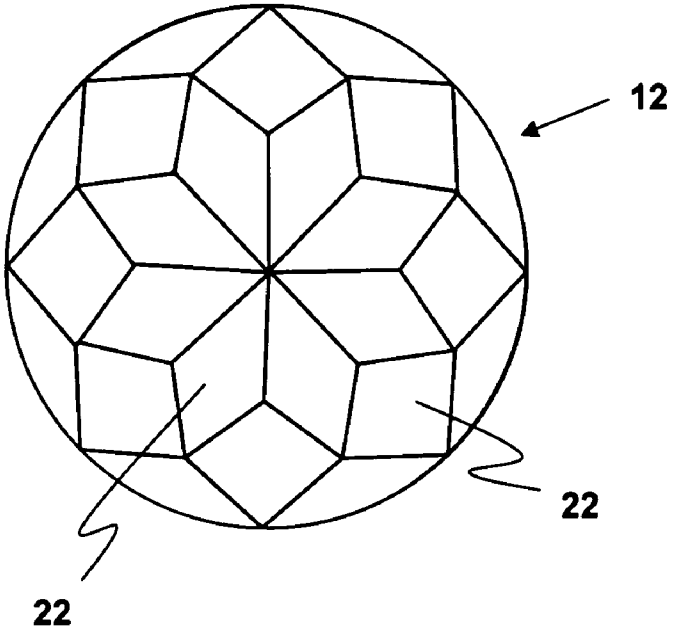


FIG. 4A

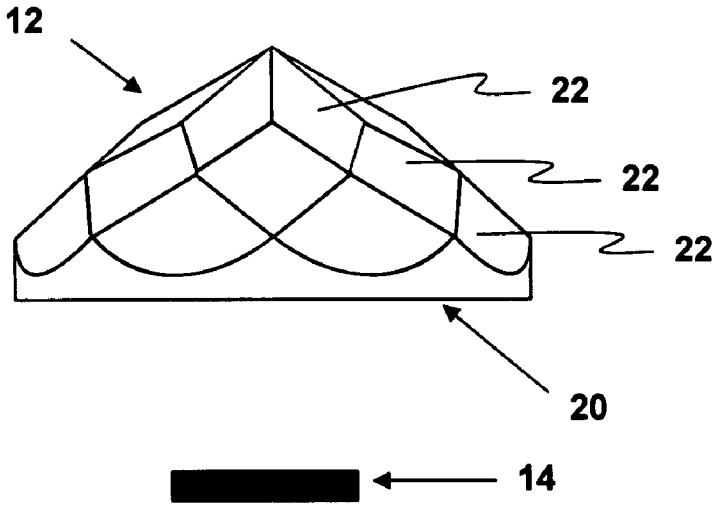


FIG. 4B

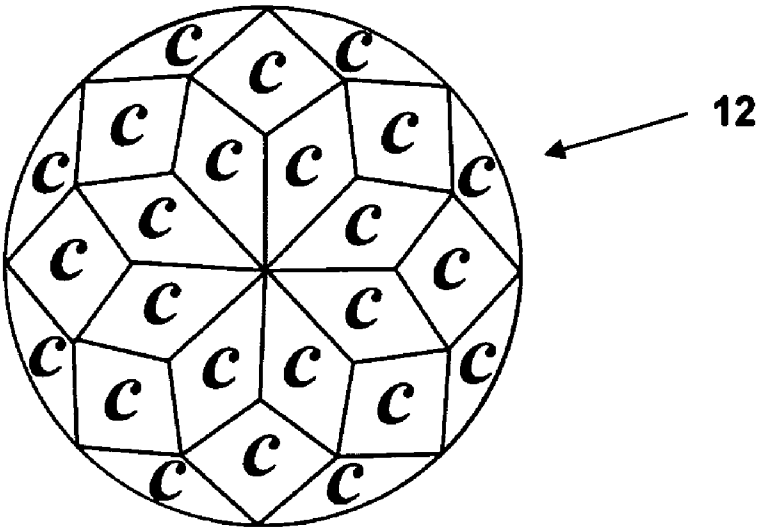


FIG. 5A

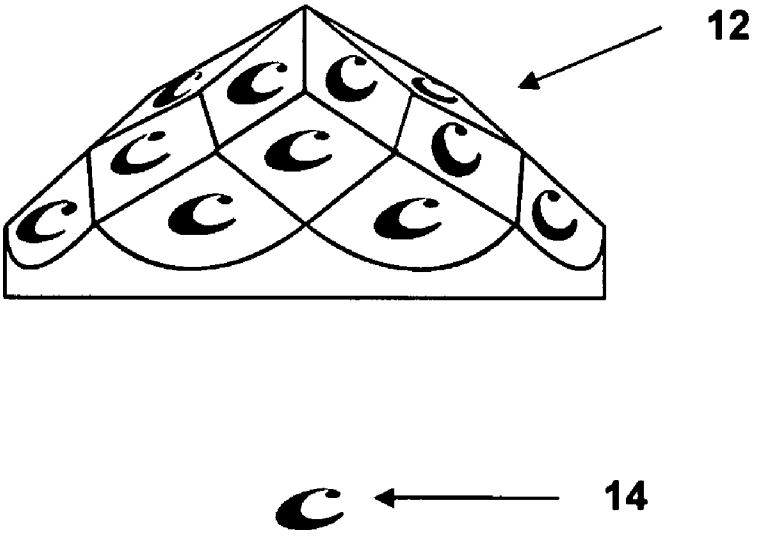
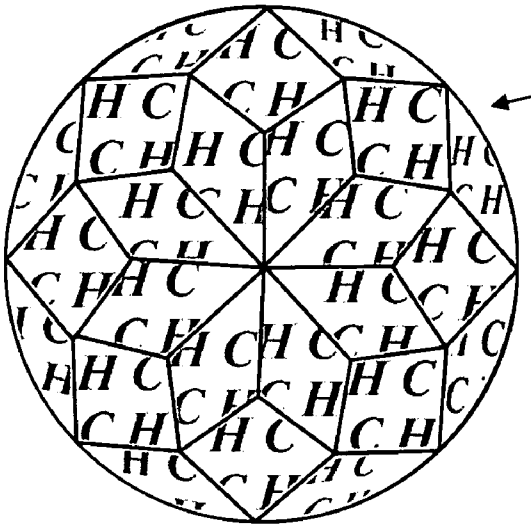


FIG. 5B



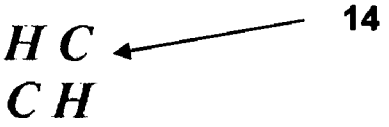
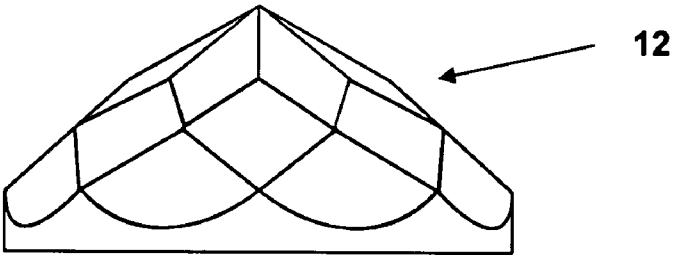


