US011287102B2

(12) **United States Patent**
Van Straten

(10) **Patent No.: US 11,287,102 B2**
(45) **Date of Patent: Mar. 29, 2022**

(54) **HEAT SOURCE FOR VEHICLE ILLUMINATION ASSEMBLY AND METHOD**

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(72) Inventor: **George A. Van Straten**, Chassell, MI (US)

(73) Assignee: **Van Straten Enterprises, Inc.**, Houghton, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 458 days.

(21) Appl. No.: **16/033,913**

(22) Filed: **Jul. 12, 2018**

(65) **Prior Publication Data**

US 2019/0017676 A1 Jan. 17, 2019

Related U.S. Application Data

(60) Provisional application No. 62/655,557, filed on Apr. 10, 2018, provisional application No. 62/597,028, filed on Dec. 11, 2017, provisional application No. 62/531,441, filed on Jul. 12, 2017.

(51) **Int. Cl.**

F21S 45/60	(2018.01)
H05B 3/06	(2006.01)
F21S 41/141	(2018.01)
F21S 41/143	(2018.01)
F21S 45/33	(2018.01)

(52) **U.S. Cl.**
CPC ***F21S 45/60*** (2018.01); ***F21S 41/141*** (2018.01); ***F21S 41/143*** (2018.01); ***F21S 45/33*** (2018.01)

(58) **Field of Classification Search**
CPC F21S 45/60; F21S 41/143; F21S 41/141; H05B 2214/02; H05B 1/02; H05B 1/0236; H05B 3/12; H05B 3/0042
USPC 219/504, 505, 213, 494
See application file for complete search history.

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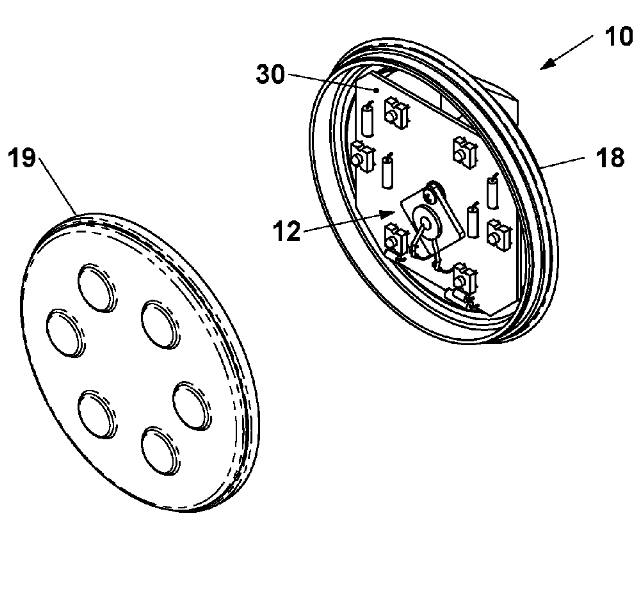
Primary Examiner — Brian W Jennison
(74) *Attorney, Agent, or Firm* — Keith D. Grzelak; Wells St. John P.S.

(57) **ABSTRACT**

A heater is provided for a vehicle illumination assembly. The heater includes a heat transfer body, a heat source, and a mounting base. The heat transfer body has a top surface and a bottom surface. The top surface has a higher emissivity than the bottom surface. The heat source is affixed in heat transfer relation with the heat transfer body. The mounting base is configured to affix the heat transfer body within a housing of a vehicle illumination assembly to provide the top surface of the heat transfer body in radiant heat transfer relation with a light transmissible portion of the vehicle illumination assembly. A method is also provided.

20 Claims, 47 Drawing Sheets



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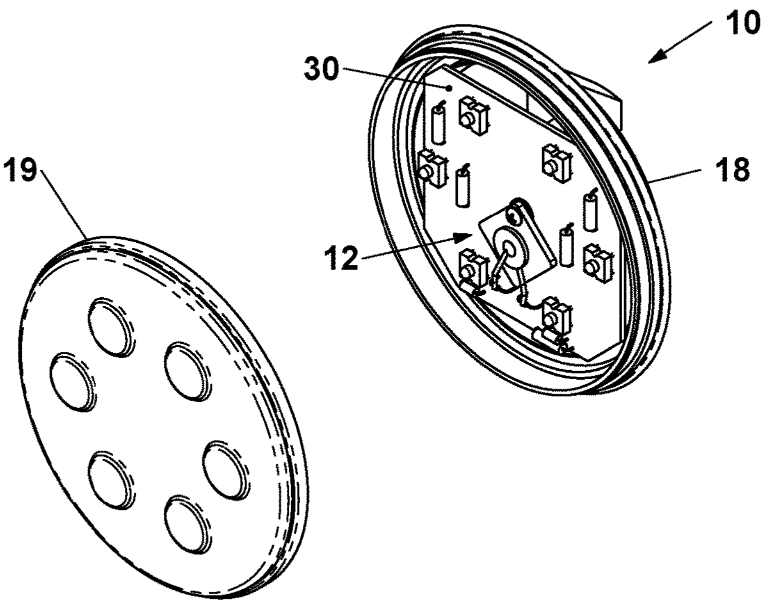

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FIG. 1

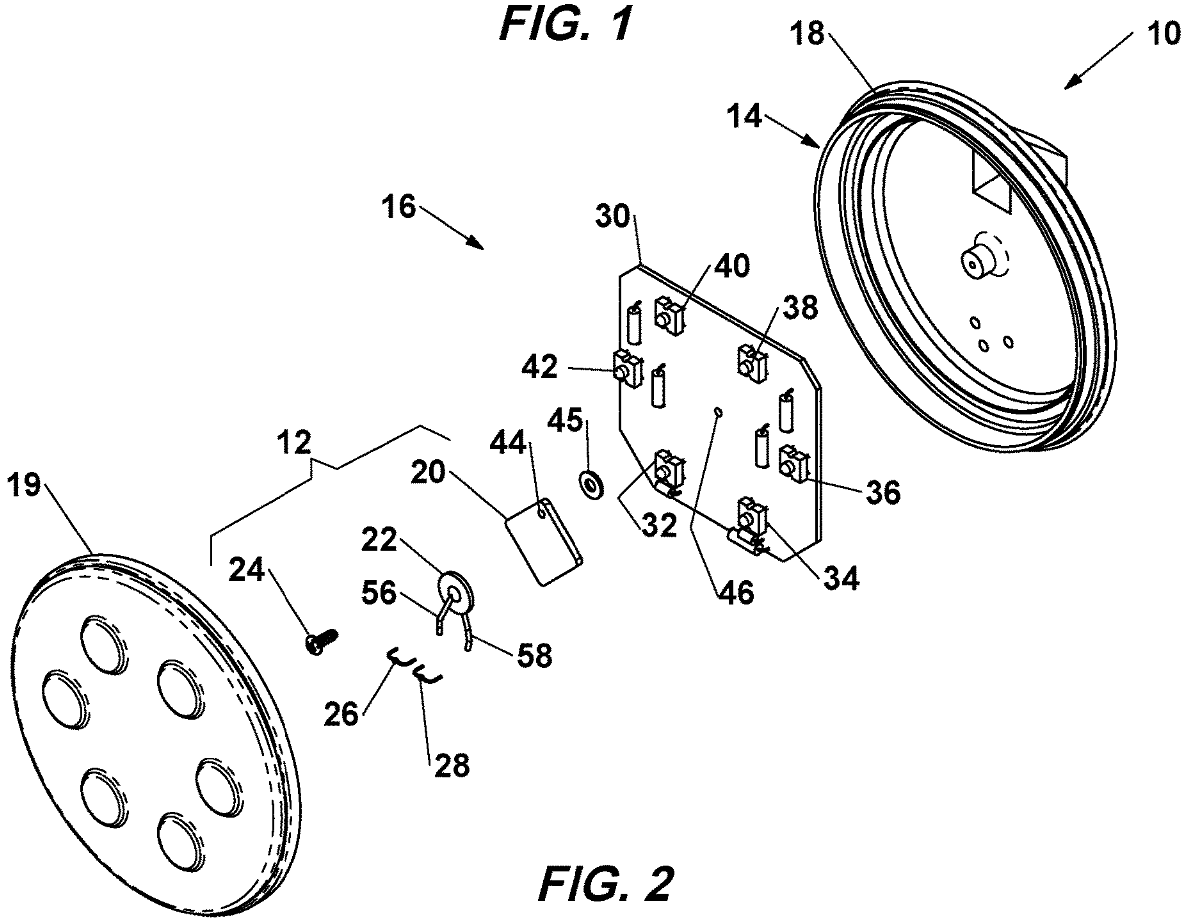

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FIG. 2

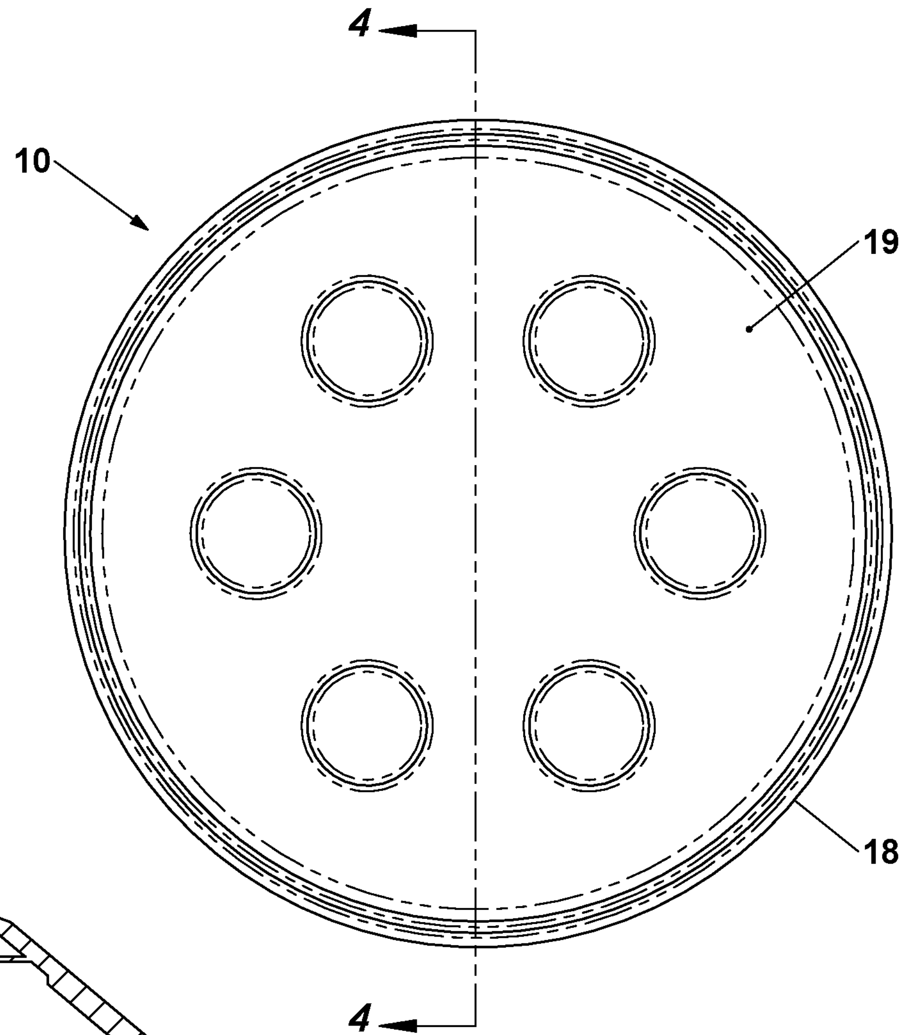
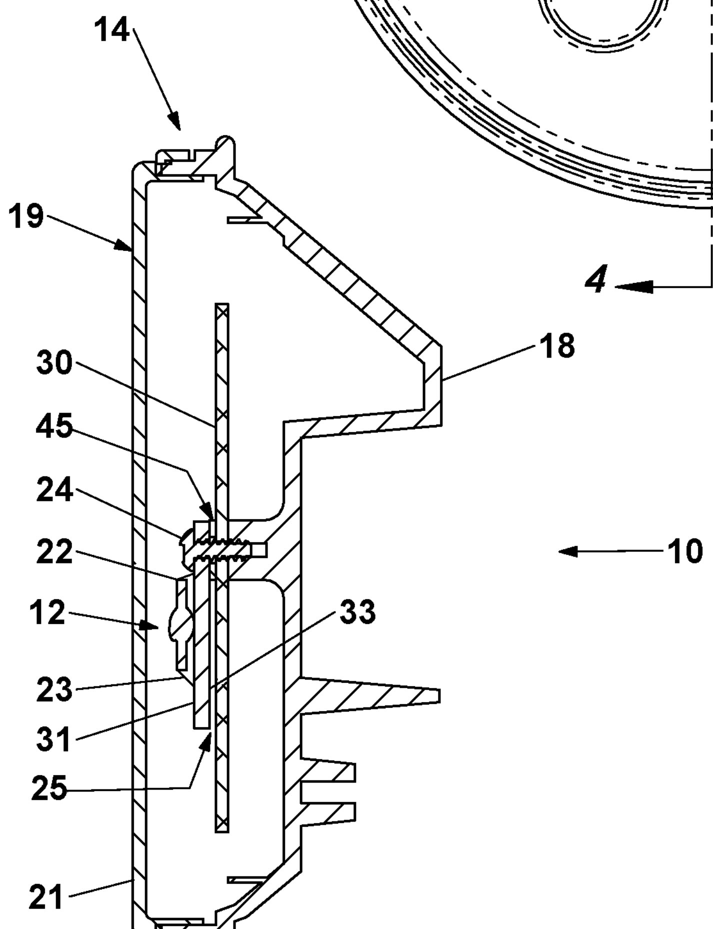


FIG. 3



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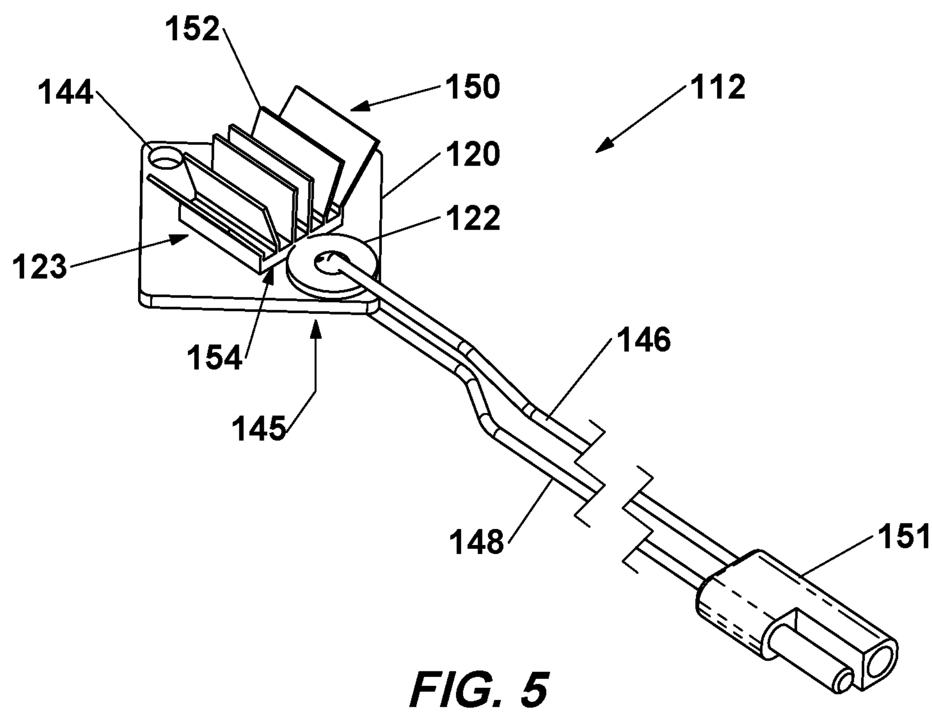
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FIG. 5

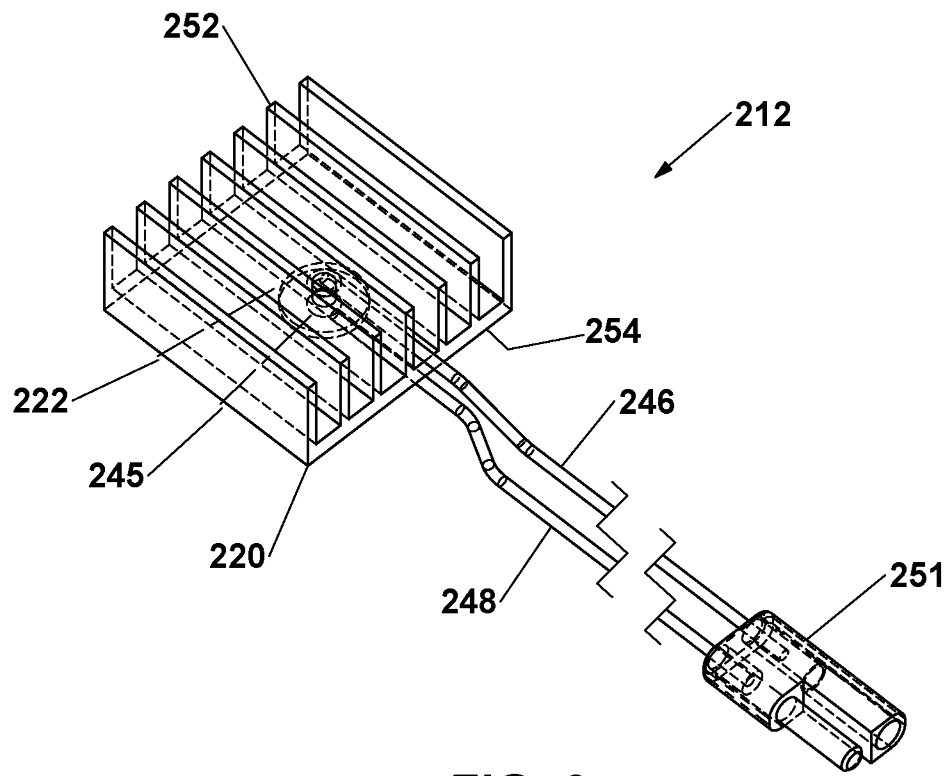
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FIG. 6

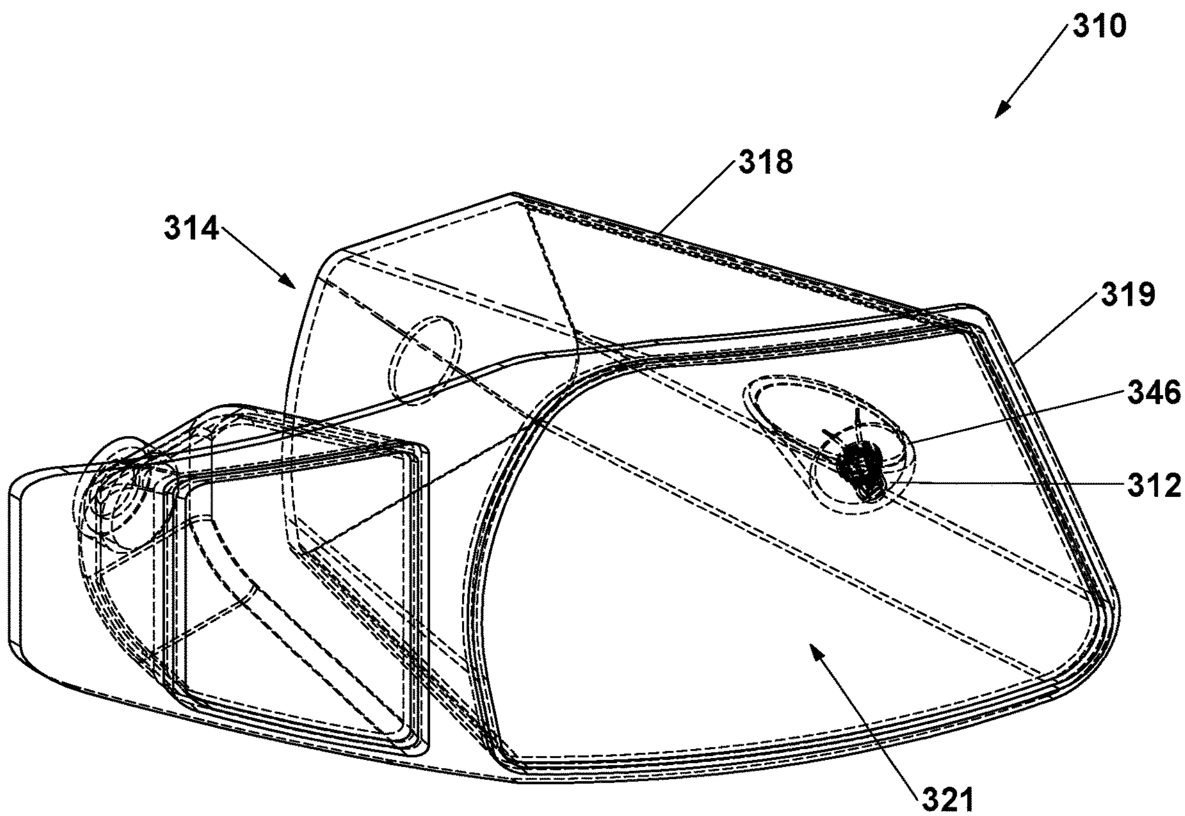


FIG. 7

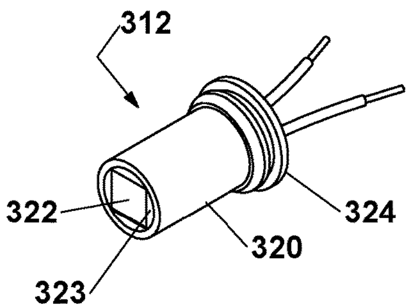
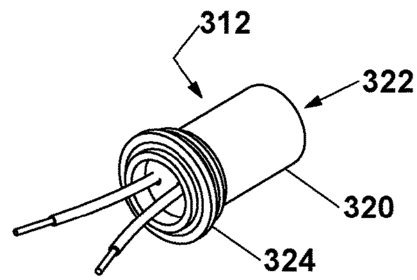