FIG. 6A



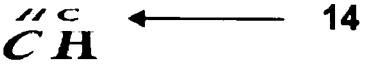


FIG. 6B

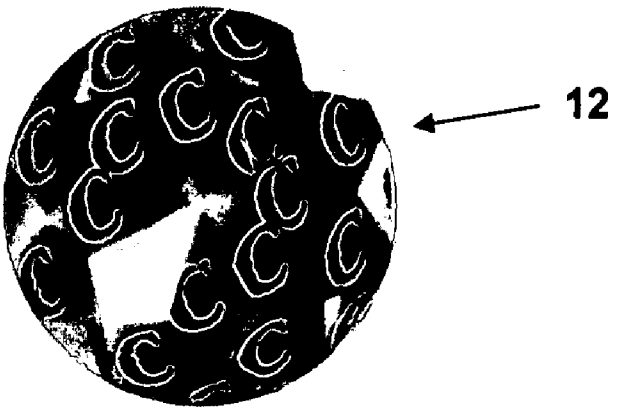


FIG. 7A

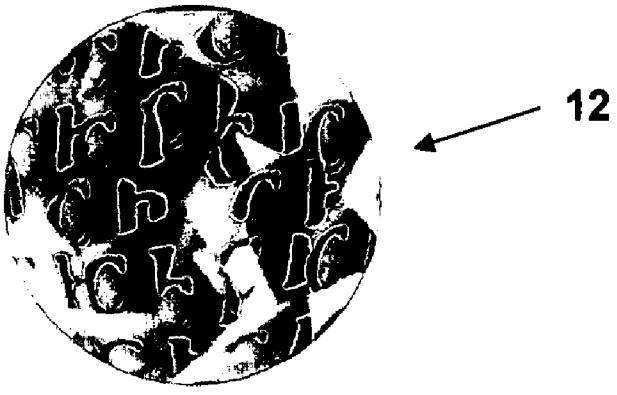


FIG. 7B



FIG. 8A

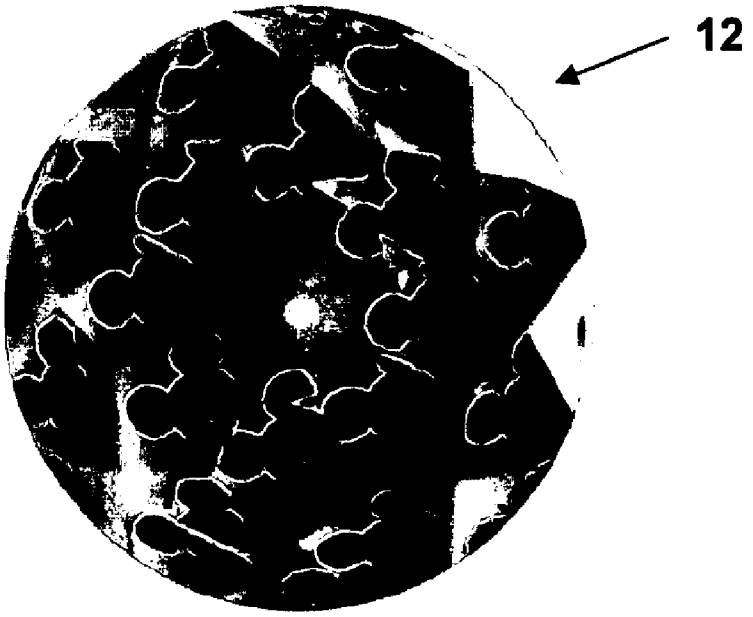


FIG. 8B

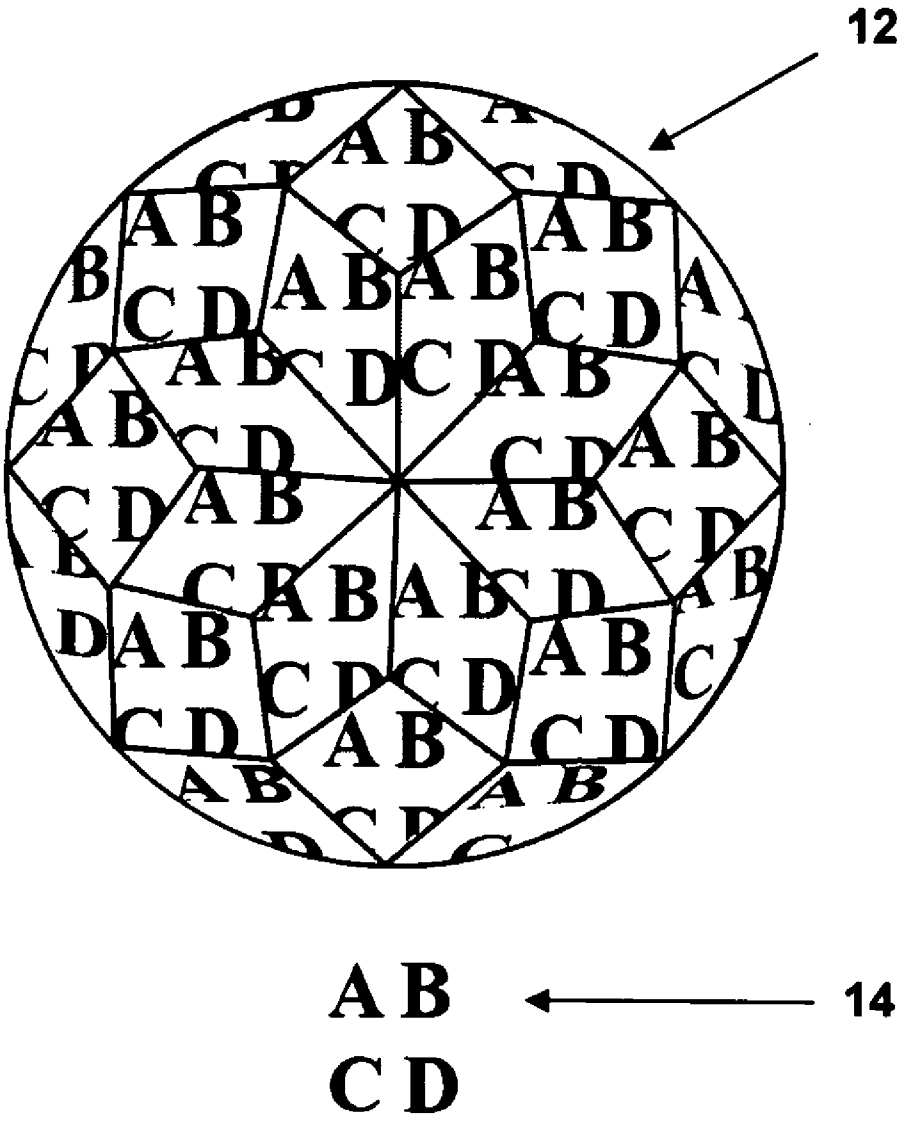


FIG. 9

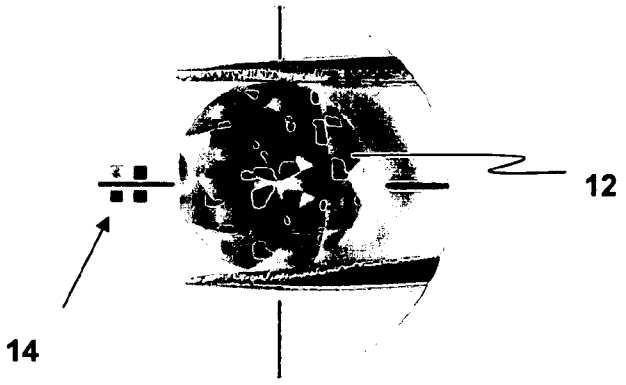


FIG. 10A

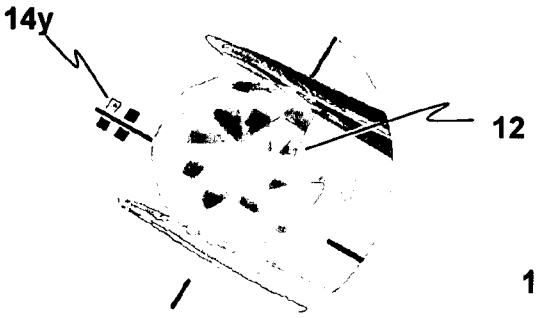


FIG. 10B

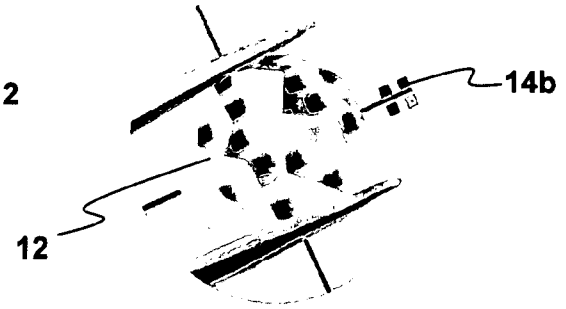


FIG. 10C

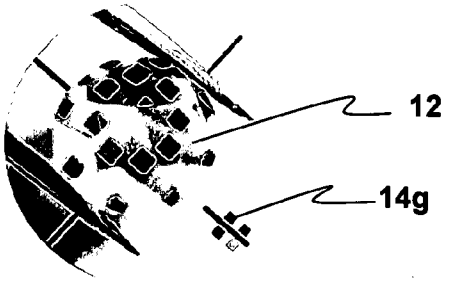


FIG. 10D

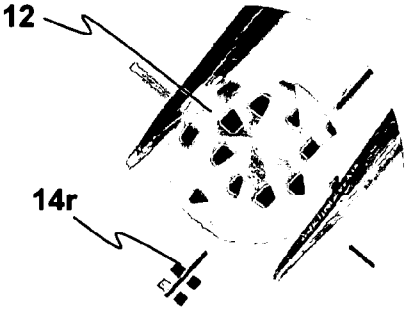


FIG. 10E

FIG. 11

Table of Common Gems, Composition and Refractive Index

Gem	Composition	Refractive Index
Actinolite	Aphibole	1.62-1.64
Agate	SiO_2	1.53-1.54
Alexandrite	$BeAl_2O_4$	1.741 - 1.760
Amethyst	SiO_2	1.544 - 1.553
Ametrine	SiO_2	1.544 - 1.553
Andalusite	Al_2SiO_5	1.628 - 1.647
Andexine-Labradorite	$NaAlSi_3O_8$	1.54 –1.55
Apatite	Phosphate group	1.63-1.64
Aquamarine	$Be_3Al_2(SiO_3)6$	1.57-1.60
Axinite		1.673 – 1.693
Benitoite	$BaTiSi_3O_6$	1.757 – 1.804
Beryl	$Be_3Al_2(SiO_3)6$	1.577-1.583
Bi Color Tourmaline	$(NaCa)(LI,MgFe,Al)9B_3Si_6(O,OH)31$	1.624-1.644
Bixbite	$Be_3Al_2(SiO_3)6$	1.577-1.583
Calcite	$CaCO_3$	1.486 - 1.658
Chalcedony	SiO_2	1.530 - 1.539
Chrome Tourmaline	$(NaCa)(LI,MgFe,Al)9BSi_6(O,OH)31$	1.624-1.644
Chrysoberyl	$BeAl_2O_4$	1.741 - 1.760
Chrysoberyl Cats Eye	$BeAl_2O_4$	1.741 - 1.760