FIG. 8



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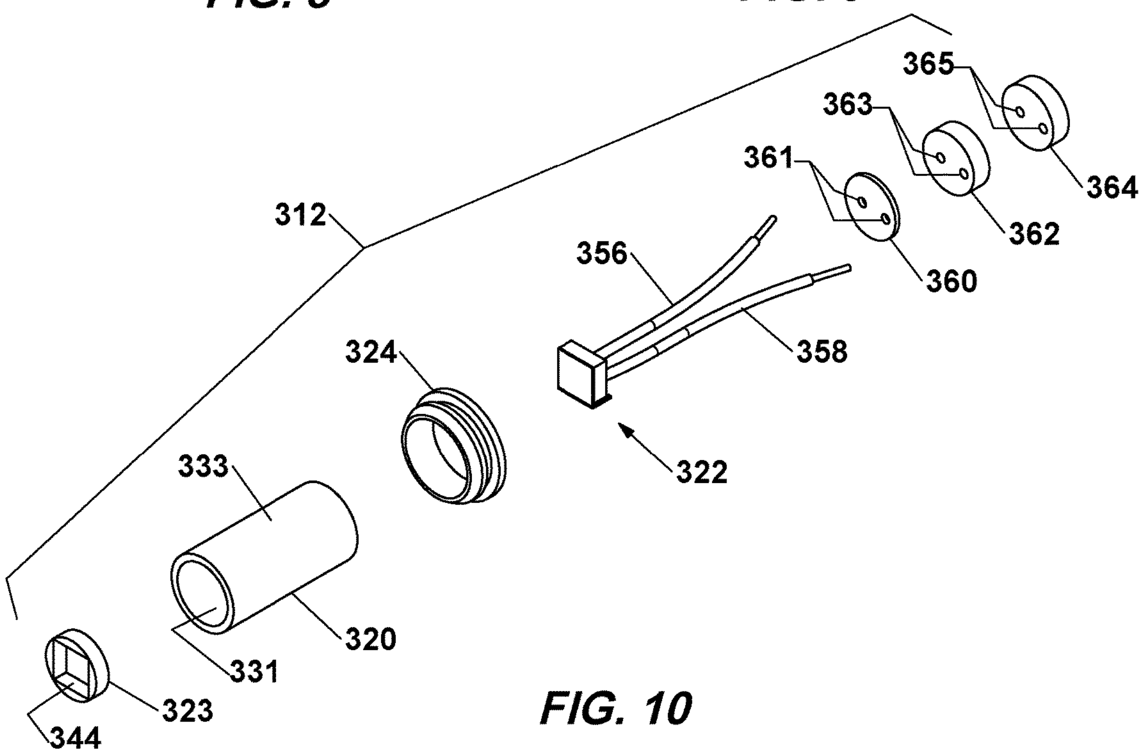
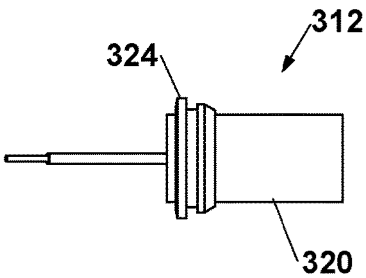


FIG. 10



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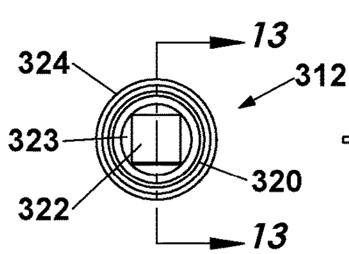


FIG. 12

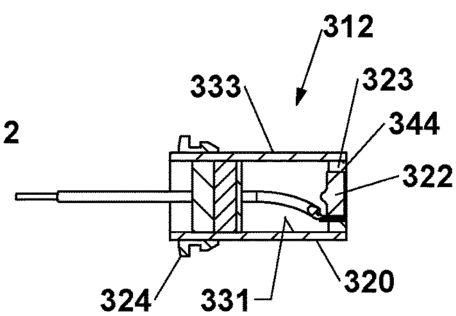
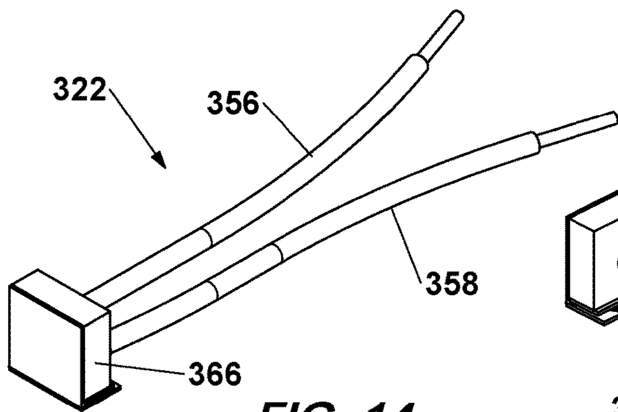


FIG. 13



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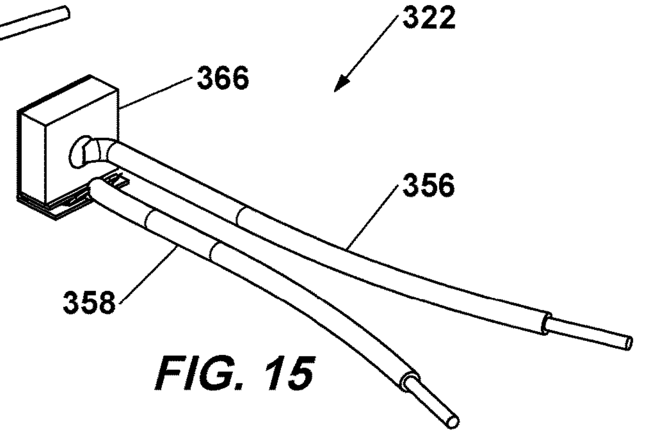

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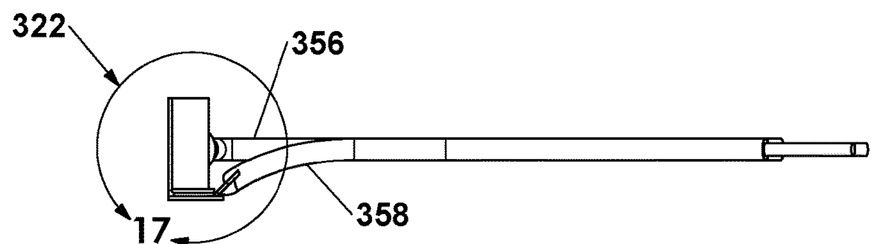

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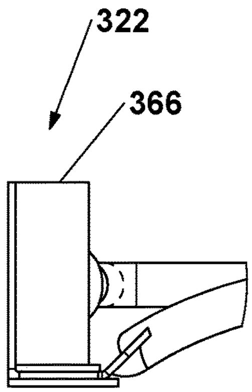

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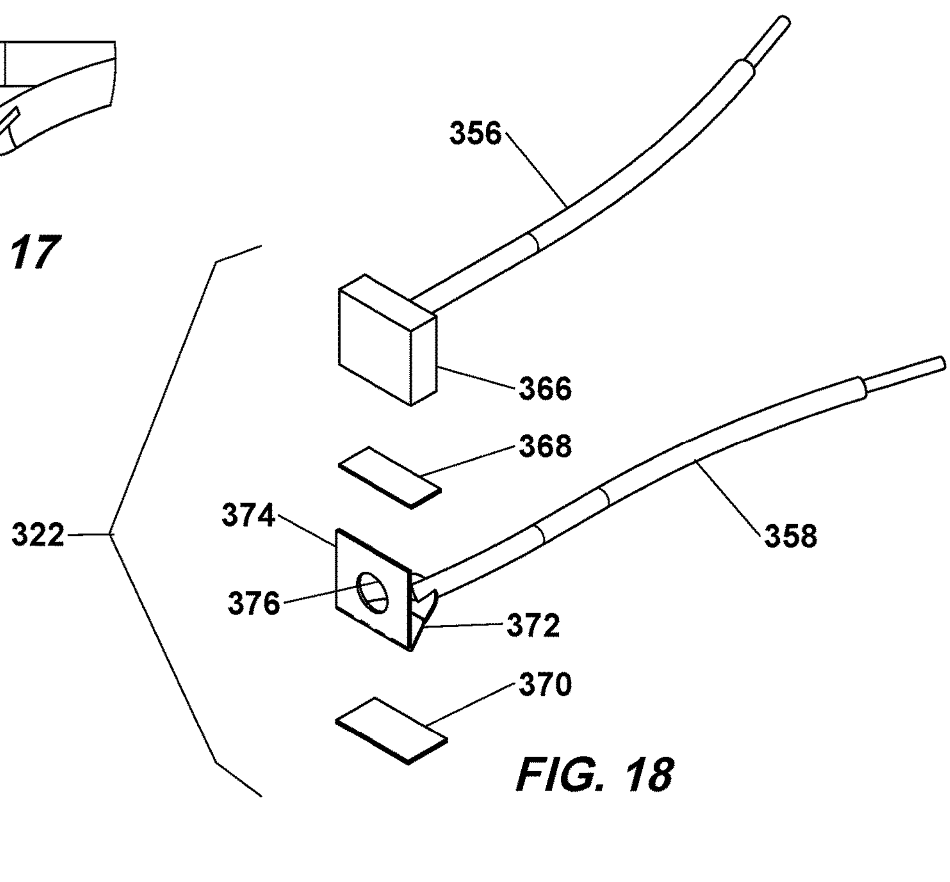
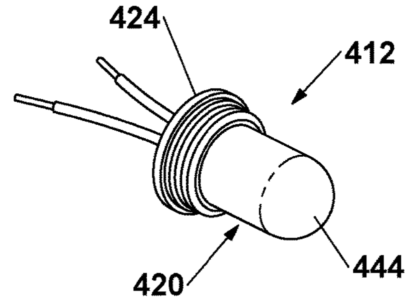


FIG. 18



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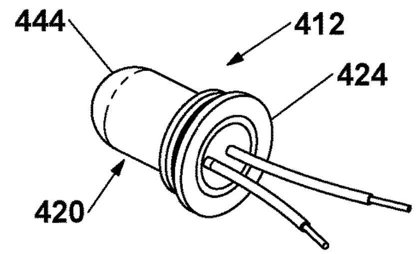


FIG. 20

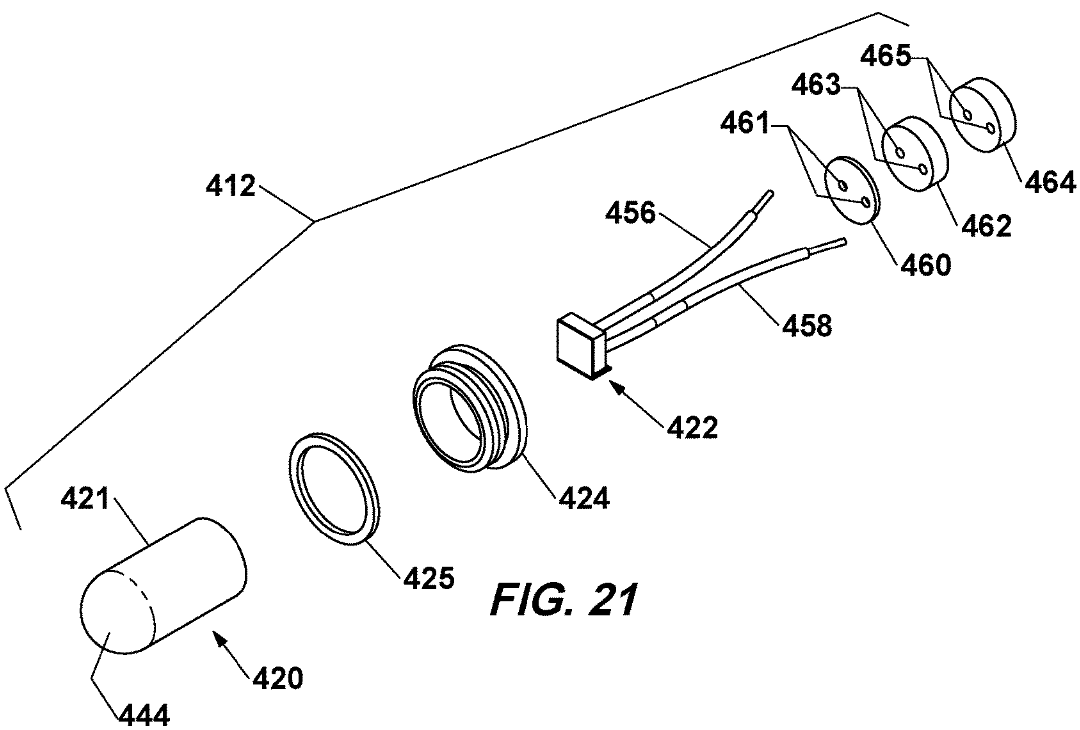


FIG. 21

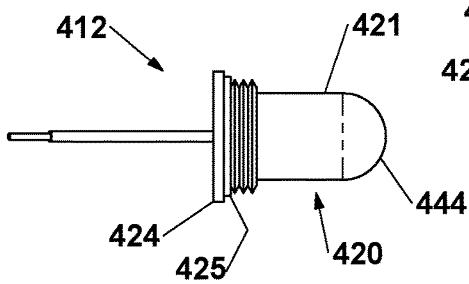
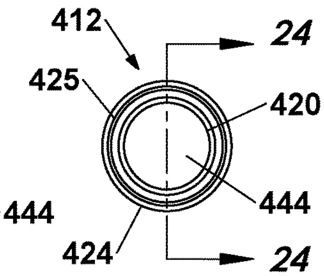


FIG. 22



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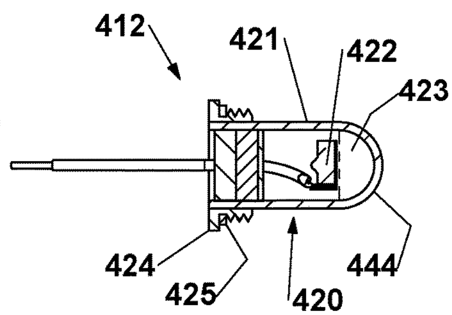

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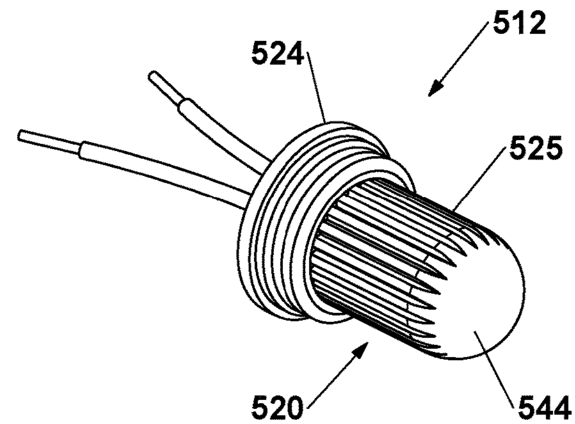

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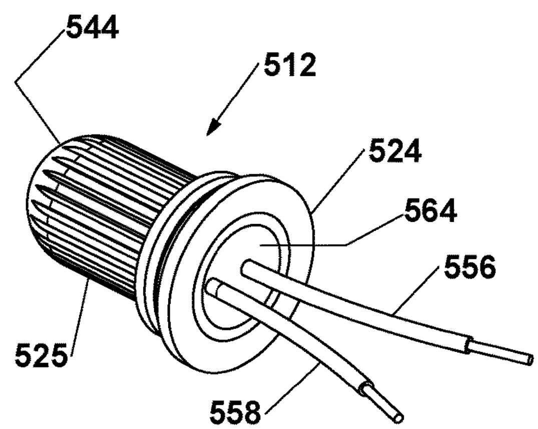

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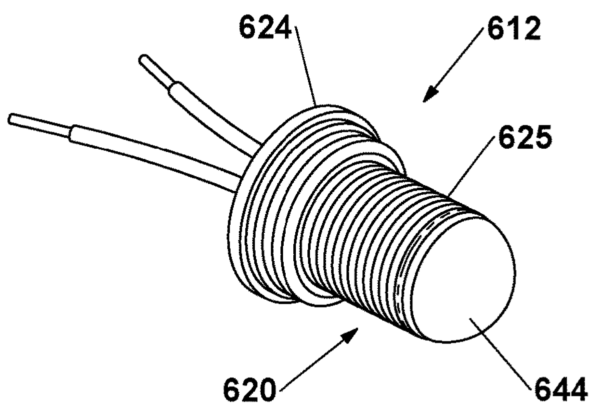
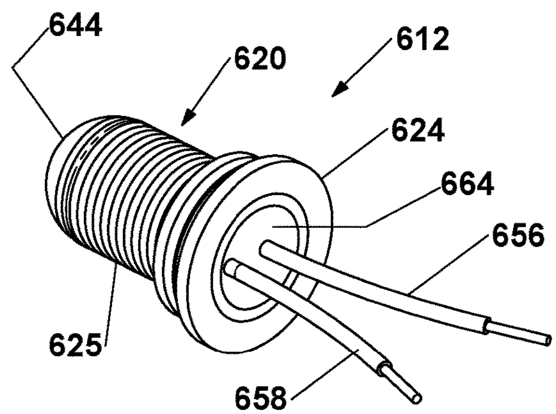


FIG. 27



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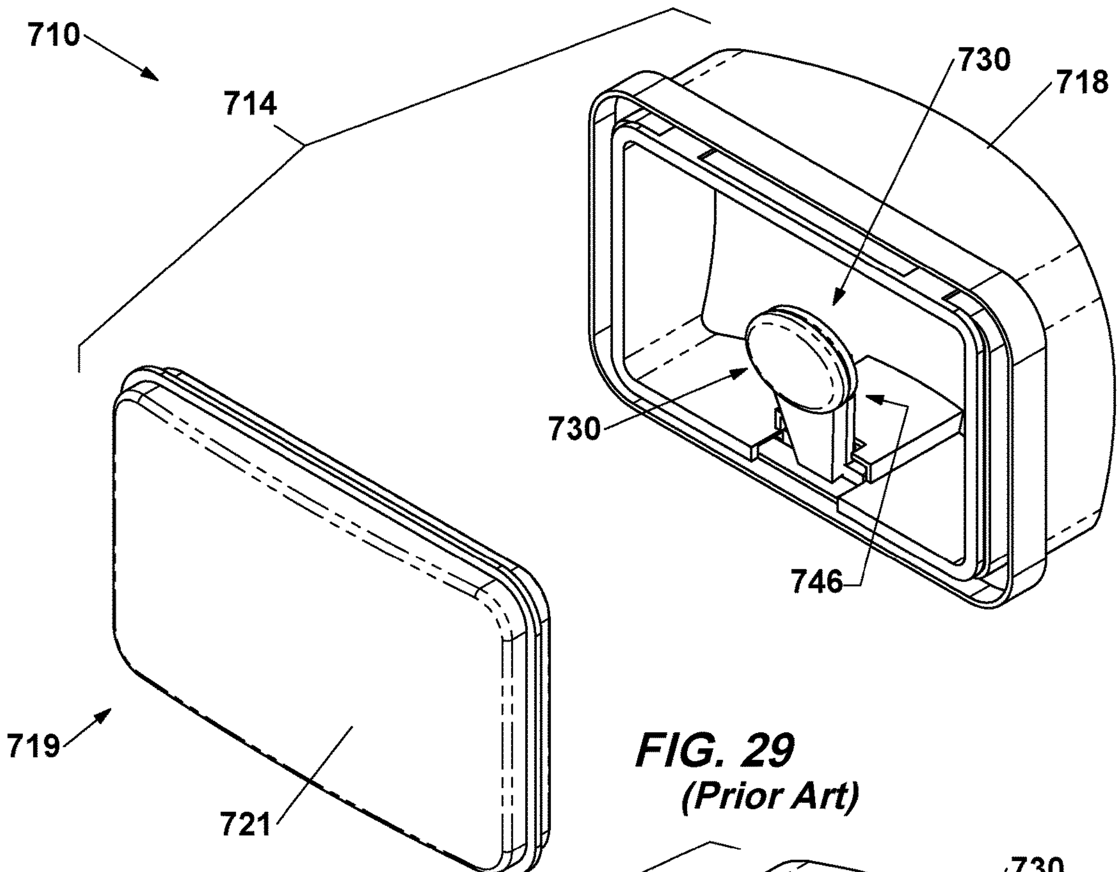

FIG. 29
(Prior Art)

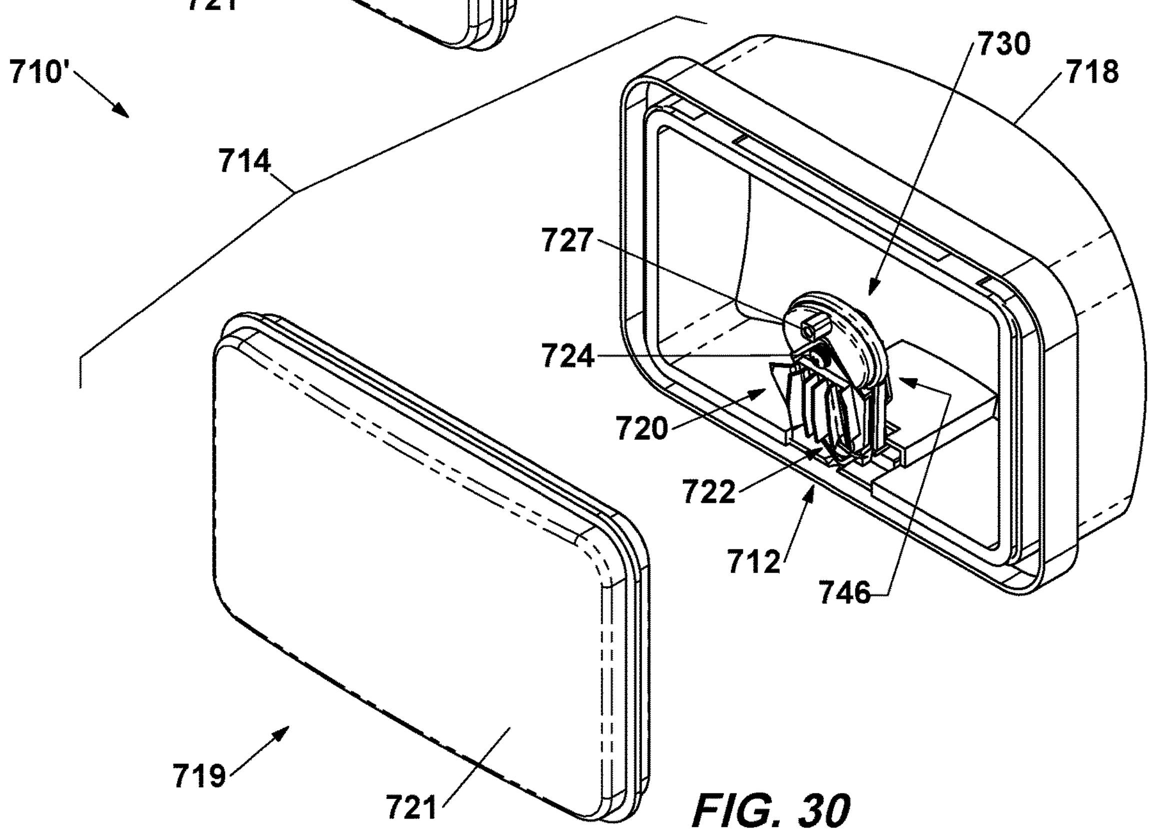

FIG. 30

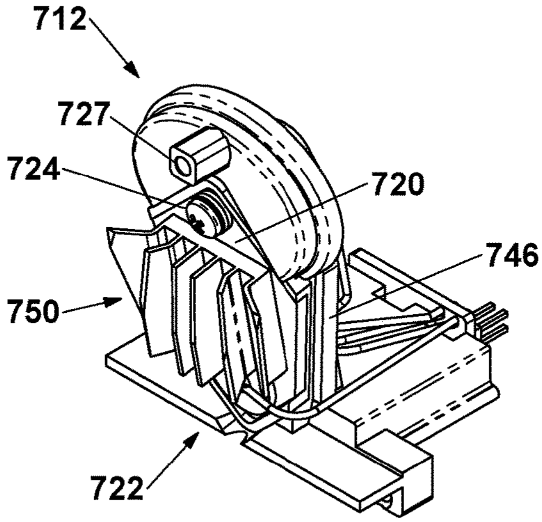

FIG. 31

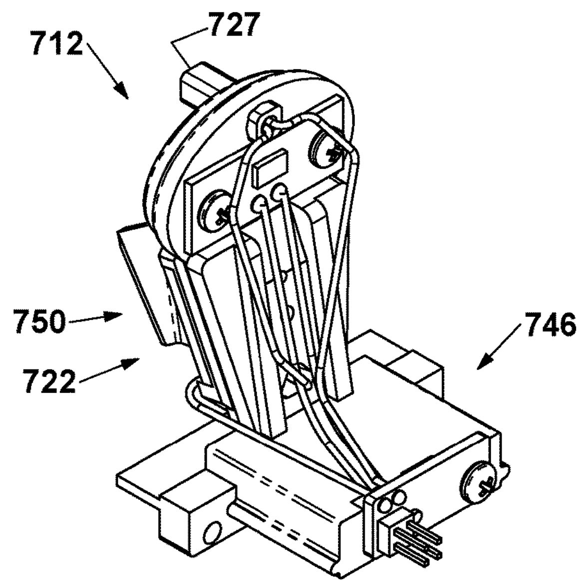

FIG. 32

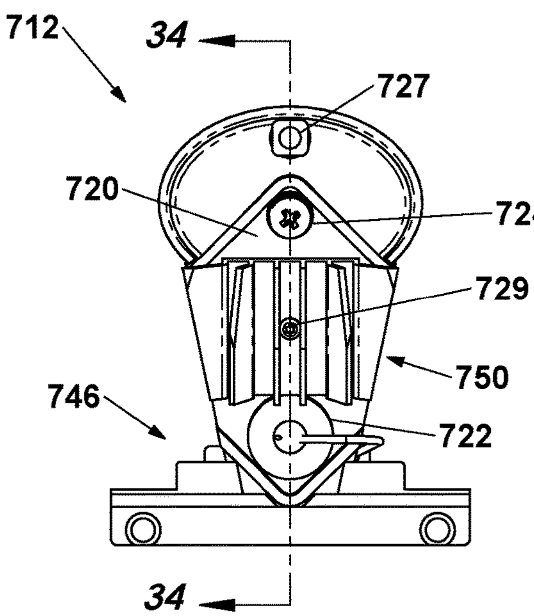

FIG. 33

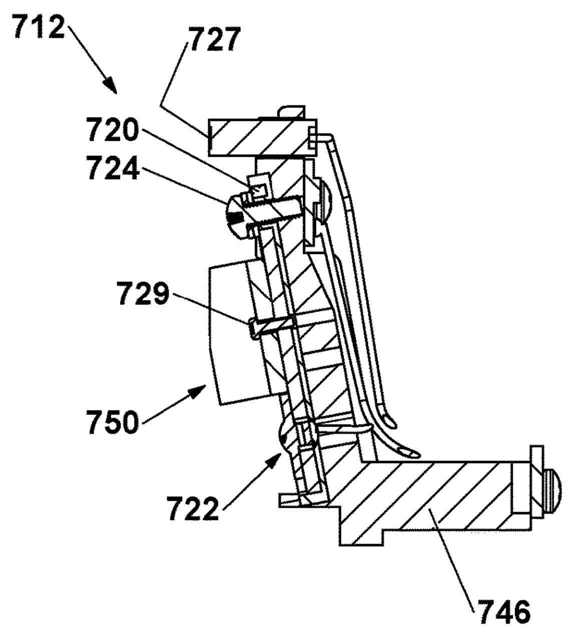

FIG. 34

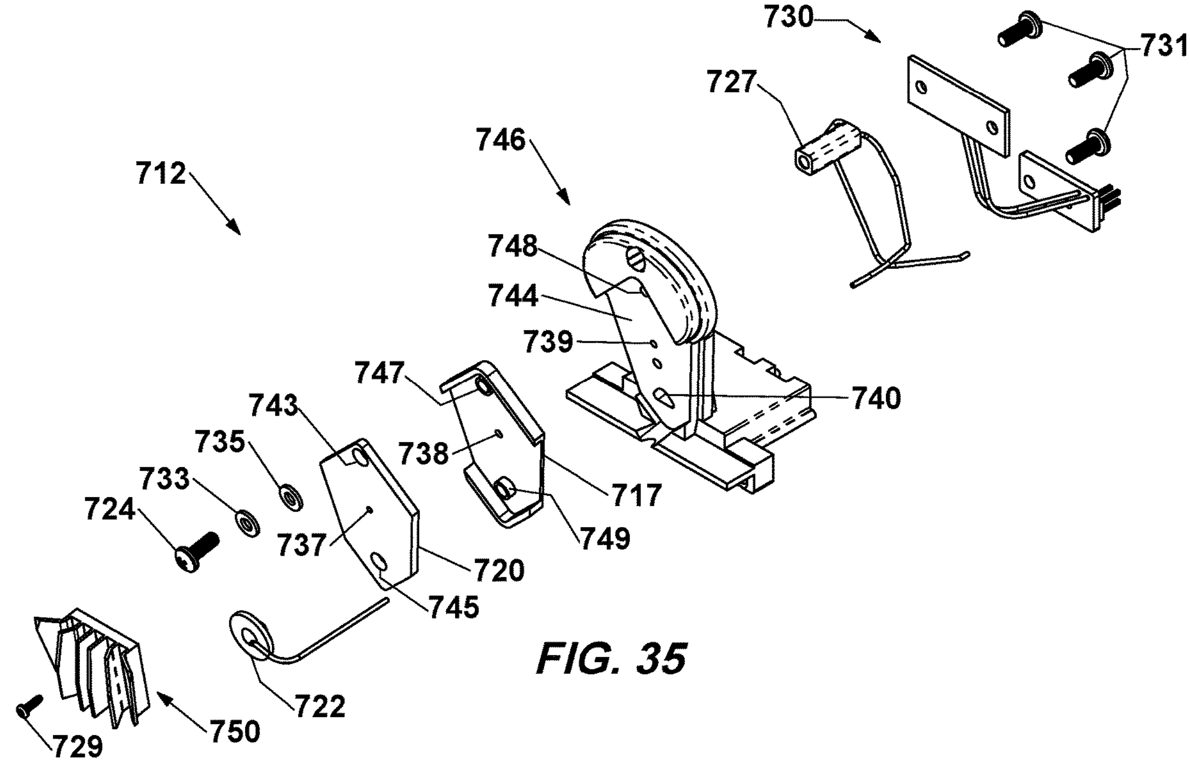
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FIG. 35

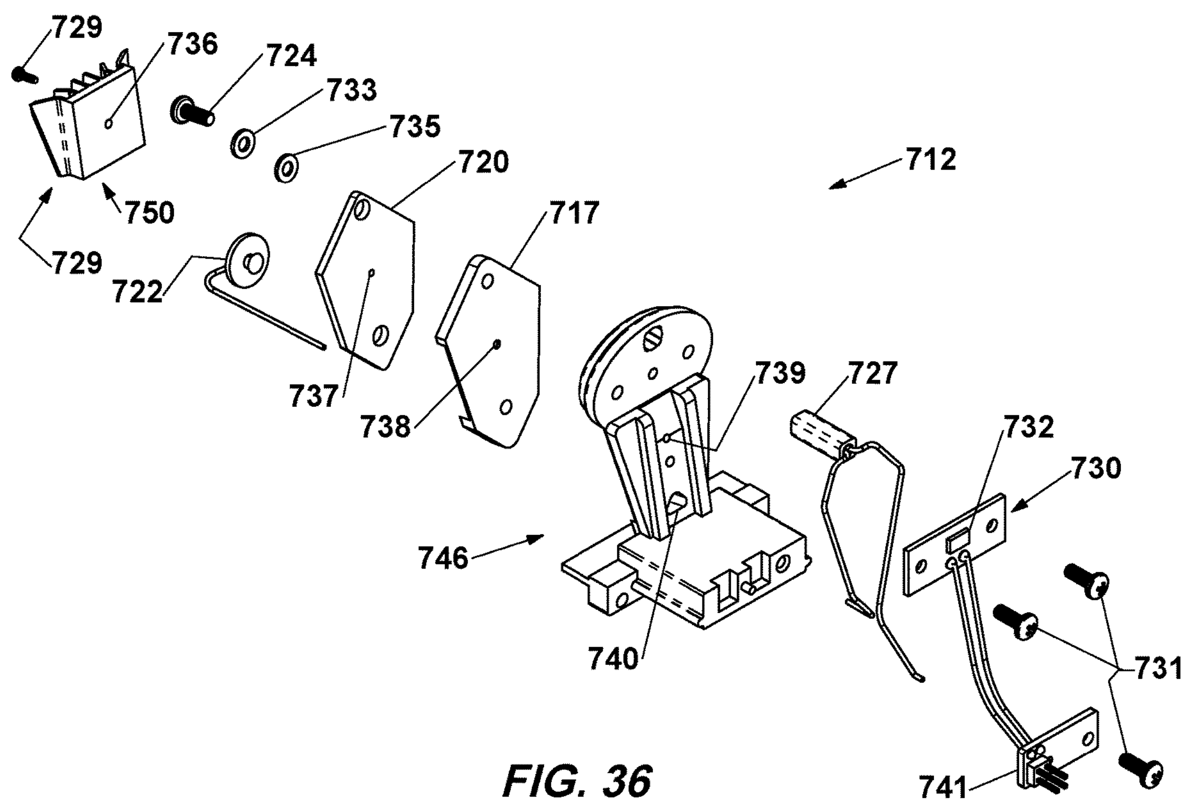
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FIG. 36

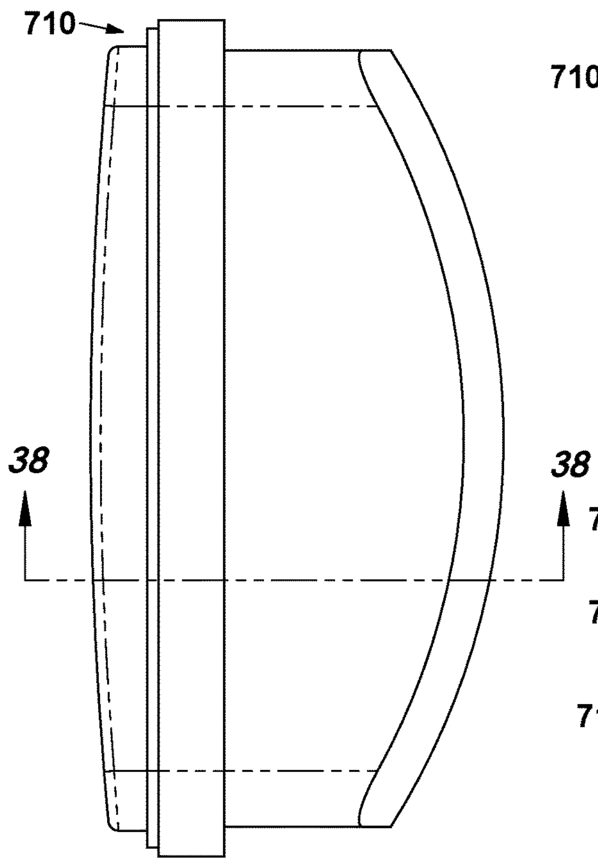
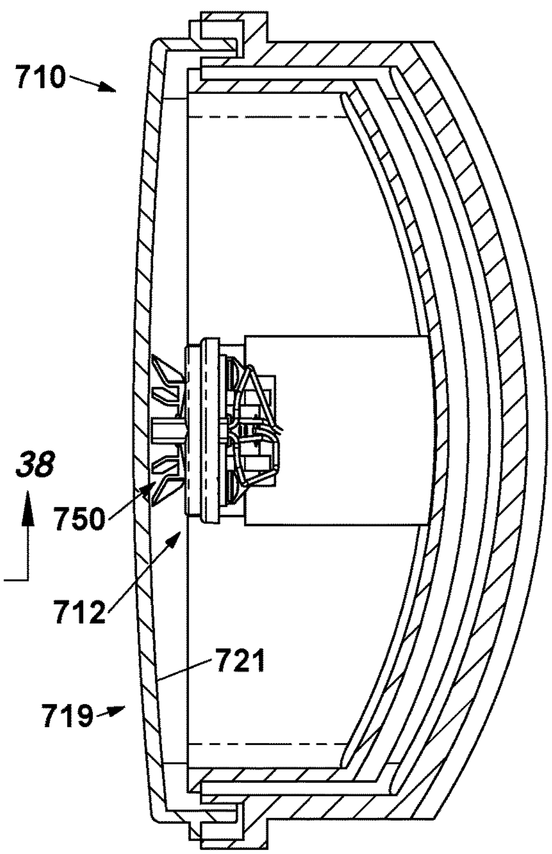


FIG. 37



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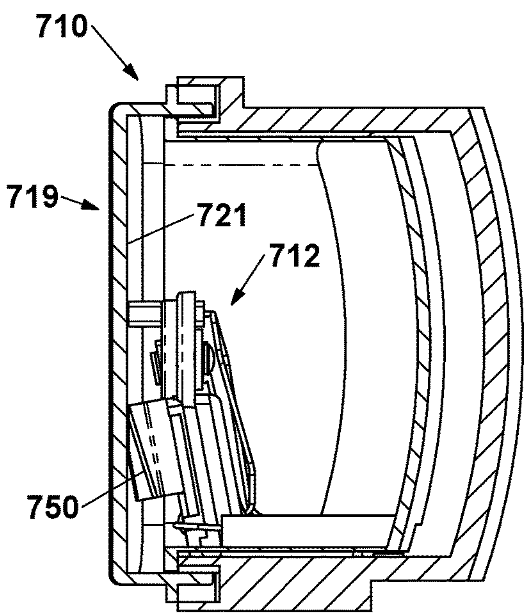

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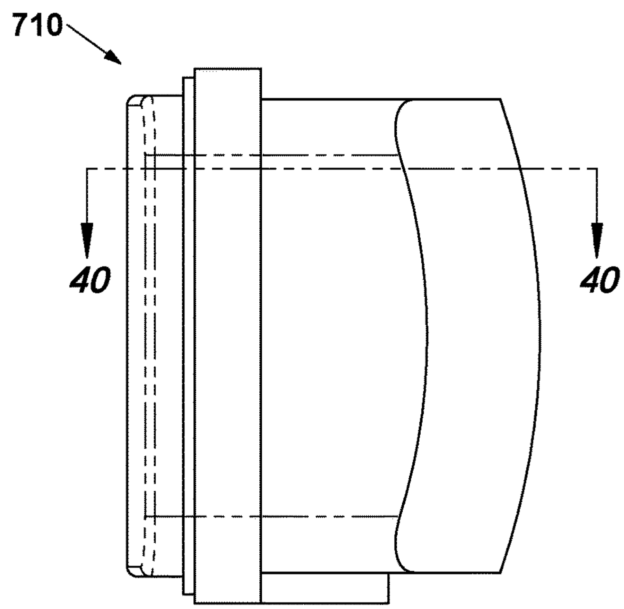

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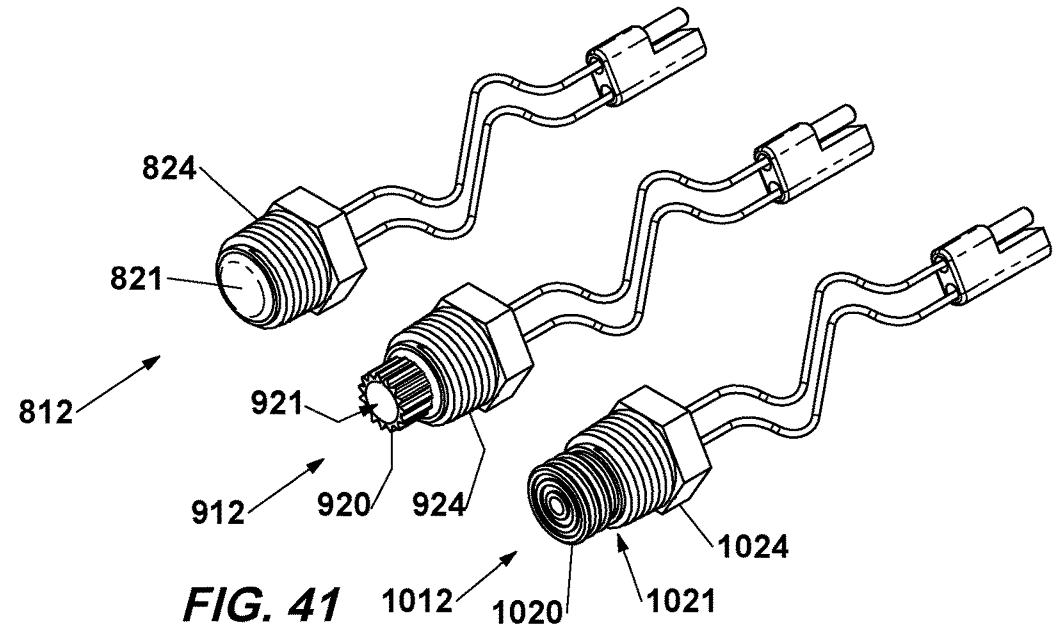