Chrysoprase	SiO_2	1.544 - 1.553
Clinohumite	Magnesium Silicate Fluoride OH	1.625 – 1.668
Danburite	calcium borosilicate	1.630-1.636
Demantoid	$Ca_3Fe_2(SiO_4)3$	1.888 - 1.889
Diamond	C	2.417
Diopside	$CaMgSi_2O_6$	1.665 - 1.730
Dioptase	$CuSiO_2(OH)_2$	1.644 – 1.709

Emerald	$Be_3Al_2(SiO_3)6$	1.577-1.583
Enstatite	$MgSiO_3$	1.663-1.673
Eculase	$BeAlSiO_4(OH)$	1.652-1.672
Fire Agate	SiO_2	1.544 - 1.553
Fluorite	CaF_2	1.43
Grossularite	$Ca_3Al_2(SiO_4)3$	1.72-1.748
Hemimorphite	$(Zn_4Si_2O_7(OH)2.H2O)$	1.612-1.633
Hessonite	$Ca_3Al_2(SIO_4)3$	1.72-1.74
Idocrase	nesosilicate or sorosilicate	1.71 - 1.73
Indicolite	$(NaCa)(LI,MgFe,Al)9B_3Si_6(O,OH)31$	1.624-1.644
Lolite	$MG_2AL_4SI_5O_{18}$	1.53 - 1.55
Jadeite	$NaAl(SiO_3)_2$	1.654 - 1.667
Kornerupine		1.665 – 1.683
Kunzite	$LiAlSi_2O_6$	1.660 - 1.675
Kyanite	AL_3SIO_5	1.716 – 1.731
Lapis	A complex aggregate	1.50
Malaia garnet	$(Mg_3 + Mn_3)AL_2(SIO_4)$	1.73 - 1.81
Mali garnet	$Ca_3Al_2(SiO_4)3$	1.72-1.748
Mawsitsit		1.52
Moonstone	$KalSI_3O_8$	1.518 – 1.526
Morganite	$Be_3Al_2(SiO_3)6$	1.577-1.583
Oligoclase	$(Na,Ca)AlSi_3O_8$	1.53 - 1.54
Opal	SIO_2nH_2O	1.44-1.46
Peridot	(Mg,Fe)2(SiO)4	1.654-1.689
Pezzottaite		1.604 - 1.615
Phenakite	Be_2SiO_4	1.651-1.696
Prehnite	$(CA_3Al_2SI_3O_{10}(OH)_2)$	1.61 - 1.64
Quartz	SiO_2	1.544 - 1.553
Rhodochrosite	$MnCO_3$	1.600 – 1.820
Rhodolite	$Al_3(SiO_4)3$	1.75 - 1.77