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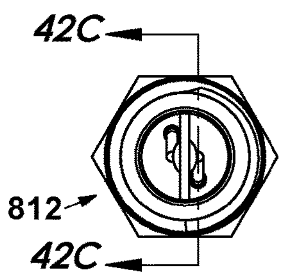

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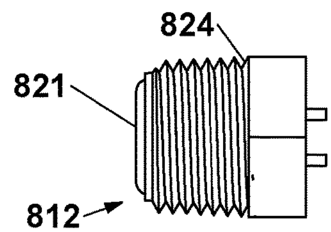


FIG. 42B

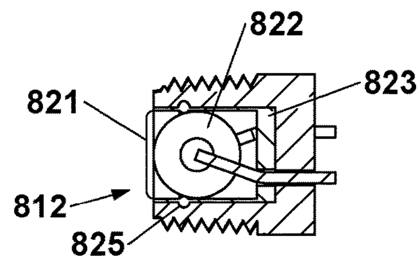


FIG. 42C

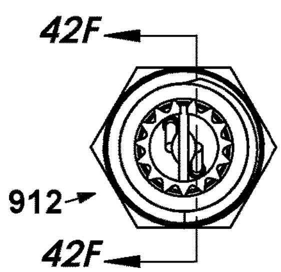


FIG. 42D

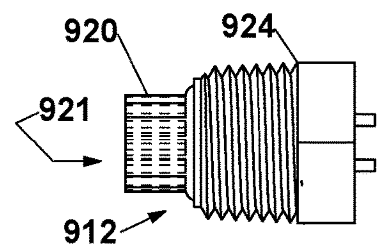
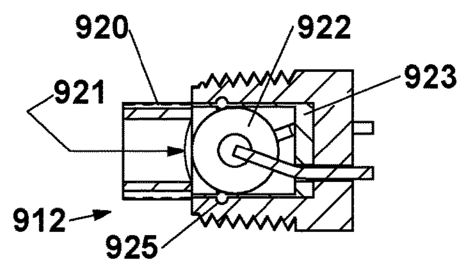


FIG. 42E



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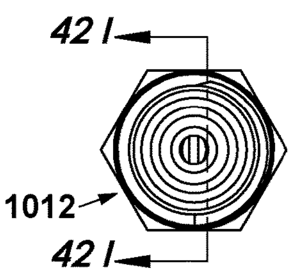

FIG. 42G

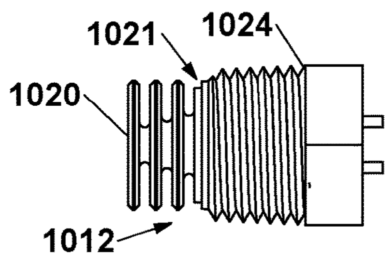

FIG. 42H

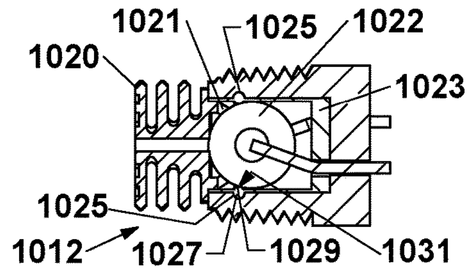

FIG. 42 I

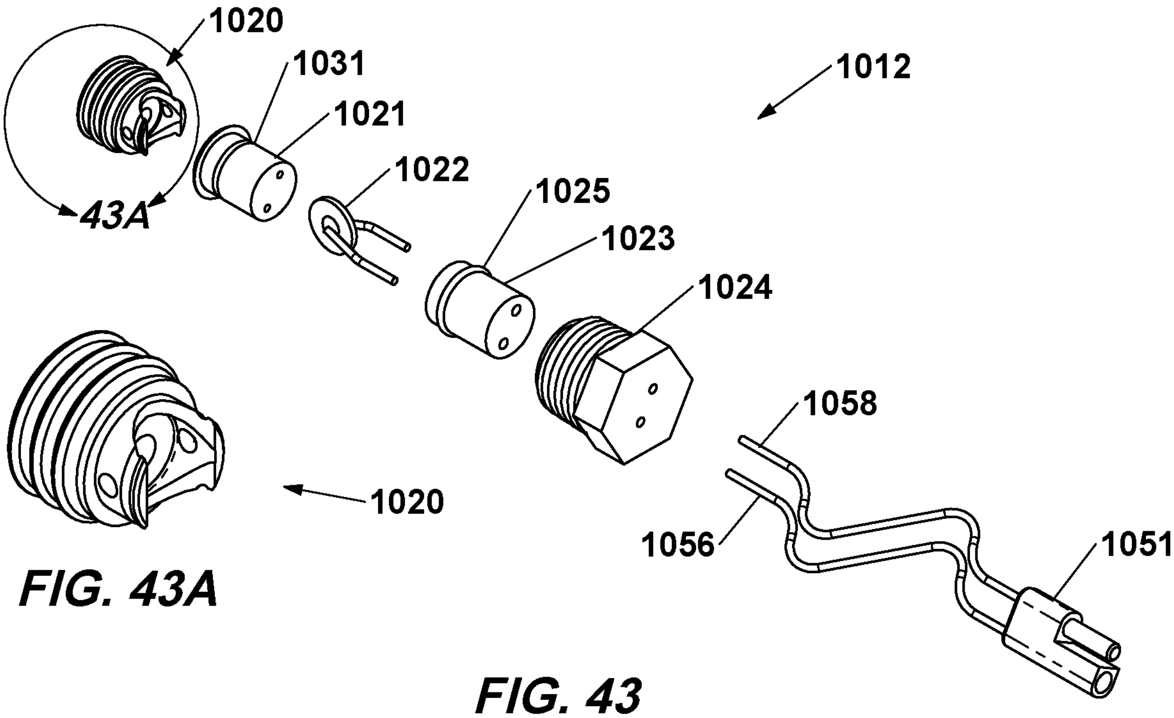

FIG. 43A

FIG. 43

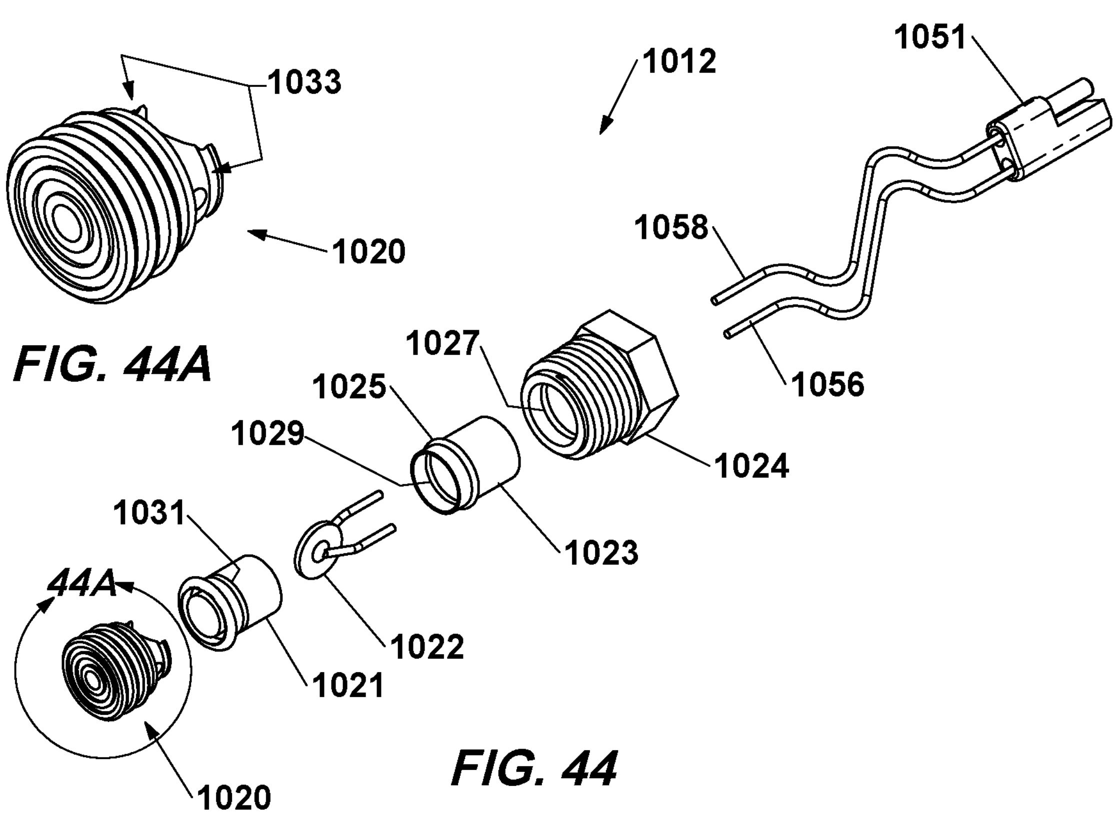

FIG. 44A

FIG. 44

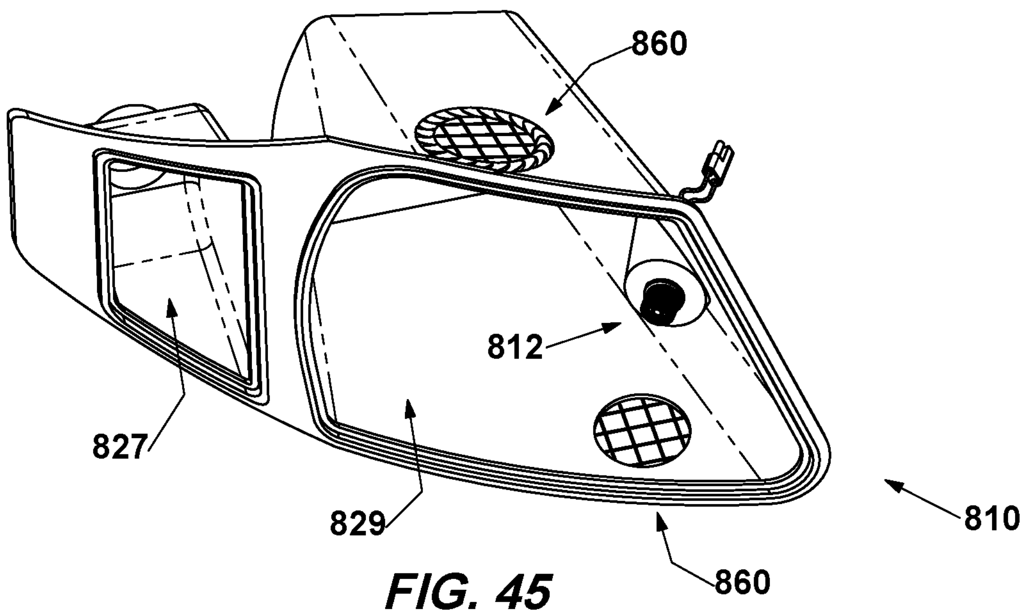
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FIG. 45

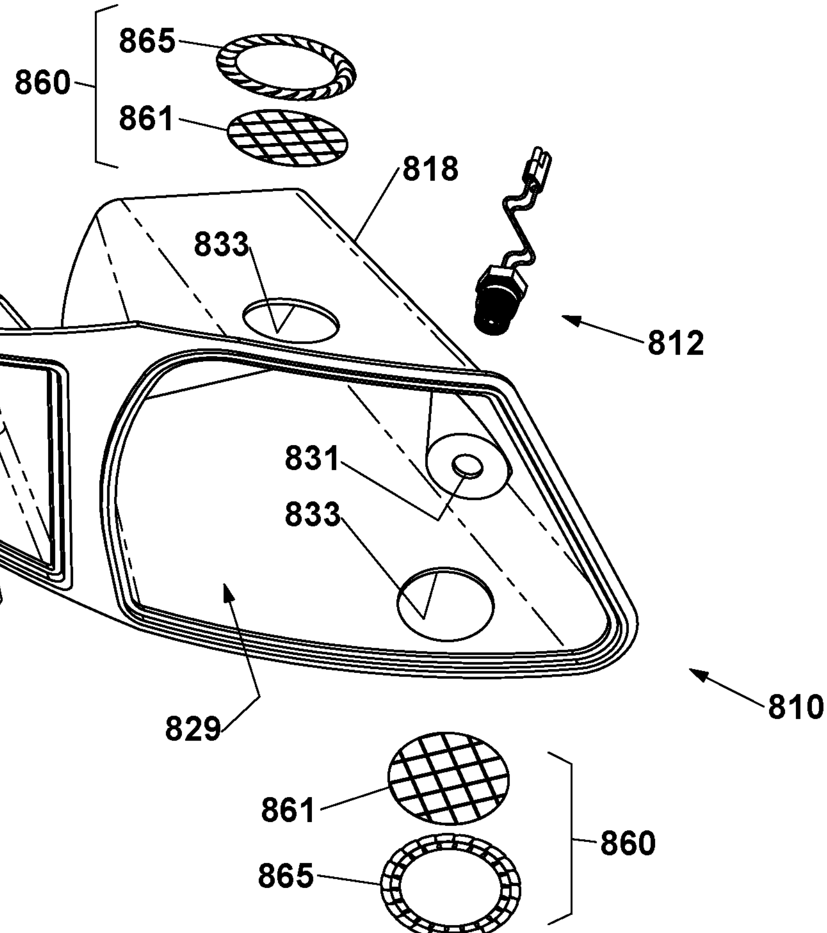
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FIG. 46

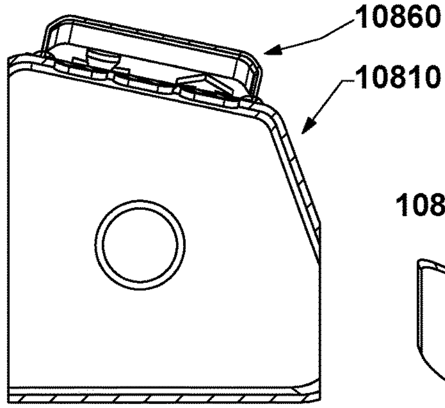


FIG. 48A

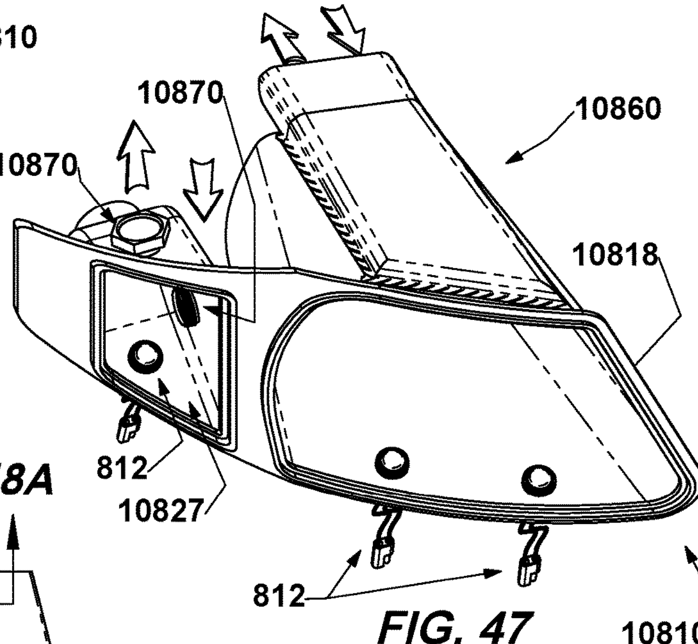


FIG. 47

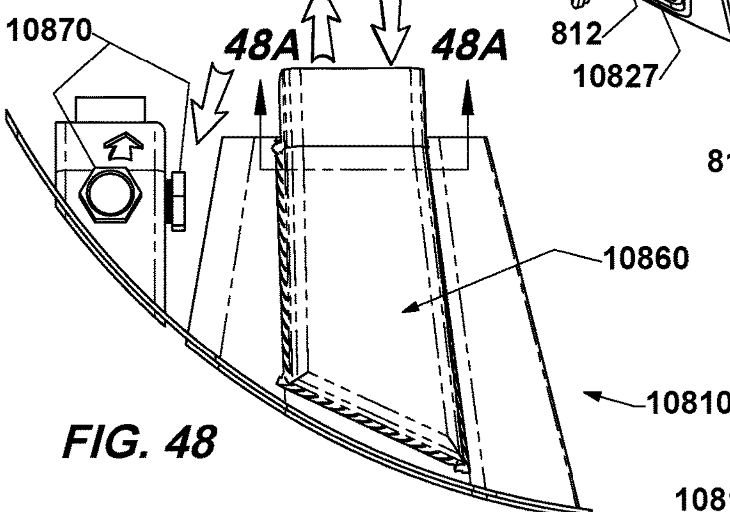


FIG. 48

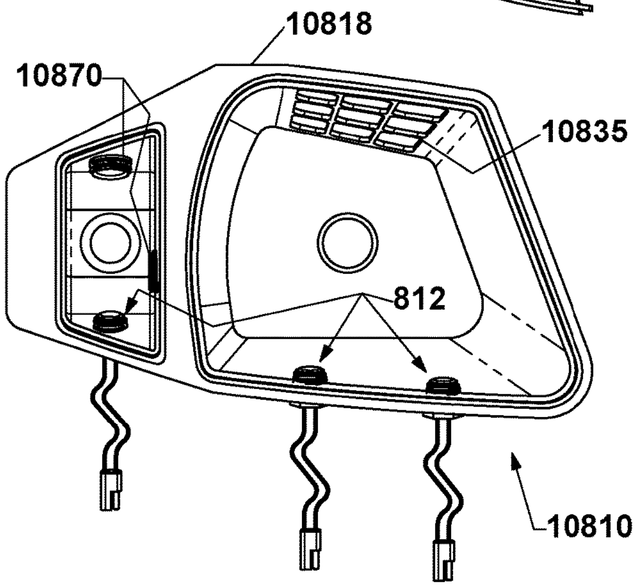


FIG. 49

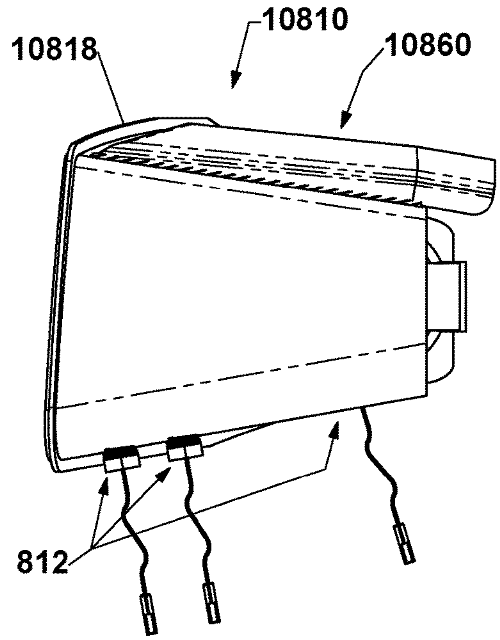
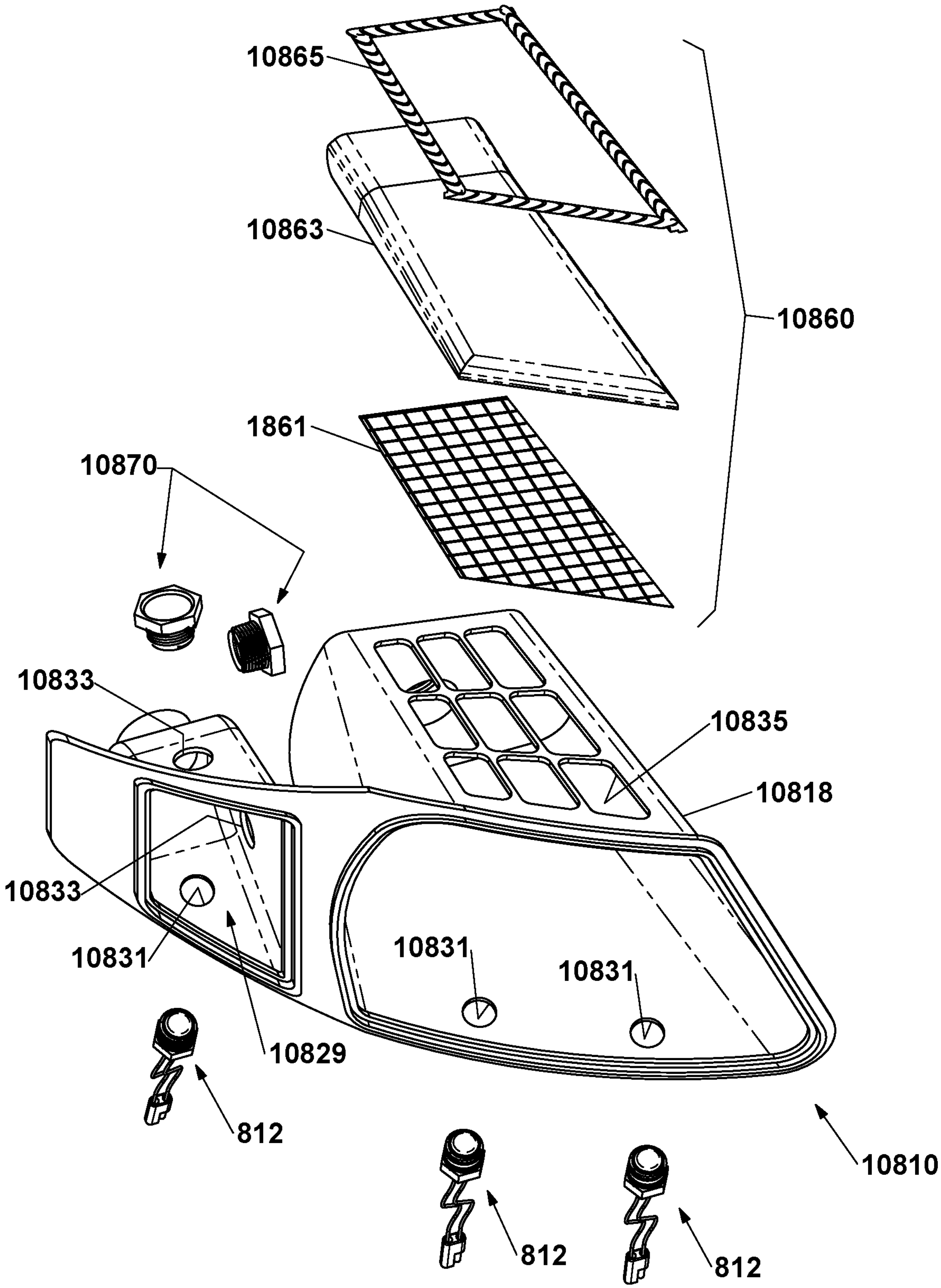