Rubelite	(NaCa)(LI,MgFe,Al)9B_3Si_6(O,OH)31	1.624-1.650
Ruby	AL_2O_3	1.759-1.778
Sapphire	AL_22O_3	1.759-1.778
Sapphirine		1.714-1.723
Scapolite		1.54 - 1.577
Scheelite	$CaWO_4$	1.918 - 1.937
Sillimantite	Al_2OSiO_4	1.658 - 1.678
Spessartite	$Mn_3Al_2(SiO_4)3$	1.79-1.81
Sphalerite	ZnS	2.37
Sphene	$CaTiSiO_5$	1.885-1.990
Spinel	$MgAl_2O_4$	1.718
Star sapphire	AL_2O_3	1.759-1.778
Sunstone	$NaAlSi_3O_8$	1.54 –1.55
Taaffeite	Beryllium magnesium aluminate wi	1.71-1.72
Tanzanite	$Ca_2(Al,OH)Al_2(SIO_4)$	1.688 - 1.707
Topaz	AL(F,OH)2SIO_4	1.629 - 1.637
Tourmaline	(NaCa)(LI,MgFe,Al)9B_3Si_6(O,OH)31	1.624-1.644
Tsavorite	$Ca_3Al_2(SiO_4)3$	1.735
Turquoise	$CuAl_6(PO_4)4(OH)85H2O$	1.62
Zircon	$ZrSiO_4$	1.780-1.984

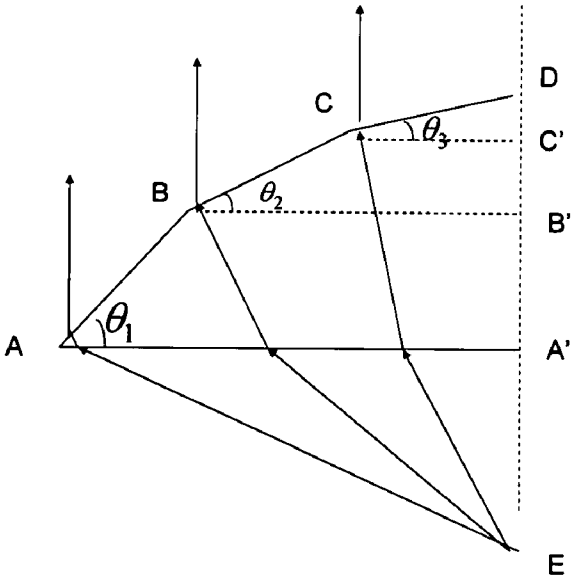

A
B
C
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C'
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A'
E
θ_1
θ_2
θ_3

FIG. 12

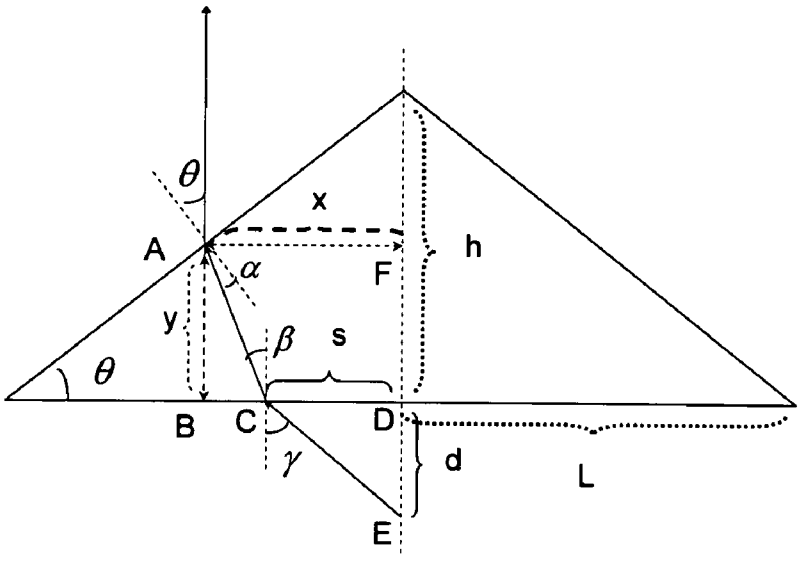

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FIG. 13

GEMSTONE SETTING INCLUDING A GEM FACETED TO DISPLAY A PLURALITY OF IMAGES FROM AN OUTER FOCAL REGION

TECHNICAL FIELD

[0001] The present invent relates to jewelry settings for gemstones and more specifically to a gemstone setting including a primary gem faceted to display a plurality of images received from a focal region outside of the primary gem.

BACKGROUND

[0002] Gemstones are minerals obtained from the earth or in some cases developed in the laboratory. The top of the gemstone is referred to as the crown. The crown frequently has polished cut surfaces called facets for enhancing the reflective nature of the gemstone. Among these facets are the table, star facets and bezel facets. The midline of a gem is referred to as the girdle. The girdle may or may not be faceted. The area below the girdle is referred to as the pavilion. The facets around the pavilion are commonly referred to as lower girdle facets and pavilion facets. The faceted pavilion causes light entering the gemstone to reflect outward through the crown creating enhanced brilliance. Below the pavilion and at the bottom of the gemstone is the cutlet. The cutlet is typically pointed such that the pavilion maximizes internal reflection of light.

[0003] Gemstone arrangements are often constructed to enhance the appearance of precious and semi-precious gems. Frequently these arrangements are constructed to mask the quality of an inferior gem or to tint to the gem with a desired color without altering the gem's chemical composition. One such technique includes mounting a secondary gem having a desired color or reflective property in close proximity to the primary gem. The effect is a primary gem that appears to have a desired hue or an enhanced brilliance. Different specific techniques are explored in more detail below.

[0004] U.S. Pat. No. 4,809,417 by Norman, Jr. (the '417 patent) discloses a method of making a multiplet jewelry product with an internally embedded visual indicia. The methods include providing a transparent layer and a gemstone, each having an interfacial surface, affixing visual indicia to one of the interfacial surfaces by applying a coating, and securing the interfacial surfaces together. The indicia are viewed through the transparent layer. In essence the '417 patent requires fusing an image between two complementary surfaces.

[0005] U.S. Pat. No. 5,664,440 by Roemer (the '440 patent) discloses a composite ring including a band, an outermost stone comprising a diamond and a innermost stone being a colored stone. The innermost stone is placed beneath the diamond at a spacing of 0.1 mm to 2 mm. The color of the innermost stone is visible when viewing the diamond. Thus, the innermost stone tints the diamond. While the innermost stone provides a general hue for the diamond, distinct images corresponding to the innermost stone are not observed. In addition, while the diamond is tinted, the diamond retains its faceted pavilion for internal reflection of light and increased brilliance.

[0006] U.S. Pat. No. 5,868,008 by Yamaura et al (the '008 patent) discloses a jewelry ornament including a base with a hole formed in a central portion thereof, a transparent or semi-transparent gem held by a prong mount and a colored back-up gem at least partially positioned in the hole. In essence, the '008 patent provides a setting for enhancing the gem's original color so it appears to have a higher color grade. In addition the gem retains the faceted pavilion commonly observed with gemstones for brilliance and sparkle.

[0007] U.S. Pat. No. 6,782,715 by Ruth (the '715 patent) discloses a primary gem including a brilliant cut diamond and a plurality of at least four complementary gems including a brilliant cut diamond. The complementary gems are positioned to reflect light lost by the primary diamond. In essence, the '715 patent discloses a gemstone setting where a set of complementary diamonds return light that was not correctly reflected by the diamond's faceted pavilion. Thus, the '715 patent discloses a setting to mask imperfections in the faceted pavilion and to enhance the brilliance of the brilliant cut diamond.

[0008] In view of the above referenced U.S. patents, there remains a need to develop a gemstone setting that displays a plurality of images corresponding to an object positioned in a focal region outside of the gem. The above inventions, some of which add a hue of color, focus light within the gemstone using a faceted pavilion to obtain the brilliance commonly associated with gemstone faceting.

SUMMARY

[0009] In contrast to current gemstone faceting techniques, the present invention does not seek to maximize brilliance by faceting the pavilion. Instead, the present invention utilizes a flat bottom and a faceted crown cut to specifications that display a plurality of images. In the preferred embodiment each facet displays an image generated from or corresponding to a colored object positioned outside of the gem. Therefore, when viewing the gemstone settings of the present invention, a plurality of images will be viewed.

[0010] In one aspect of the present invention a gemstone setting is disclosed, including a substantially transparent primary gem including a flat bottom and a faceted top, the faceted top faceted to display a plurality of images from a focal region outside of the primary gem and a colored object positioned within the focal region. In one embodiment the colored object is one or more secondary gems also referred to as a set of secondary gems. Thus, the primary gem displays a plurality of images that mimic or correspond to distinct features of the colored object or the secondary gems such as color, shape, partial shape and the like. Examples of gems that may be used with the present invention are precious or semi-precious gems. As nonlimiting examples, the following gems may be used with the present invention as a primary gem or as a secondary gem: an agate, an alexandrite, an amber, an ametrine, an amethyst, an aquamarine, an apatile, a beryl, a bloodstone, a chrysoberyl or cat-eye, a citrine, a corundum, a chalcedony, a chysocolla, a coral, a diamond, an emerald, a green beryl, a garnet, a quartz, a lolite, a jadcite, a kupzite, a lapis lazuli, a moonstone, a malachite, a moamite, an onyx, an opal, a pearl, a peridot, a red corundum, a ruby, a sardonyx, a sapphire, a spessartime, a sphene, a spinel, a star ruby and sapphiren, a sunstone, a tanzanite, a tiger eye, a tourmaline, a topaz, a turquoise, a tsavorite, and a zircon.

[0011] In one embodiment the faceted top includes at least three facet angles. As a nonlimiting example, the second facet angle is above the first and the third is above the second. The facets display a plurality of images, which may correspond to one or more different colors, one or more typographical symbols, a picture or portion thereof. In some embodiments the

plurality of images are projected outward from the faceted top to create an appearance that the plurality of images are floating in space.

[0012] The focal region of the primary gem is positioned outside, such as but not limited to vertically beneath and horizontally about the center of the primary gem. The focal region may be less than half of the area of the primary gem, less than 25% of the area of the primary gem, less than 10% of the area of the primary gem and the like.

[0013] In another aspect of the present invention a gemstone setting is disclosed including a substantially transparent primary gem including a flat bottom and a faceted top. The majority or more preferably each of the facets of the facet top is faceted to receive an image from a single focal region positioned outside of the primary gem. The setting also includes a colored object positioned in the single focal region such that a plurality of images corresponding to the colored object is displayed via the faceted top.

[0014] In another aspect of the present invention a gemstone setting is provided, including a substantially non-reflective primary gem having a faceted top and a flat bottom, wherein the facets of the faceted top are optically aligned such that an optical path vector from any two of the facets intersect beneath the primary gem, and an object optically aligned with the primary gem such that the faceted top displays a plurality of images corresponding to the object.

[0015] In another aspect of the present invention a method of producing a gemstone setting is provided including providing a substantially transparent primary gem and a set of colored secondary gems, the primary gem having a flat bottom; assigning a focal region beneath the primary gem for placement of the colored secondary gems; faceting the top of the primary gem to receive an image within the focal region; and permanently positioning the primary gem above the secondary colored gems such that the colored secondary gems remain in the focal region.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1** is a representation of a gemstone setting **10** including a primary gem **12** displaying a plurality of images corresponding to a colored object **14**.

[0017] FIG. **2** is a top plan view of a gemstone setting **10** including a primary gem **12** displaying a plurality of images housed in a setting structure **16**. The primary gem **12** in FIG. **2**A is displaying a plurality of images including the letter "C" and the primary gem **12** in FIG. **2**B is displaying a plurality of images including the letters "CH", or portions thereof.

[0018] FIG. **3** is a photograph depicting assembly of the gemstone setting **10**. FIG. **3**A is a top plan view showing a setting structure **16** having an aperture **18** for mounting to a desired jewelry item. FIG. **3**B is a top plan view showing the step of positioning a colored object **14** having the letter "C" in the focal region. FIG. **3**C is a perspective cutaway view of FIG. **3**B. FIG. **3**D is a perspective cutaway view depicting a faceted primary gem **12** positioned above the colored object **14**. The flat bottom **20** is also depicted. FIG. **3**E is a side elevational view of an assembled gemstone setting **10**. FIG. **3**F is a top view of the gemstone setting **10** depicting a plurality of images that correspond to the colored object **14** placed in the focal region of the primary gem **12**.

[0019] FIG. **4**A is a top plan view of a faceted primary gem **12** showing multiple individual facets **22**. FIG. **4**B is an elevational side view of the faceted primary gem **12** shown in FIG. **4**A showing a flat bottom **20**, multiple facets **22** and the general positioning of a colored object **14**.

[0020] FIG. **5**A is a top plan view of a faceted primary gem **12** displaying a plurality of images depicting the letter "C." FIG. **5**B is a side elevational view of the primary gem **12** shown in FIG. **5**A demonstrating the plurality of images correspond to a single colored object **14** positioned outside of the primary gem **12**.

[0021] FIG. **6**A is a top plan view of a faceted primary gem **12** displaying a plurality of images depicting the letters "CH." Also shown in FIG. **6**A is a colored object **14** including diagonal arrangement of the letters "CH" used to generate the plurality of images. FIG. **6**B is a side elevational view of the primary gem **12** (without showing the plurality of images) and a prospective view of the approximate positioning of the colored object **14** including the diagonally aligned letters "CH."

[0022] FIG. **7**A is a photograph depicting a top plan view of the primary gem **12** displaying a plurality of images that correspond to the letter "C." FIG. **7**B is a photograph depicting a top plan view of the primary gem **12** displaying a plurality of images that correspond to the letters "CH" or portions thereof.

[0023] FIG. **8**A is a top plan view of a colored object **14** having a picture of Mickey Mouse printed thereon. FIG. **8**B is a top plan view of a primary gem **12** displaying a plurality of images corresponding to the colored object **14** shown in FIG. **8**A.

[0024] FIG. **9** is a top plan view of a primary gem **12** displaying a plurality of images A, B, C and D and the layout of the corresponding colored objects **14** depicting the letters "A, B, C and D" diagonally arranged.