FIG. 50


10865
10863
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1861
10870
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10831
10829
812
10810
812
812

FIG. 51

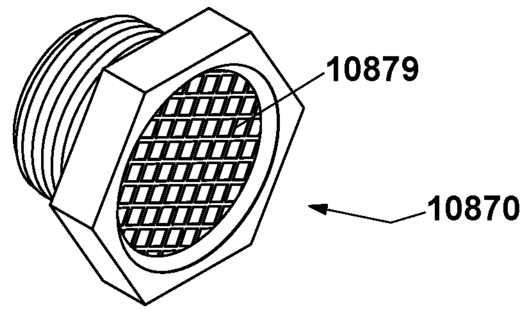

FIG. 52

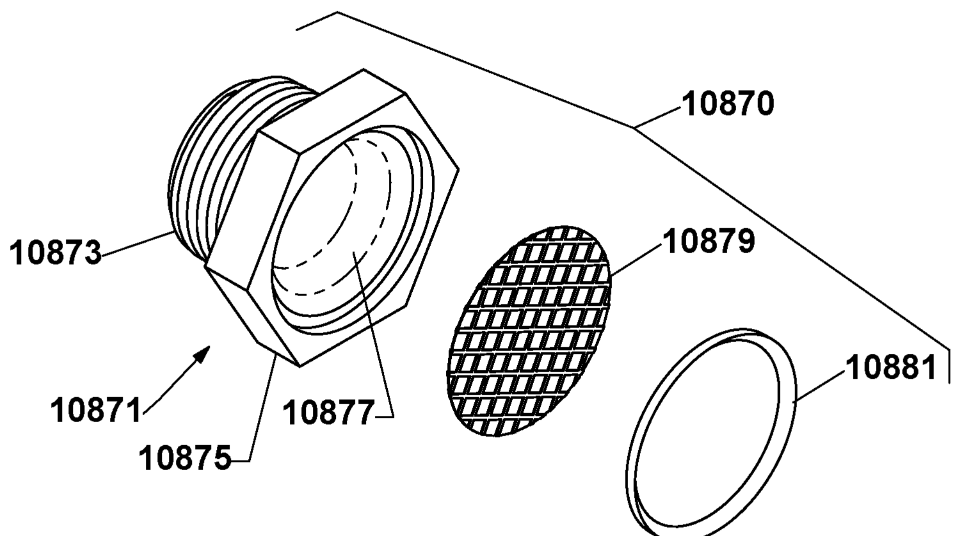

FIG. 53

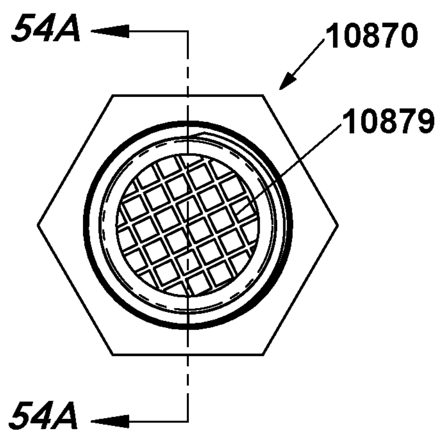

FIG. 54

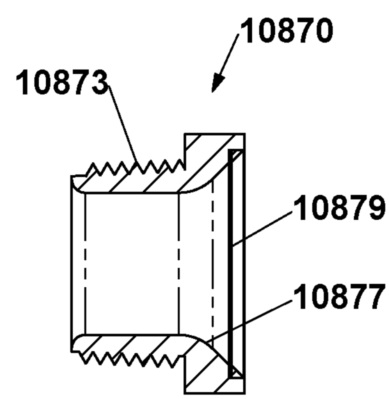

FIG. 54A

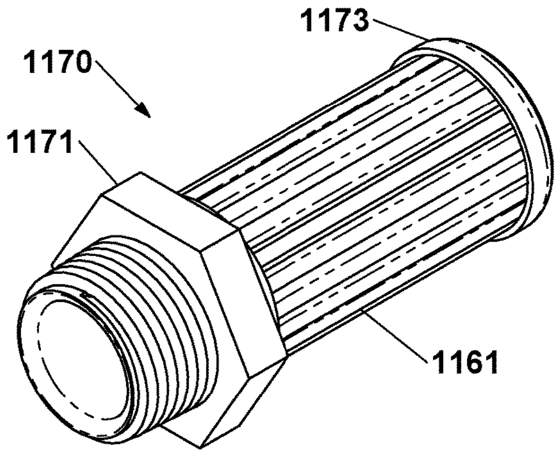

FIG. 55

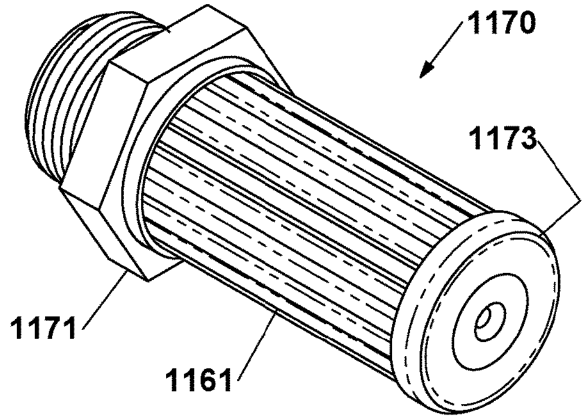

FIG. 56

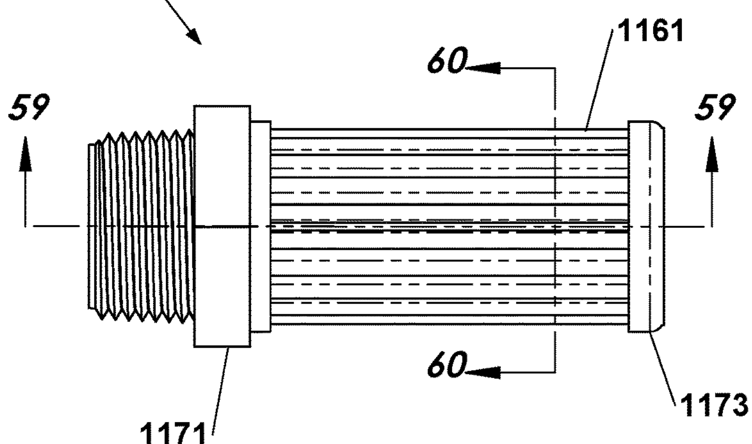

FIG. 57

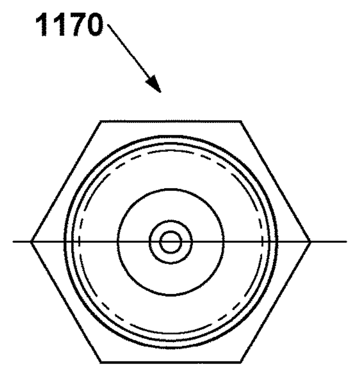

FIG. 58

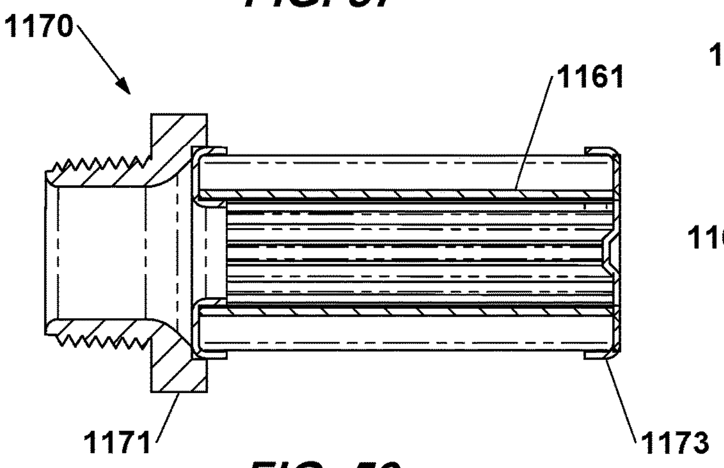

FIG. 59

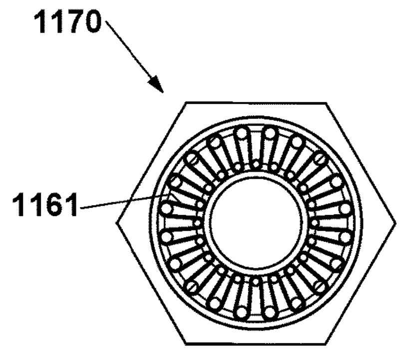

FIG. 60

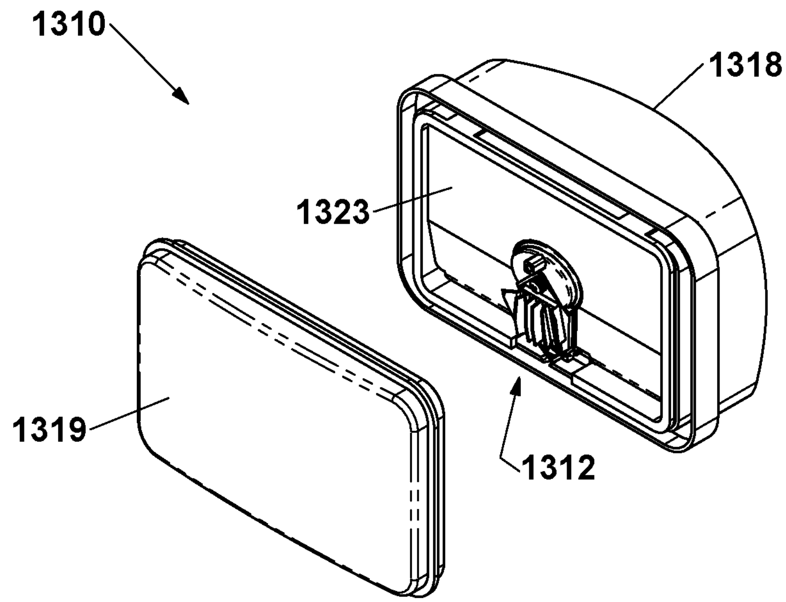

FIG. 61

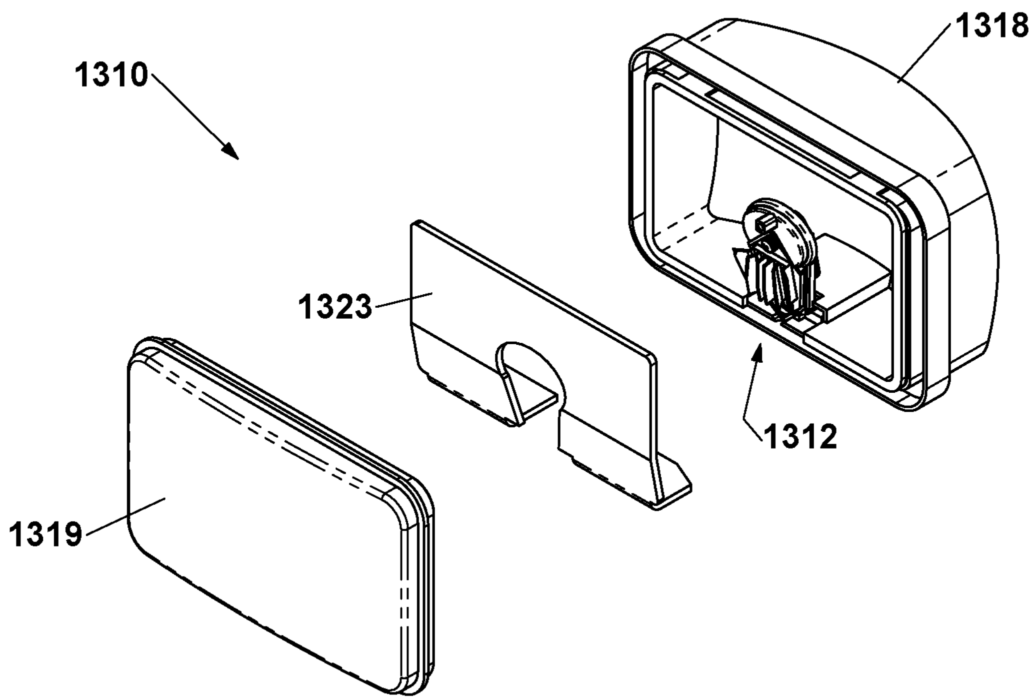

FIG. 62

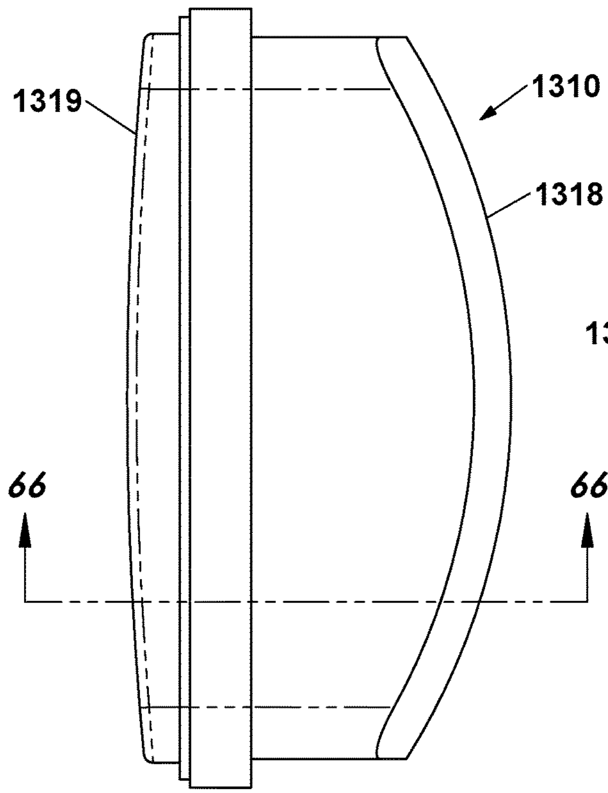

FIG. 63

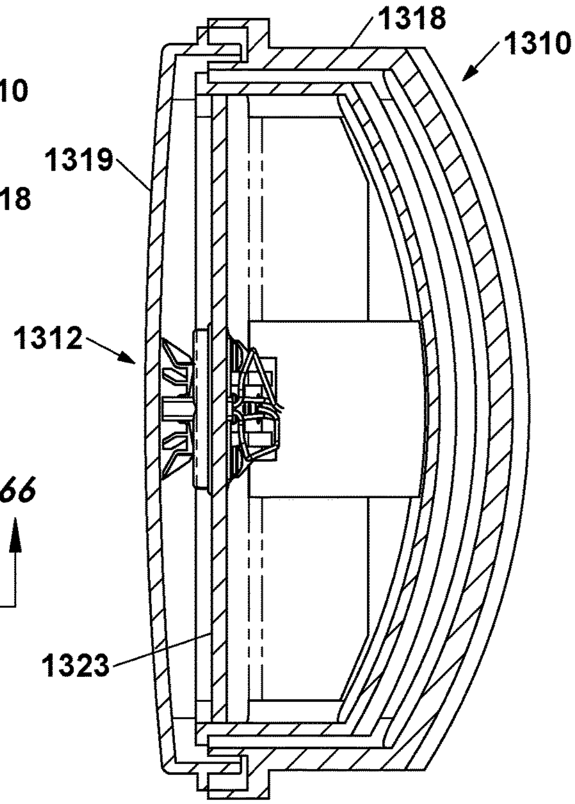

FIG. 64