[0025] FIG. **10** is a series of photographs of top plan views of a faceted primary gem **12** demonstrating the displayed plurality of images may shift or change depending on the viewer's orientation to the primary gem **12**. The colored objects **14** placed within the focal region include four geometrically shaped colored objects: yellow **14***y*, red **14***r*, blue **14***b* and green **14***g*, the layout of which is also depicted next to the faceted primary gem **12**. FIG. **10**A depicts the faceted gem **12** displaying each of the four colored objects **14**. FIG. **10**B is the faceted gem shown in FIG. **10**A rotated counterclockwise such that the majority of facets display a yellow image corresponding to the yellow object **14***y*. FIG. **10**C is the faceted gem shown in FIG. **10**B further rotated such that the majority of facets display a blue image corresponding to the blue colored object **14***b*. FIG. **10**D is the faceted gem **12** shown in FIG. **10**C further rotated such that the majority of facets display a green image corresponding to the green colored object **14***g*. FIG. **10**E is the faceted gem shown in FIG. **10**D further rotated such that the majority of the facets display an red image corresponding to the red colored object **14***r*.

[0026] FIG. **11** is a nonlimiting table of gems that may be used with the present invention. Also provided is the general composition and the refractive index.

[0027] FIG. **12** is an image depicting three facets on a primary gem. Each of the three facets have different angles (θ_1, θ_2, θ_3) and a focal region depicted as E.

[0028] FIG. **13** is an image depicting methods of determining the desired facet angle using trigonometry.

DETAILED DESCRIPTION

[0029] This invention may be embodied in many different forms and should not be construed as limited to the embodi-

ments set forth herein. Rather, these embodiments are provided as guidance for one skilled in the art to which the present invention belongs.

I. Definitions:

[0030] The term "substantially transparent" as used herein refers to a property of a gem that permits an image or a colored image to be viewed or projected through the gem. A substantially transparent gem is not opaque.

[0031] The term "plurality of images" as used herein refers to the display of more than one distinct or identifiable image or color. In contrast to a tinted gem that colors the entire facet, a plurality of images allow the viewing of distinct images which may include an observable border or characteristic not commonly associated with tinting. In the preferred embodiment each facet displays an image corresponding to the colored object, or portion thereof, placed within the focal region. The plurality of images may include multiple copies of the same image, or portions thereof, or may include images of different colored objects. The colored object, which is be projected or viewed through the facets, is provided in a focal region outside of the primary gem.

[0032] The term "focal region" as used herein refers to the three dimensional region outside of the primary gem where colored objects (e.g. indicia, typographical symbols, secondary gems) are placed for forming a plurality of images viewable when viewing the primary gem.

[0033] The term "optical path vector" as used herein refers to the path or vector in which a light ray would pass through space and the primary gem. The optical path vectors of the present invention are not reflected internally by faceted pavilions, but traverse the gem according to the gem's refraction index, faceted crown or top and flat bottom.

II. Gemstone Settings that Display a Plurality of Images

[0034] Referring to FIGS. **1-3**, the gemstone settings **10** of the present invention include a primary gem **12** faceted to display a plurality of images. The plurality of images are distinct or identifiable images that correspond to one or more colored objects **14** or portions thereof, which are positioned within a focal region outside of the primary gem **12**. The appearance may include defined boundaries or spacing between objects **14**. The primary gem **12** and colored objects **14** are held in place by attachment to a structural casting or setting structure **16**, which can then be attached to any conventional jewelry item such as but not limited to a ring, a pendant, a pin, a necklace, a bracelet and the like. Attachment may be further stabilized by providing an aperture **18** for desired alignment or attachment. The colored object **14** is placed vertically beneath the primary gem **12** at a distance that allows the facets **22** to focus on one or more particular areas of the object **14**, thus displaying a plurality of images.

[0035] In conventional gemstone settings, the gem has a faceted crown or top and a faceted pavilion. This configuration is designed to reflect incoming light against the facet pavilion and to direct the light outwards through the crown. The term "critical angle" is known to those skilled in the jewelry arts to be the angle in which there will be total internal reflection. In fact, studies indicate the maximum brilliance of a gem is obtained when a step cut crown is used in combination with a brilliant cut pavilion.

[0036] Now referring to FIGS. **4-10**, the present invention utilizes a primary gem **12** with a faceted top also referred to herein as a facet gem **12** and substitutes a faceted pavilion with a flat bottom **20**. The substitution of a flat bottom **20** prevents substantial internal reflection within the primary gem **12**. Thus, by eliminating or reducing the facets on a pavilion, the flat bottom **20** permits light rays to be directed through the gemstone **12**. As can also be seen by FIGS. **4-10**, each facet **22** may display a singe image corresponding to a single object **14** or display an image corresponding to multiple objects **14**. Moreover the one or more of the plurality of images may appear to shift, vanish or appear when viewing the primary gem **12** at variable angles. One or more of the plurality of images may appear to float above the gem **12** such as an image projected outside and generally above the gem **12**.

[0037] As will now be envisioned by one skilled in the jewelry arts, the primary gem **12** can be any gem that is substantially transparent such that an image may be projected or visually observed when viewing the primary gem **12**. Non-limiting examples of gems that may be used with the present invention include, but are not limited to an agate, an alexandrite, an amber, an ametrine, an amethyst, an aquamarine, an apatile, a beryl, a bloodstone, a chrysoberyl or cat-eye, a citrine, a corundum, a chalcedony, a chysocolla, a coral, a diamond, an emerald, a green beryl, a garnet, a quartz, a lolite, a jadcite, a kupzite, a lapis lazuli, a moonstone, a malachite, a moamite, an onyx, an opal, a peridot, a red corundum, a ruby, a sardonyx, a sapphire, a spessartime, a sphene, a spinel, a star ruby and sapphiren, a sunstone, a tanzanite, a tiger eye, a tourmaline, a topaz, a turquoise, a tsavorite, and a zircon. The desired gem may vary between individuals and may be affected in part by the refraction index of the particular gem. A table of gems, their general composition and their refractive index are provided as FIG. **11**, each of which is incorporated as part of the present invention.

[0038] The top or crown of the primary gem **12** is faceted to display a plurality of images corresponding to an object **14** positioned within the focal region. The focal region is the region in which the object(s) **14** are positioned such that they can be displayed by the primary gem **12**. As shown in FIG. **12** and labeled "E", the focal region generally corresponds to the region at which the optical paths of light waves traveling through the gem **12** intersect or nearly intersect. The focal region is outside of the primary gem **12**. Although nonlimiting, the distance between the focal region and the flat bottom **20** of the faceted gem **12** may be from about 0.001 cm to about 10 cm, from about 1 cm to about 9 cm, from about 2 cm to about 8 cm, about 5 cm and the like. The particular distance may vary depending on the needs of the user, the size of the gem and the refractive index of the gem **12**.

[0039] In various nonlimiting embodiments, the colored object **14** placed in the focal region is a typographical symbol such as a letter, multiple letters, a corporate symbol or logo, a picture and the like. In some embodiments the colored object **14** is a colored geometric shape such as but not limited to a circle, a sphere, a cylinder, a square, a cube, a triangle, a pyramid, a polygon and the like. In other embodiments the object **14** placed in the focal region includes one or more gems, such as colored gems. In some embodiments, a chipped gem or less desired gem fragments are used as the colored gem(s). Examples of colored gems are any gems known in the jewelry arts or cited in jewelry publications and may be the same or different than the primary gem **12**. The colored gem or colored object **14** may be an imitation gem such as a colored stone or colored molded plastic. In other embodiments, objects may be substrates colored with one or more inks.