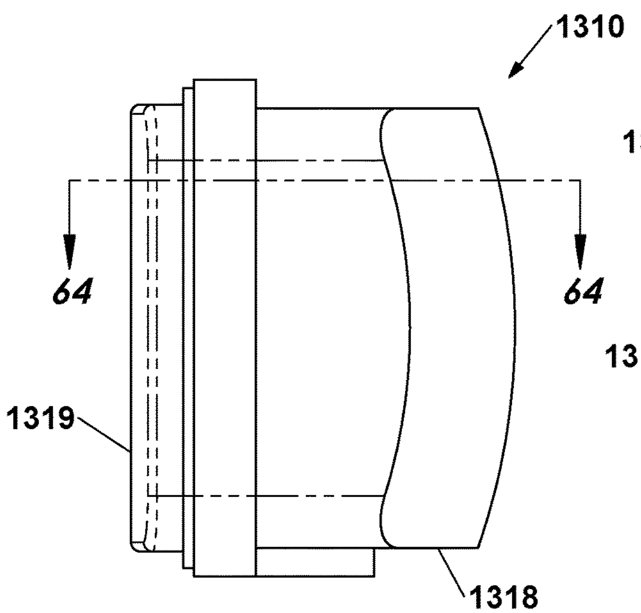

FIG. 65

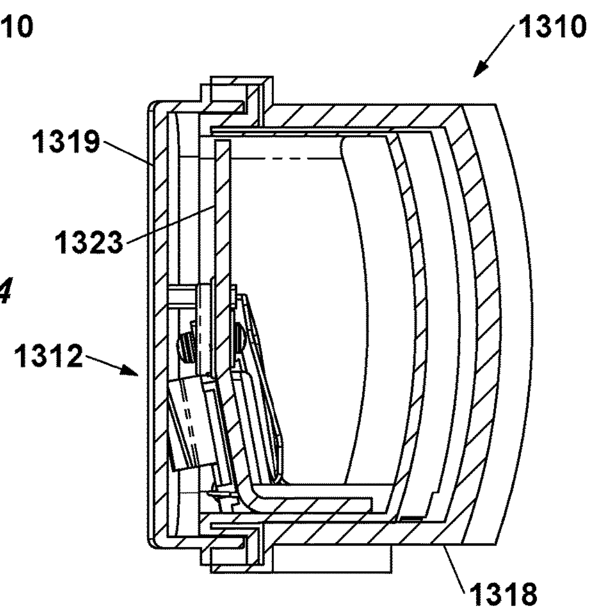

FIG. 66

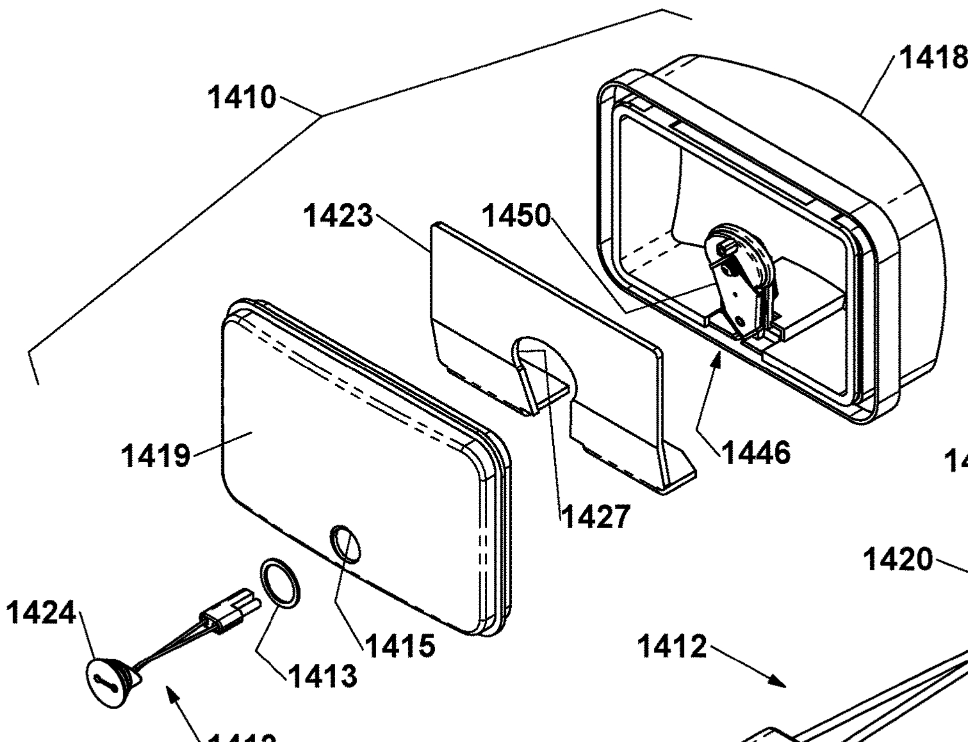

FIG. 67

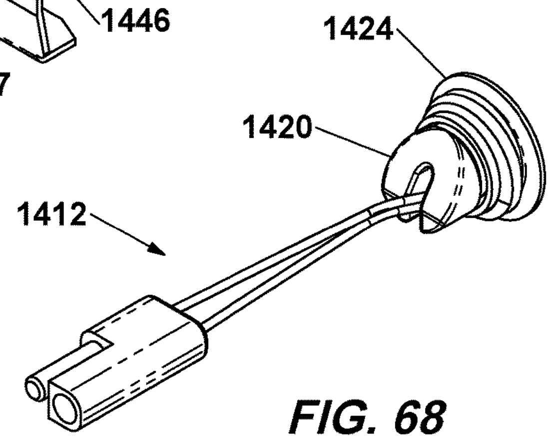

FIG. 68

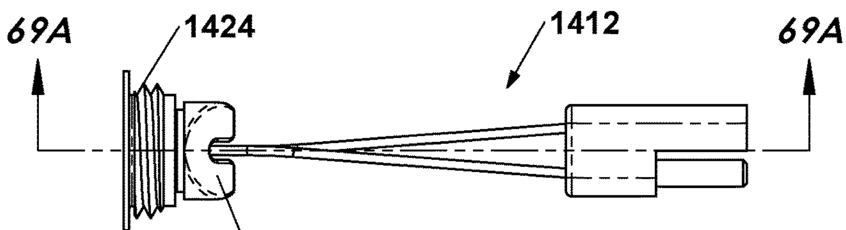

FIG. 69

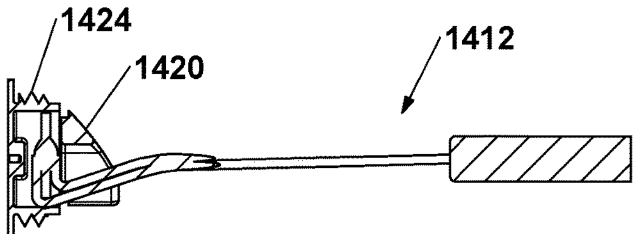

FIG. 69A

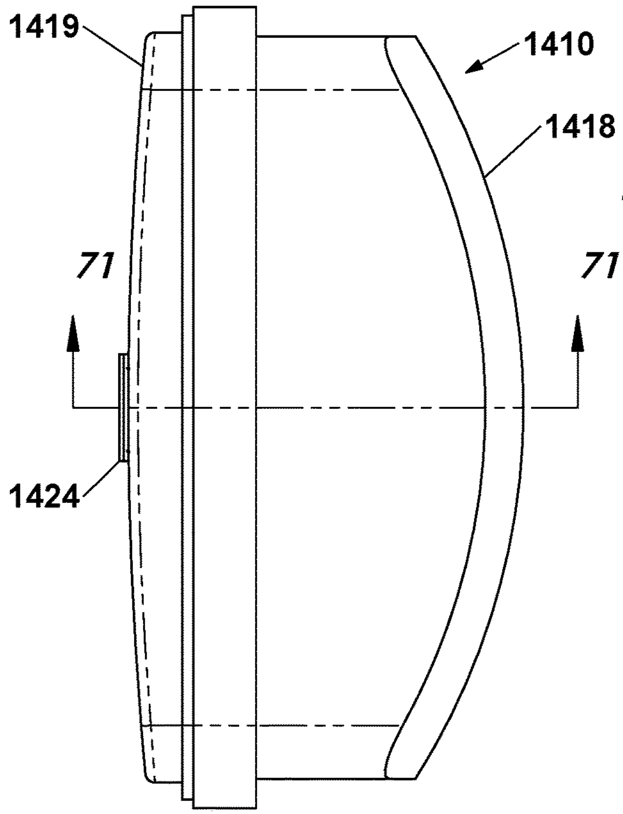

FIG. 70

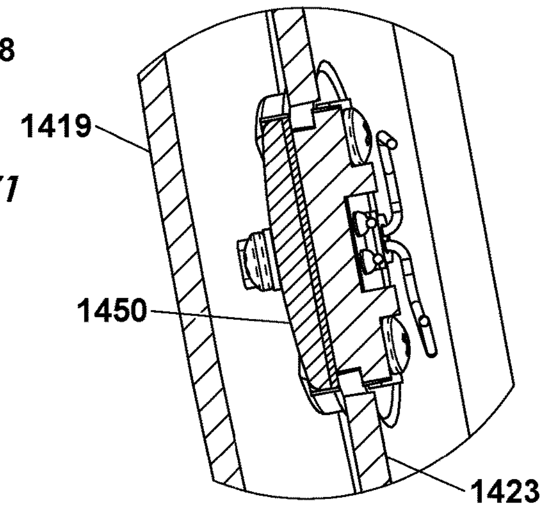

FIG. 71B

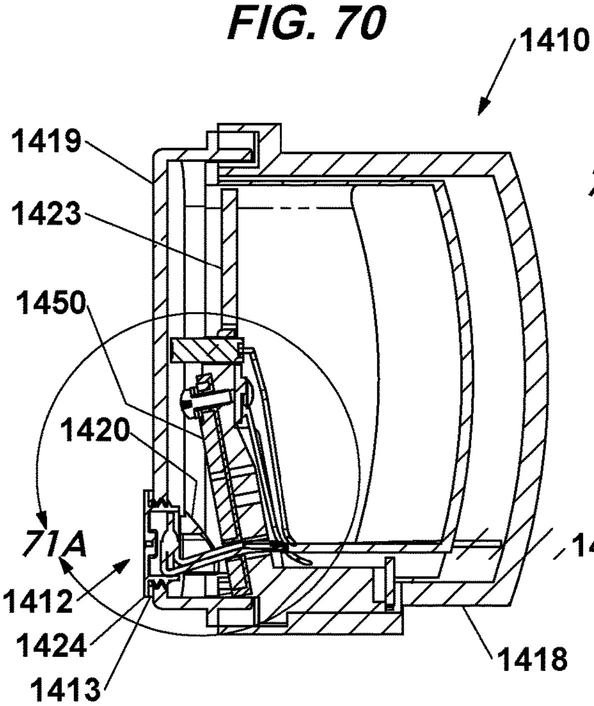

FIG. 71

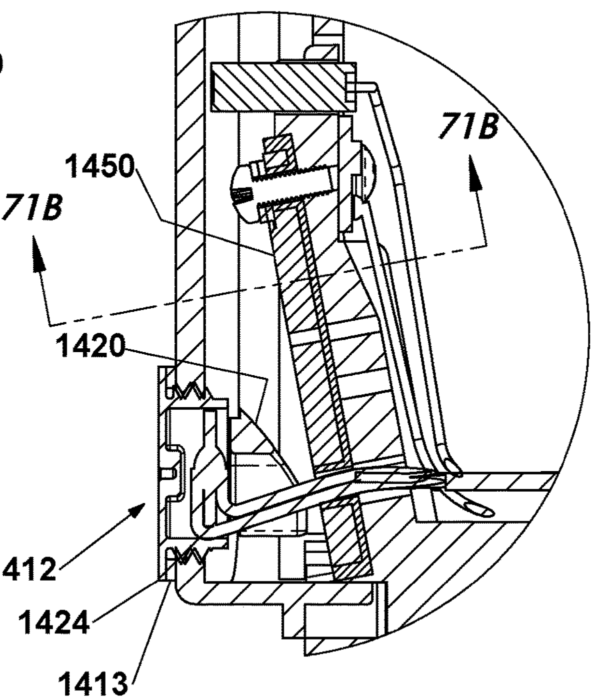

FIG. 71A

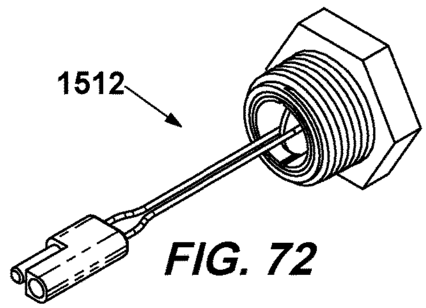

FIG. 72

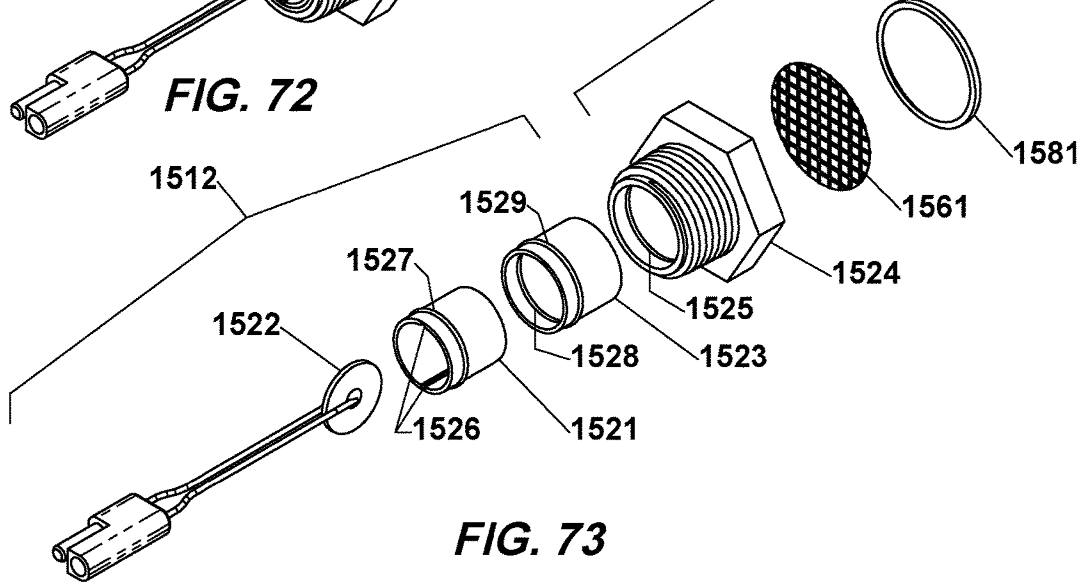

FIG. 73

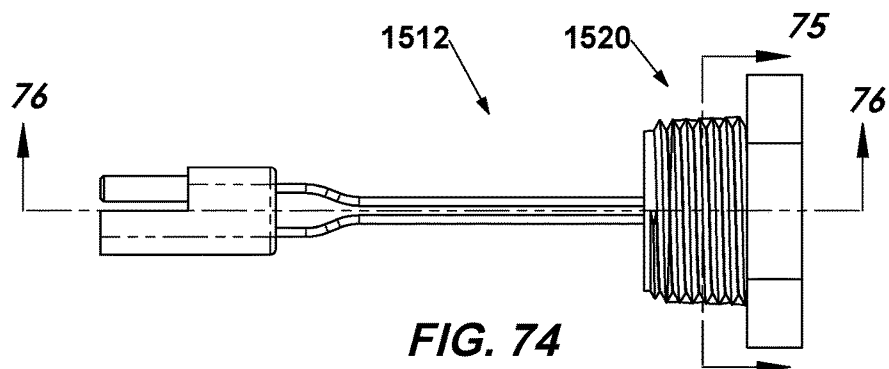

FIG. 74

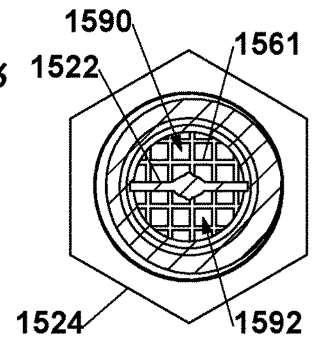

FIG. 75

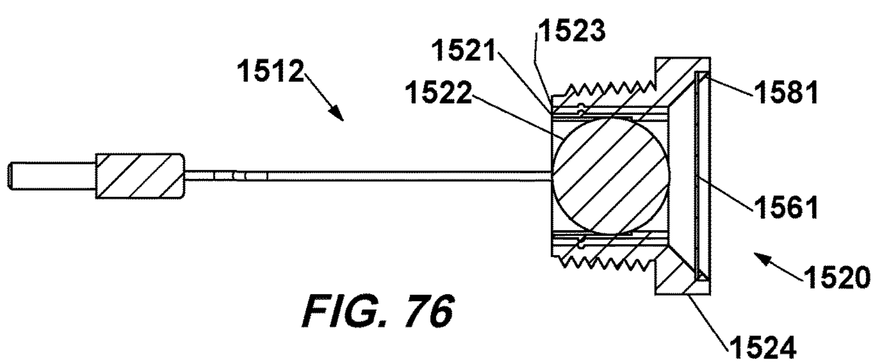

FIG. 76

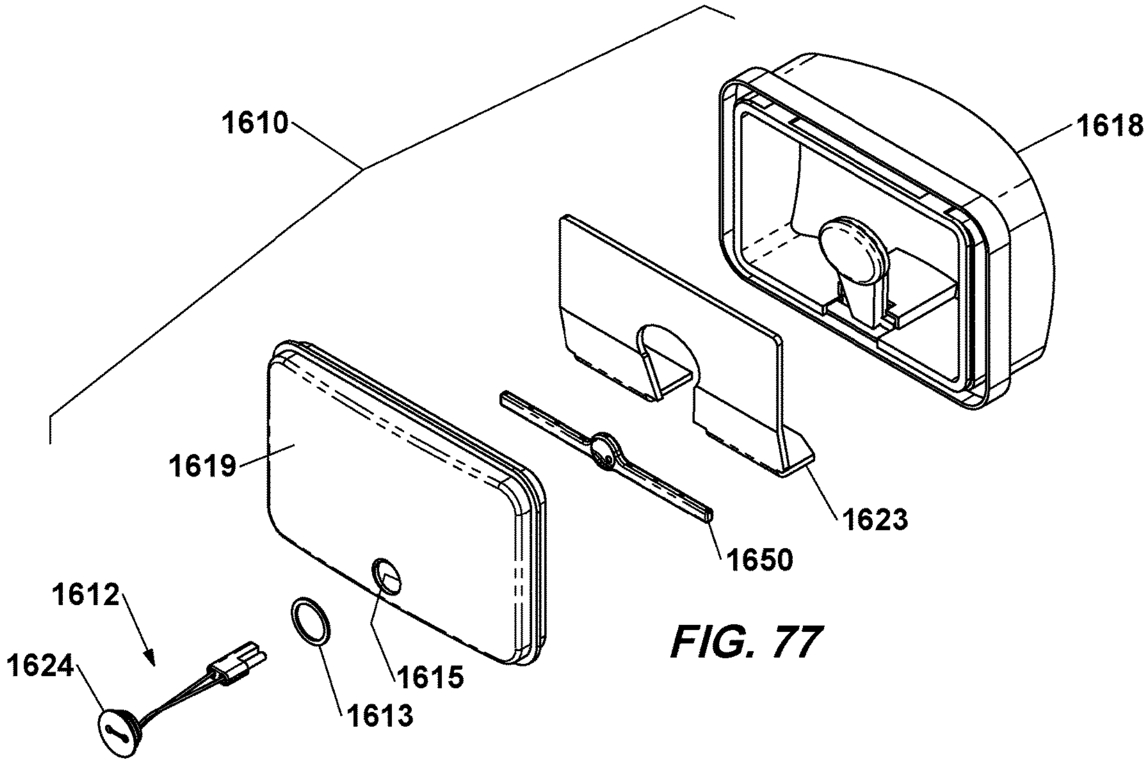

FIG. 77

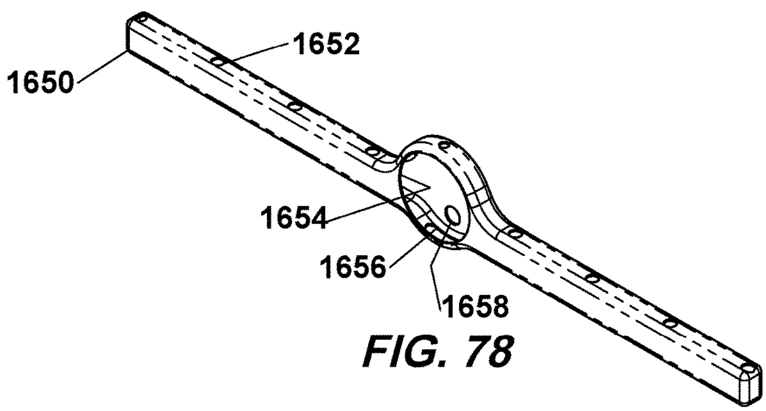

FIG. 78

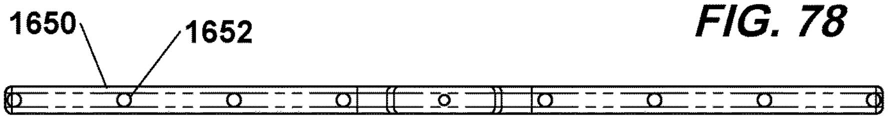

FIG. 79