[0040] The angle of the facet surface is determined based on the gem media, or the refractive index of the gem **12**, the desired display and the desired focal region. Thus, optical path vectors may be used to determine the appropriate facet angle. Once determined, the facet **22** is cut and polished according to techniques well known in the jewelry arts. Jewelry faceting machines are commercially available through a variety of suppliers. Thus a variety of facets **22** may be cut depending on the desired positioning of the focal region and the refractive index of the primary gem **12**.

III. Methods of Manufacturing the Gemstone Setting

[0041] The gemstone setting **10** of the present invention is formed by providing a substantially transparent primary gem **12**, assigning a focal region outside of the primary gem **12**, positioning a colored object(s) **14** to be projected or viewed as a plurality of images within the focal region, cutting the bottom of the primary gem **12** flat, faceting the top of the primary gem **12** such that the majority or preferably each facet **22** displays an image corresponding the colored object **14** or portion thereof, and positioning the primary gem **12** such that a plurality of images may be viewed when viewing the gem **12**. The methods described herein may be practiced by one skilled in the jewelry arts.

[0042] As can now be envisioned by one skilled in the art to which the present invention belongs, any substantially transparent gem may be used with the present invention as a primary gem **12**. Gems may be obtained from any suitable source such as found in nature or purchased from a seller. The gems may require tumbling and polishing to obtain the substantially transparent form.

[0043] A focal region is determined such that the majority or preferably, each of the facets **22**, will display an image corresponding to an object **14** placed within the focal region. The focal region may vary depending on the size or chemical composition of the gem **12**. As general guidance the focal region is vertically below the primary gem **12** and may include a horizontal area or vertical area of about 75%, 50%, 25%, 10%, 5%, or 1% of the area of the gem's flat bottom **20**. The distance of the focal region from the flat bottom **20** may vary but includes from about 0.001 cm to about 10 cm, from about 1 cm to about 9 cm, from about 2 cm to about 8 cm, about 5 cm and the like.

[0044] The plurality of images includes a projected or reflected image that corresponds to the colored object(s) **14** positioned within the focal region. Thus, the colored object **14** may be any object that results in a desired plurality of images and should not be colorless. In some embodiments the object **14** is one or more gems. Each facet **22** may display an image corresponding to all gems, fewer than all gems, a portion of one or more gems, spacing between the gems and the like. The object **14** may fixed in position by permanently attaching the object **14** to a structural casting or setting structure **16**. In some embodiments the object **14** is retained by prongs positioned within the structural casting **16**. In other embodiments, the object is fused or soldered directly to the structural setting **16** itself. In other embodiments, the object is glued or adhered to a set of prongs or the structural setting **16**. In still other embodiments the object(s) **14** is interchangeable allowing multiple objects **14** to be selectively inserted or removed according to the individual's desires. When multiple objects **14** are positioned within the focal area, a variety of alignment configurations may result in a variety of displayed images.

[0045] The bottom of the primary gem **12** is cut flat to prevent or reduce reflection of light within the gem **12**. In the preferred embodiment there is not a faceted pavilion. However in some embodiments a faceted pavilion is also provided. Tools and methods of cutting gemstones to produce a variety of surface features are well known in the jewelry arts. A variety of suppliers provide tumbling, cabbing, faceting and carving tools, which may be used to produce the gemstone settings **10** of the present invention.

[0046] The top or crown of the primary gemstone **12** is faceted to display a plurality of images corresponding to the colored object **14** positioned within the focal region. The faceting takes into account the particular media that is being faceted (or gemstone composition) in the form of its refractive index and the positioning of the focal region. The refractive index of a particular gem **12** may be researched in publications or determined using a refractometer. A table is provided as FIG. **11** for guidance, and is included as part of the present invention.

[0047] Refraction is the change in direction of a wave, such as a light wave due to a change in its speed. This is most commonly seen when a wave passes from one medium to another. In the present invention a light wave passes from air to the primary gemstone **12**. Snell's law is a formula used to describe the relationship between the angles of incidence and refraction when referring to light waves passing through a boundary between two different isotropic media, such as air and the gemstone **12**. In essence, the law says that the ratio of the sines of the angles of incidence and of refraction is a constant that depends on the media. More specifically, the ratio of the sines of the angles of incidence and refraction is equal to the ratio of velocities in the two media, or equivalently to the inverse ratio of the indices of refraction:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1} \quad \text{(Equation 1)}$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \quad \text{(Equation 2)}$$

[0048] Thus, when determining the angle of each facet **22**, the optical path vector is considered. The optical path vectors are paths in which rays of light will pass through air and the primary gem **12**. The optical path vector depends on the refractive index of the primary gem **12** and therefore may be used to determine the appropriate facet angle.

[0049] The top of the primary gem **12** is faceted to display a plurality of images. The plurality of images includes projections or viewed images that correspond to an object **14** positioned beneath the primary gem **12** within a defined focal region such that the facet **22** may focus on the object, or portion thereof. Each facet angle may be calculated and cut such that each facet **22** focuses on the object(s) **14** placed in the focal region. In embodiments where there are more than one object **14** placed in the focal region, each facet **22** may focus on at least one of a single object **14**, more than one object **14**, spacing around or spacing in between the objects **14**. The primary gem **12** may be facetted such that the right portion of the faceted top focuses on a left portion of the focal region and the left portion focusing on a right portion of the focal region.

[0050] The primary gemstone **12** is secured to the structural casting or setting structure **16** after securing the colored object **14**. The primary gemstone **12** is positioned above the

colored object **14**. The primary gemstone **12** may be secured using any technique known in the jewelry arts such as positioning within a set of prongs, gluing the gem **12** with jeweler's adhesive and the like.

EXAMPLES

[0051] The examples provided herein are for illustration of the instant invention and are not intended to limit the scope of the disclosed invention. It will be understood that various omissions, modifications, substitutions and changes in the forms and details of the gemstone setting described herein and in its operation can be made by those skilled in the art without departing in any way from the spirit of the present invention.

Example 1

Faceting a Gemstone to Display a Plurality of Images

[0052] The following example demonstrates the faceting of a gemstone to display a plurality of images. The example uses the refraction index associated with a diamond. Referring to FIG. **12**, the gem is to be faceted such that three facets focus on a focal region E. Other gems may be substituted using their corresponding refraction index.