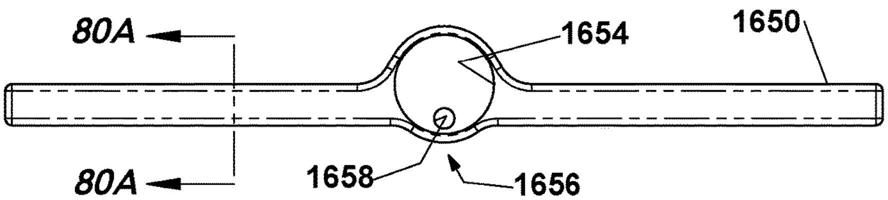

FIG. 80

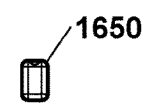

FIG. 80A

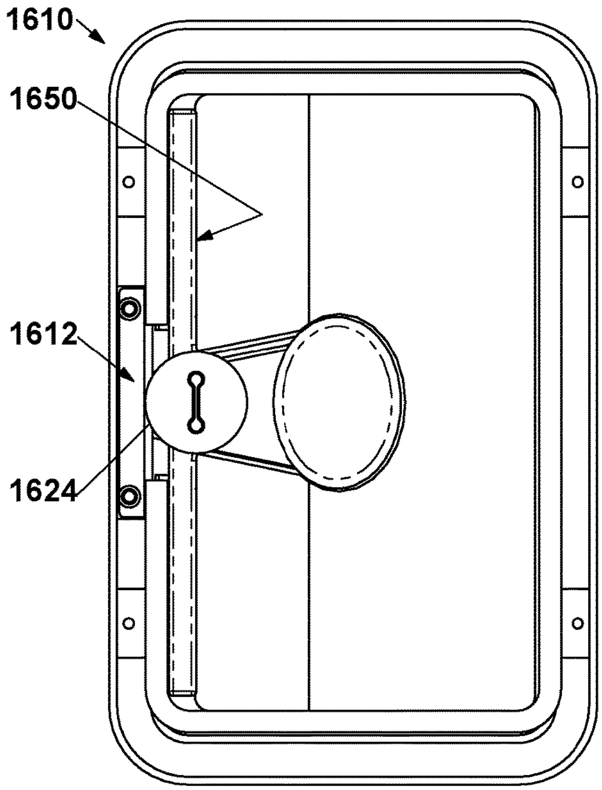

FIG. 81

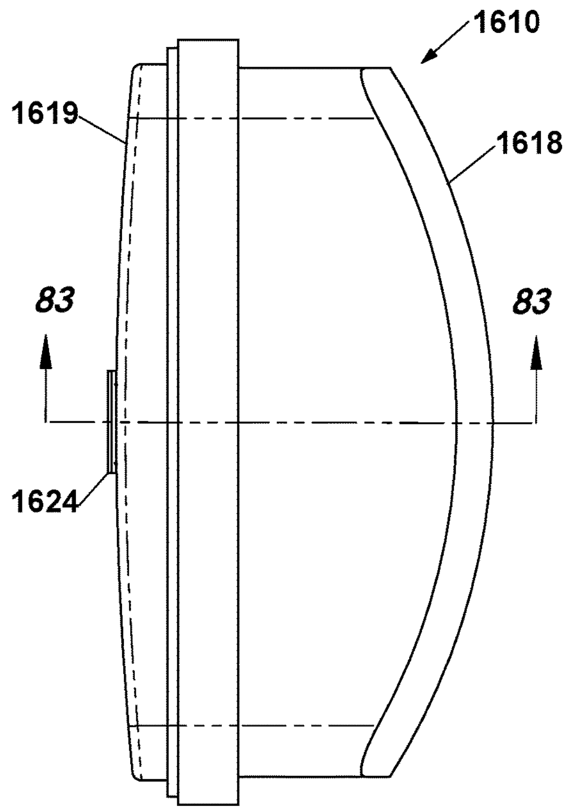

FIG. 82

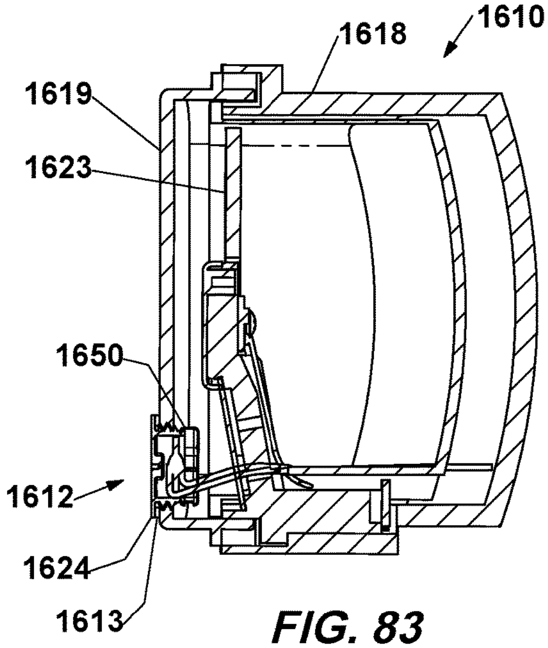

FIG. 83

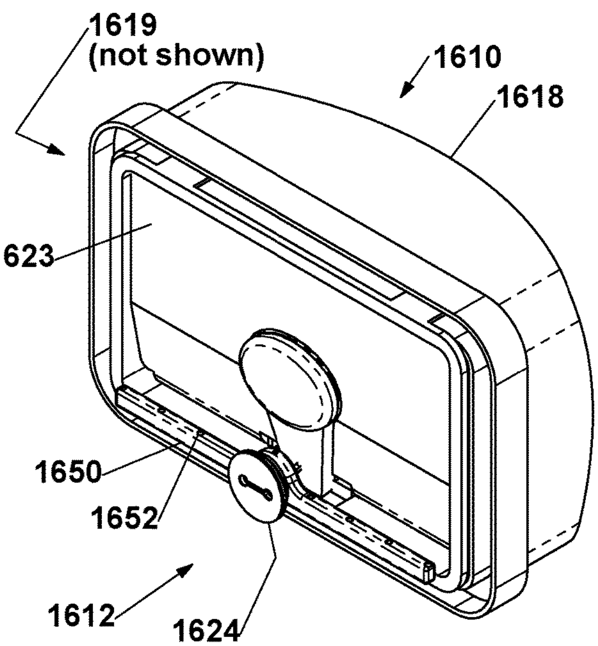

FIG. 84

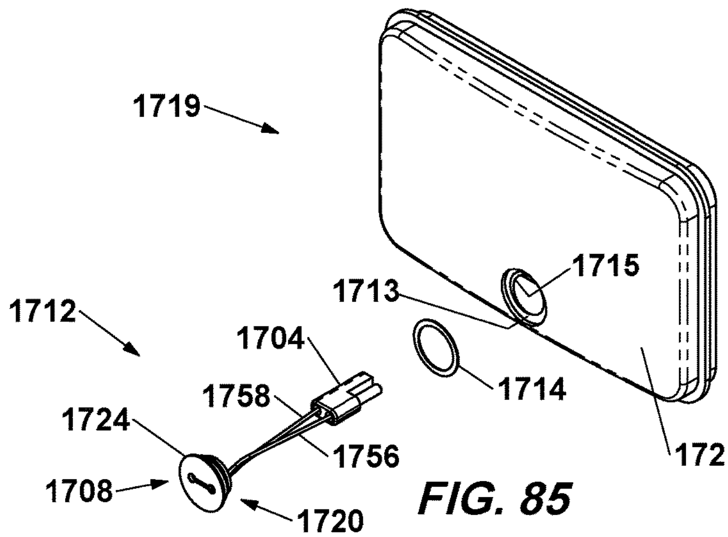

FIG. 85

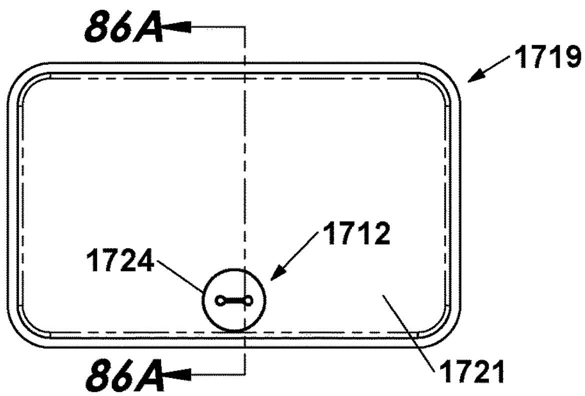

FIG. 86

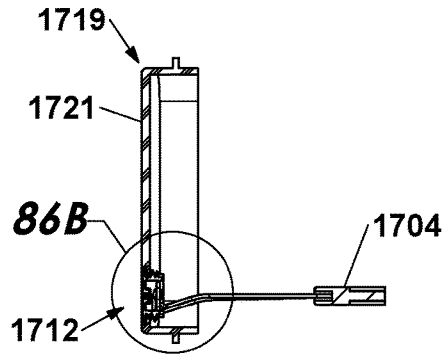

FIG. 86A

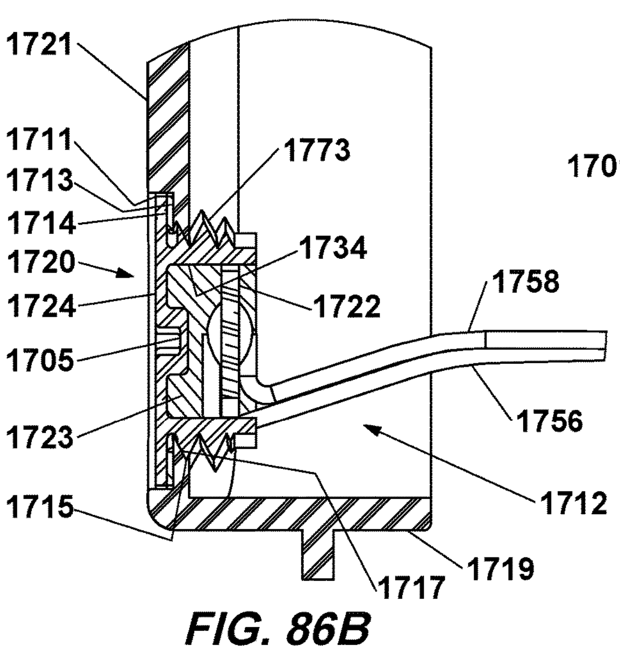

FIG. 86B

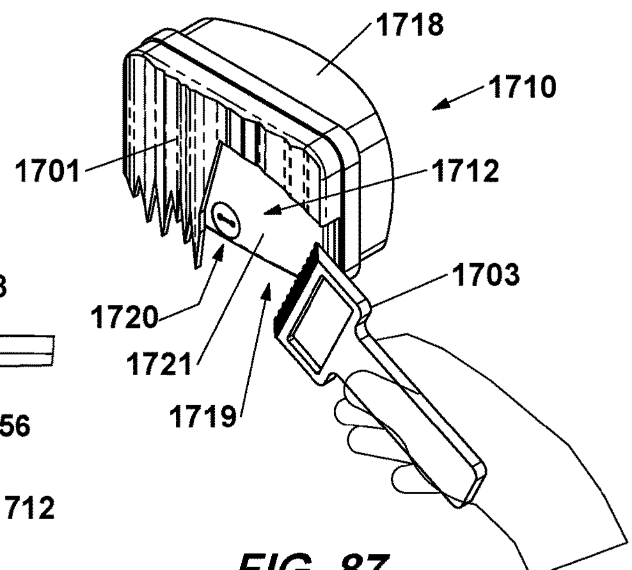

FIG. 87

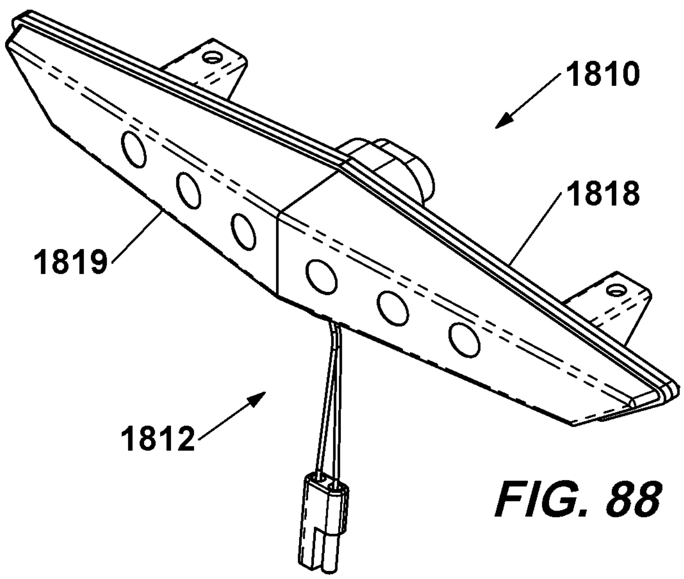

FIG. 88

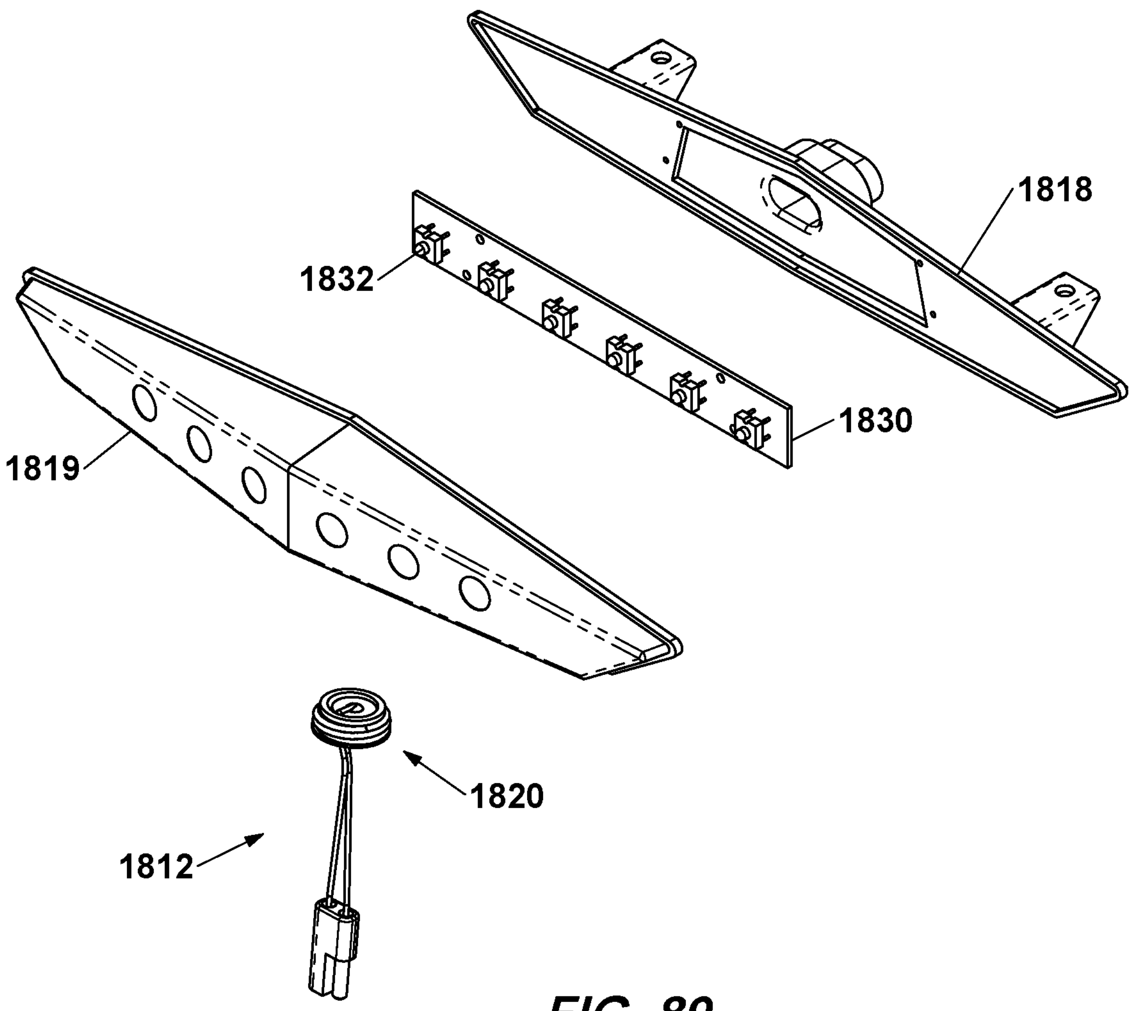

FIG. 89

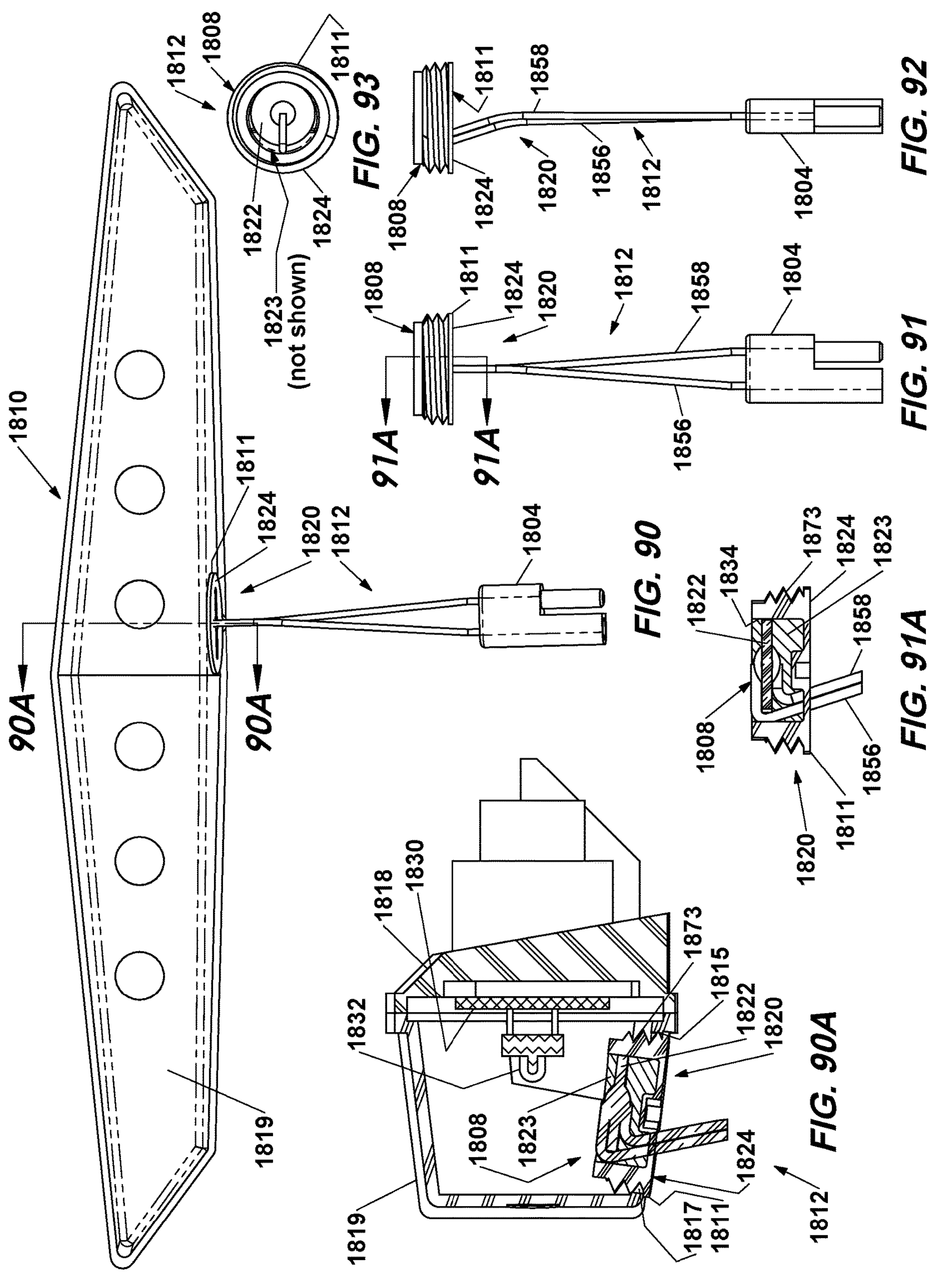

FIG. 90
FIG. 90A
FIG. 91
FIG. 91A
FIG. 92
FIG. 93
90A
91A
1804
1808
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1823
1823 (not shown)
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1858
1873