[0053] Referring to FIG. **13**, light comes out of the gem from point A. We define the position of A by measuring distance from A to center, AF=x, from A to the bottom line, AB=y. and angle of triangle is θ, we calculate DE=d assume we know x, y and θ. Using sin θ=n sin α we obtain

$$\alpha=\sin^{-1}(\sin\theta/n) \quad \text{(Equation 3)}$$

$$\beta=\theta-\alpha \quad \text{(Equation 4)}$$

$$\gamma=\sin^{-1}(n\sin\beta) \quad \text{(Equation 5)}$$

$$s=x-y\tan(\beta) \quad \text{(Equation 6)}$$

$$d=s/\tan(\gamma) \quad \text{(Equation 7)}$$

[0054] Now referring to FIG.**12**, AB, BC, CD are three facets tilted at different angles. BB'=2/3*AA', CC'=1/3*AA'. Now calculate the angle $\theta_1,\theta_2,\theta_3$ so the light comes out vertically from the edge of the three facets, i.e., point A, B and C.

	index n			
	2.417	2.417	2.417	
	point			
	A	B	C	D
x	5	3.333333	1.666667	
y	0	0.897407	1.547212	1.886299
theta	28.3	21.3	11.5	
alpha	11.31176	8.64374	4.731458	
beta	16.98824	12.65626	6.768542	
gamma	44.92559	31.97627	16.55076	
s	5	3.131814	1.483034	
d	5.01301	5.016576	4.990407	

[0055] The gem used is a diamond. Referring to the table provided as FIG. **11**, the refractive index n is 2.417. Assume AA'=5 cm, so x of A is X_A=5, y of A is y_A=0 since it's on the bottom line. Then try different number for θ_1 so the d will be close to 5 cm if one wants to put the object 5 cm below the stone. We found 28.3 for θ_1 in the above table. Since BB'=2/3*AA' we found x of B is x_B=3.33333, y of B is $y_B=y_A+5/3\times\tan(\theta_1)$=0.897407. Put them in the second column of the table corresponding to x, y. Then try theta to have d close to 5. We found 21.3 degrees for θ_2. Since CC'=1/3*AA', then x of C is x_C=1.66666, y of C is $y_C=y_B+5/3\times\tan(\theta_2)$=1.547212. And try theta to find d=5. We found 6.95 degrees for θ_3.

[0056] One skilled in the art to which the present invention belongs would be able to adapt the examples, methods and compositions provided above for other gems, and are herein incorporated by reference.

1. A gemstone setting comprising:

a) a substantially transparent primary gem comprising a flat bottom and a faceted top, said faceted top faceted to display a plurality of images from a focal region outside of said primary gem; and

b) a colored object positioned in said focal region, wherein said colored object does not contact said primary gem:

wherein said plurality of images comprises multiple images of each colored object or portion thereof.

2. The gemstone according to claim **1**, wherein said primary gem is selected from the group consisting of an agate, an alexandrite, an amber, an ametrine, an amethyst, an aquamarine, an apatile, a beryl, a bloodstone, a chrysoberyl or cat-eye, a citrine, a corundum, a chalcedony, a chysocolla, a coral, a diamond, an emerald, a green beryl, a garnet, a quartz, a lolite, ajadcite, a kupzite, a lapis lazuli, a moonstone, a malachite, a moamite, an onyx, an opal, a peridot, a red corundum, a ruby, a sardonyx, a sapphire, a spessartime, a sphene, a spinel, a star ruby and sapphiren, a sunstone, a tanzanite, a tiger eye, a tourmaline, a topaz, a turquoise, a tsavorite, and a zircon.

3. The gemstone setting according to claim **1**, wherein said faceted top comprises at least three facet angles, wherein the second is above the first and the third is above the second, wherein each of the first, second or third faceted angles are equal around the perimeter of said primary gem.

4. The gemstone setting according to claim **1**, wherein said plurality of images correspond to one or more colored geometric shapes or portions thereof.

5. The gemstone setting according to claim **1**, wherein said plurality of images comprise at least a portion of a typographical symbol.

6. The gemstone setting according to claim **1**, wherein said plurality of images project outward from said facet top to create an appearance that said plurality of images are floating in space.

7. The gemstone setting according to claim **1**, wherein said focal region is positioned vertically beneath and horizontally about the center of said primary gem.

8. The gemstone setting according to claim **1**, wherein said focal region is less than half of the area of said flat bottom of said primary gem.

9. The gemstone setting according to claim **8**, wherein said focal region is less than 25% of the area of said flat bottom of said primary gem.

10. The gemstone setting according to claim **9**, wherein said focal region is less than 10% of the area of said flat bottom of said primary gem.

11. The gemstone setting according to claim **1**, wherein said colored object is a secondary gem or set of secondary gems selected from the group consisting of an agate, an alexandrite, an amber, an ametrine, an amethyst, an aquamarine, an apatile, a beryl, a bloodstone, a chrysoberyl or cat-

eye, a citrine, a corundum, a chalcedony, a chysocolla, a coral, a diamond, an emerald, a green beryl, a garnet, a quartz, a lolite, ajadcite, a kupzite, a lapis lazuli, a moonstone, a malachite, a moamite, an onyx, an opal, a pearl, a peridot, a red corundum, a ruby, a sardonyx, a sapphire, a spessartime, a sphene, a spinel, a star ruby and sapphiren, a sunstone, a tanzanite, a tiger eye, a tourmaline, a topaz, a turquoise, a tsavorite, and a zircon.

12. The gemstone setting according to claim **1**, wherein said colored object is a substrate with a photograph printed thereon.

13. A gemstone setting comprising:

a) a substantially transparent primary gem comprising a flat bottom and a faceted top comprising multiple individual facets, wherein said faceted top displays a plurality of images from a focal region positioned outside of said primary gem; and

b) at least four colored objects positioned along a plane and in said focal region such that when viewed in at least two orientations the majority of facets of said facet top display only one of said at least four colored objects, wherein said at least two orientations include downward towards the top of said primary gem and are selected from at least two of the group consisting of:

i) a first orientation, wherein the majority of facets display the first of said at least four colored objects:

ii) a second orientation rotated counterclockwise from said first orientation, wherein the majority of facets display the second of said at least four colored objects:

iii) a third orientation rotated counterclockwise from said second orientation, wherein the majority of facets display the third of said at least four colored objects: and

iv) a fourth orientation rotated counterclockwise from said third orientation, wherein the majority of facets display the fourth of said at least four colored objects:

wherein said at least four colored objects do not contact said primary gem.

14. A gemstone setting comprising:

a) a substantially transparent primary gem having a faceted top and a flat bottom, wherein the facets of said faceted top are optically aligned such that an optical path vector from any two of said facets intersect beneath said primary gem; and

b) a colored object positioned beneath said primary gem in optical alignment with said optical path vector, wherein said colored object does not contact said primary gem:

wherein multiple copies of each colored object or portion thereof is displayed.

15. A method of producing a gemstone setting comprising:

a) providing a substantially transparent primary gem and a set of colored secondary gems, said primary gem having a flat bottom;

b) assigning a focal region beneath said primary gem for placement of said set of colored secondary gems;

c) faceting the top of said primary gem to display a plurality of images corresponding to said focal region; and

d) permanently positioning said set of colored secondary gems in said focal region and said primary gem above said set of colored secondary gems, wherein said set of colored secondary gems do not physically contact said primary gem;

wherein said plurality of images comprises multiple images of each of said colored secondary gems.

16. The gemstone setting according to claim **1**, wherein said plurality of facets comprises multiple individual facets, further wherein said colored object comprises at least two colored objects, further wherein rotation in viewer orientation results in a shift in color of said plurality of images.

17. The gemstone setting according to claim **1**, wherein said plurality of facets comprises multiple individual facets, further wherein each individual facet displays an image corresponding to at least a portion of said colored object.

18. The gemstone setting according to claim **13**, wherein said at least two orientations comprise at least four orientations and each of said at least four colored objects is a different color.

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