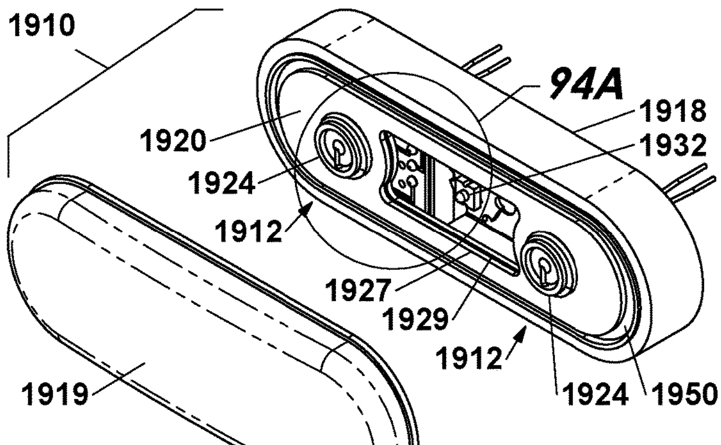

FIG. 94

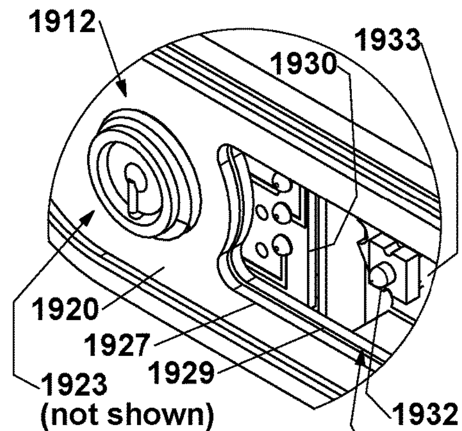

FIG. 94A

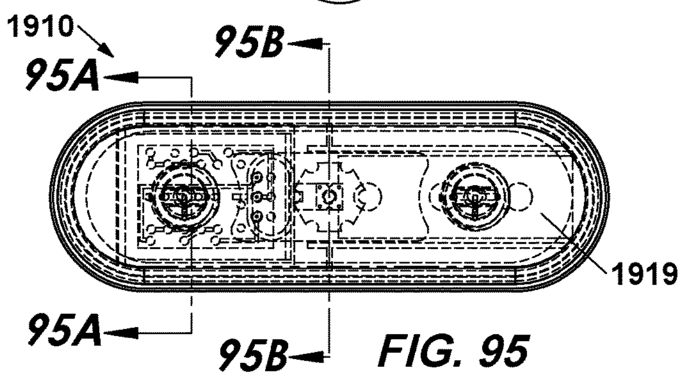

FIG. 95

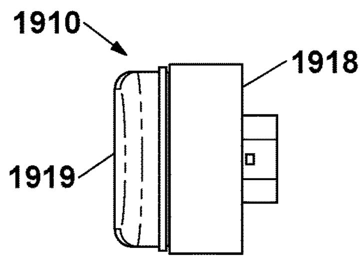

FIG. 96

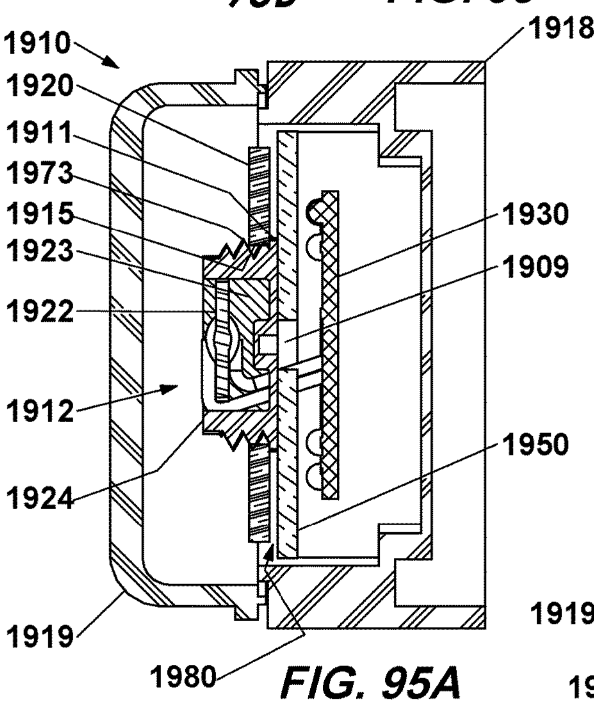

FIG. 95A

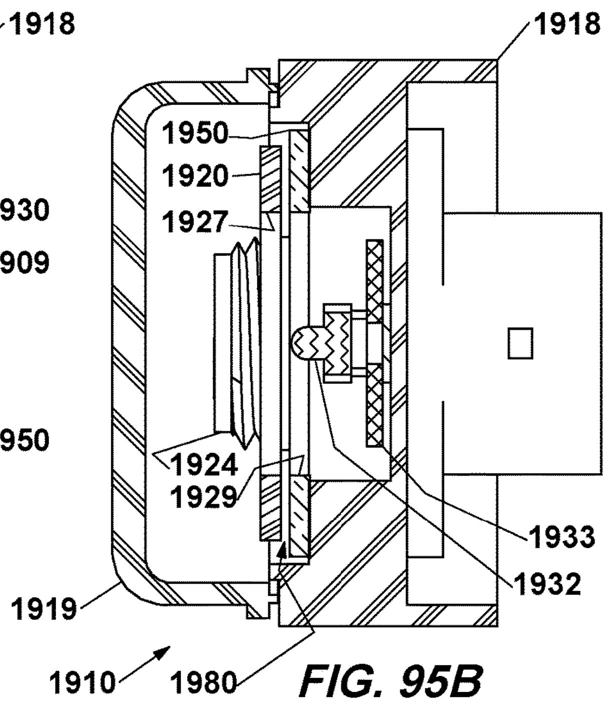

FIG. 95B

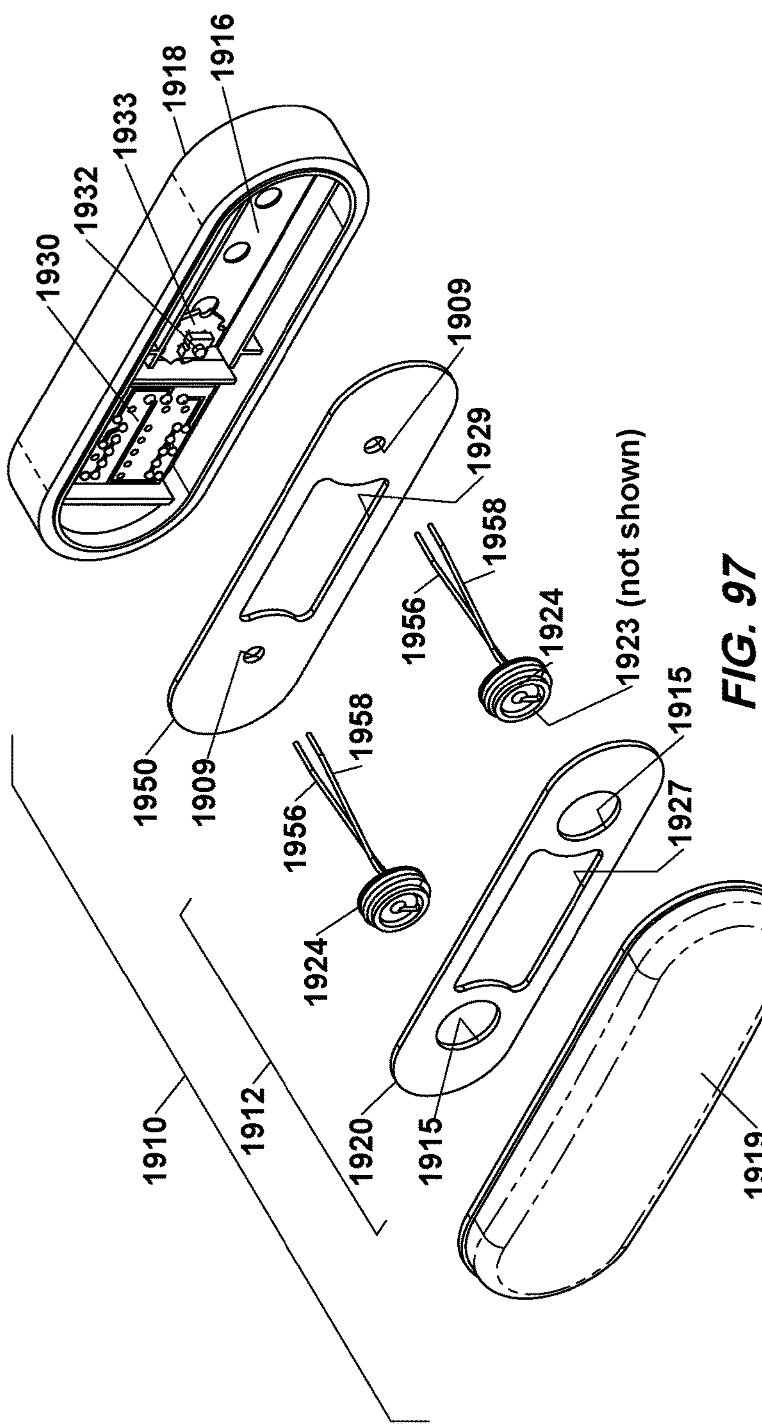

FIG. 97

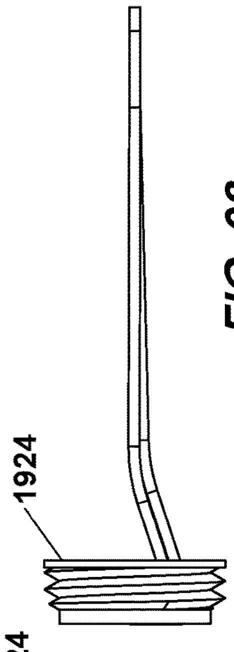

FIG. 98

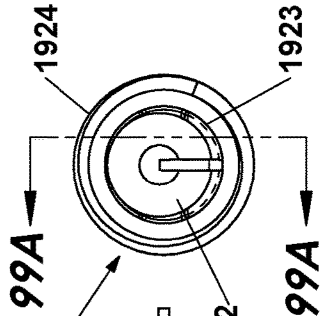

FIG. 99

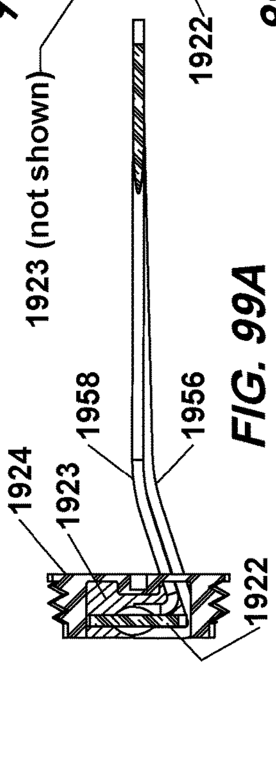

FIG. 99A

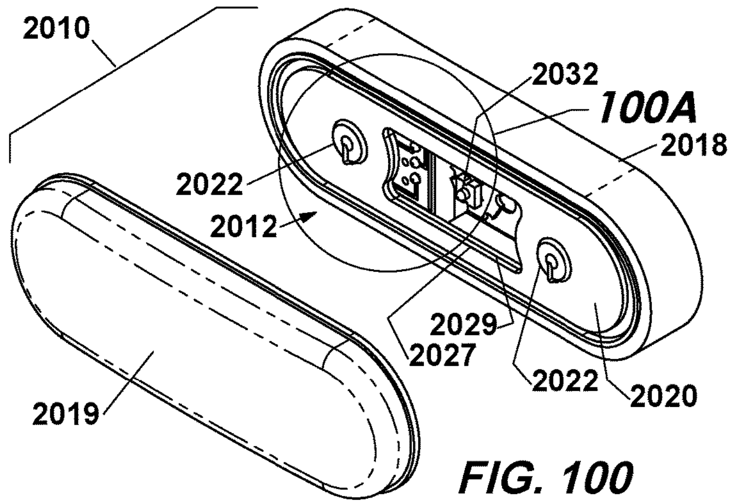

FIG. 100

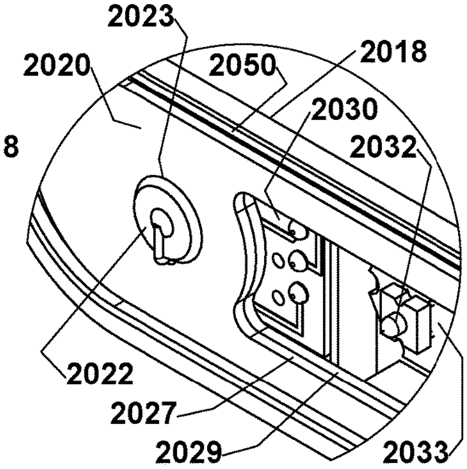

FIG. 100A

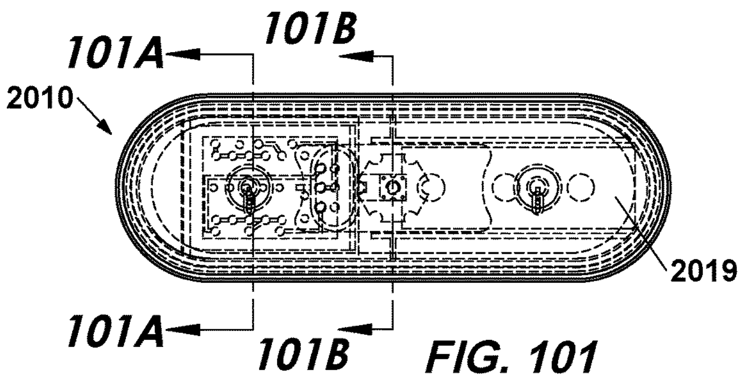

FIG. 101

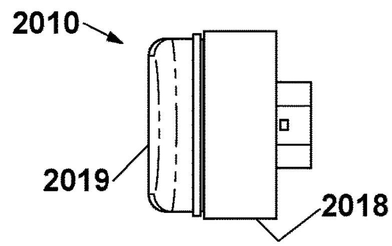

FIG. 102

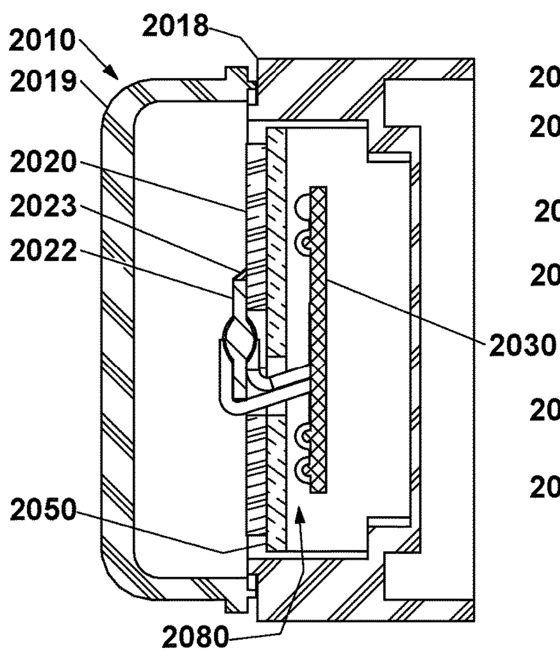

FIG. 101A

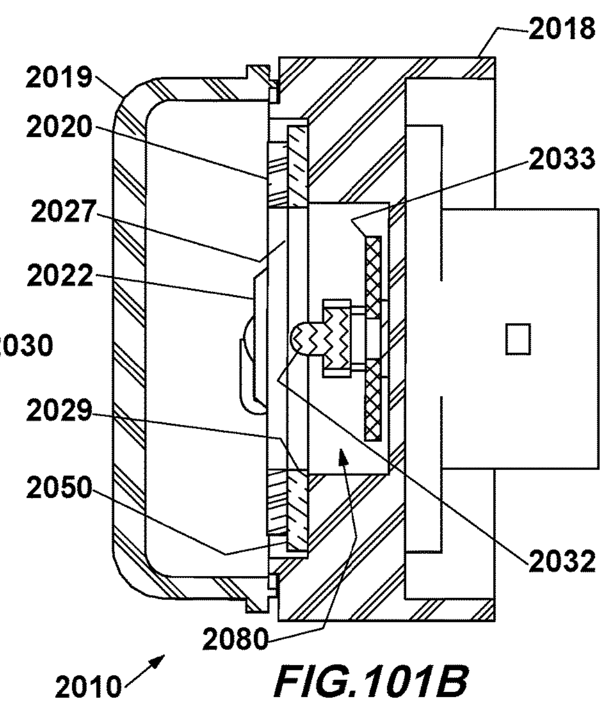

FIG.101B

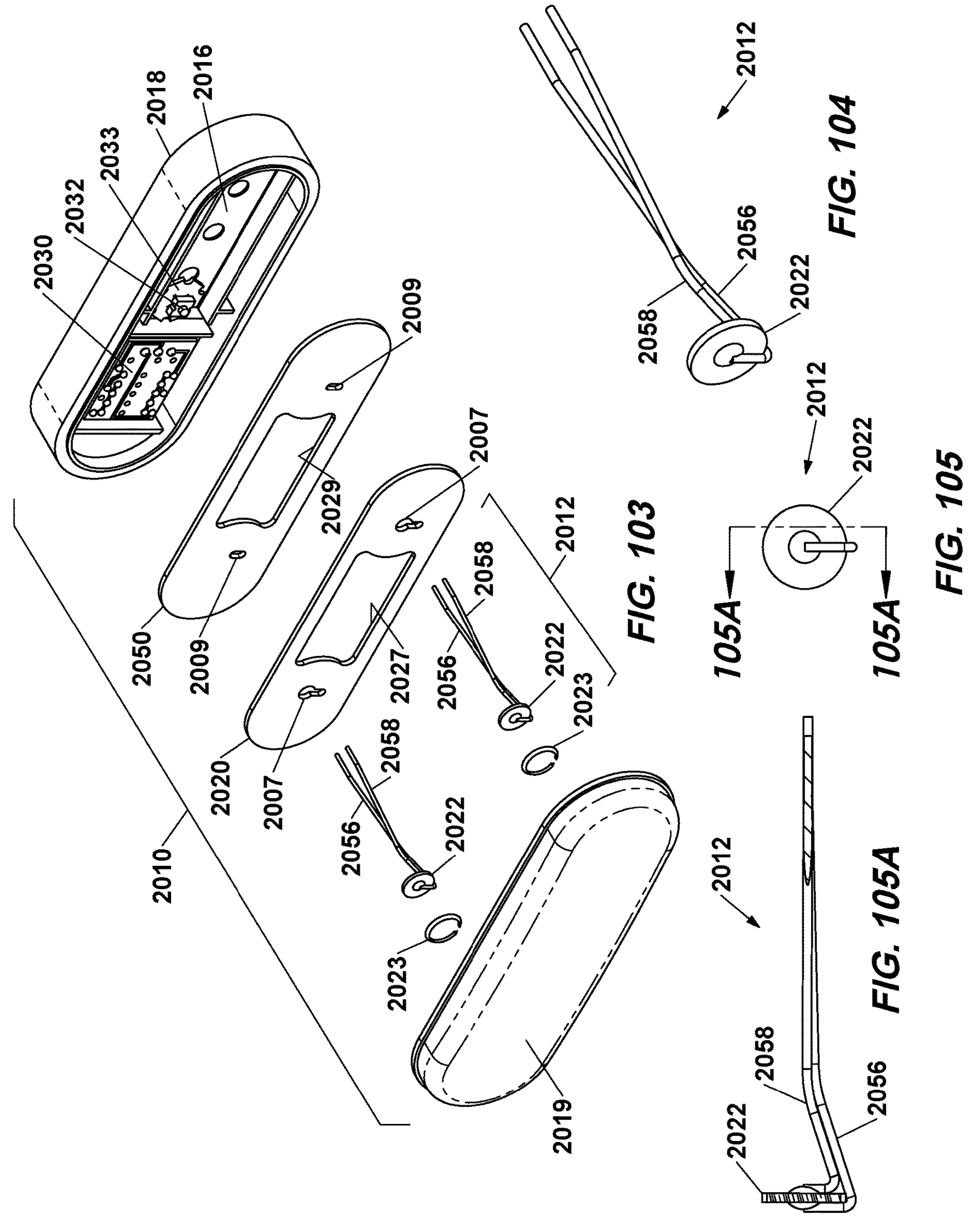

FIG. 103

FIG. 104

FIG. 105

FIG. 105A

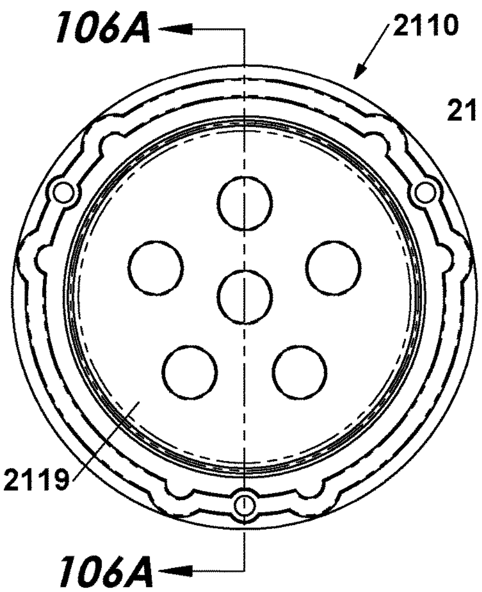

FIG. 106

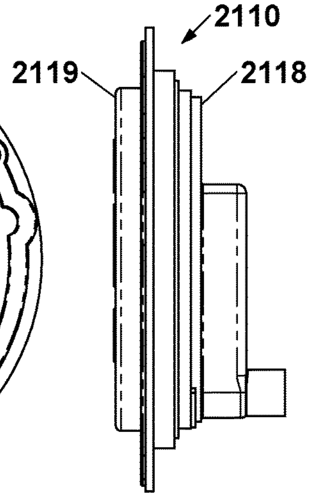

FIG. 107

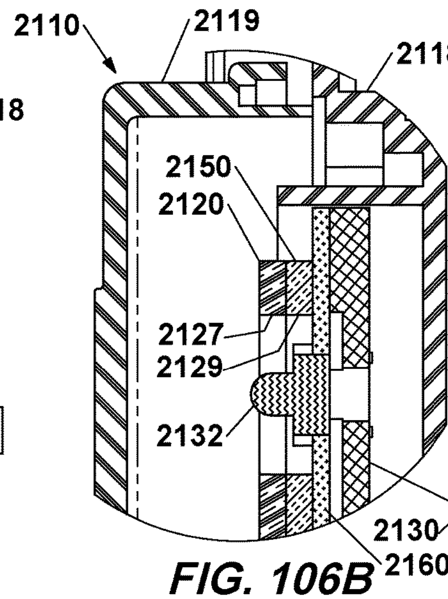

FIG. 106B

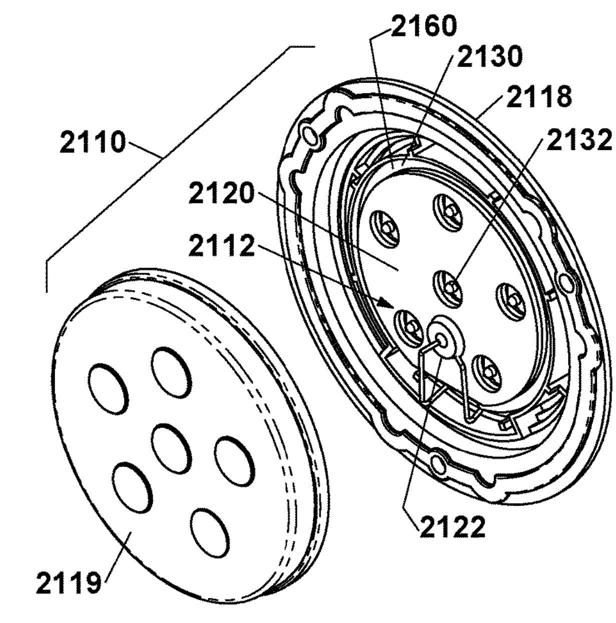

FIG. 108

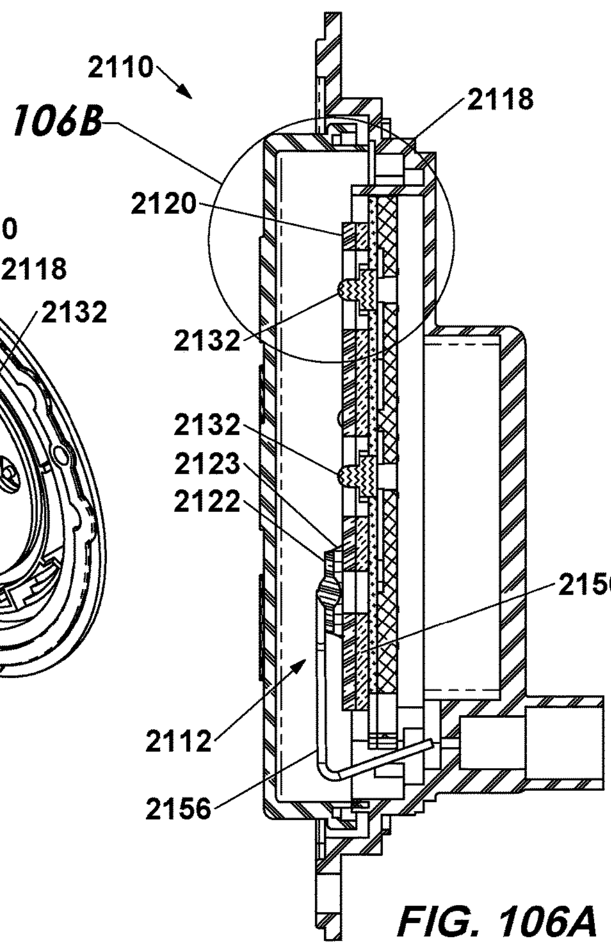

FIG. 106A

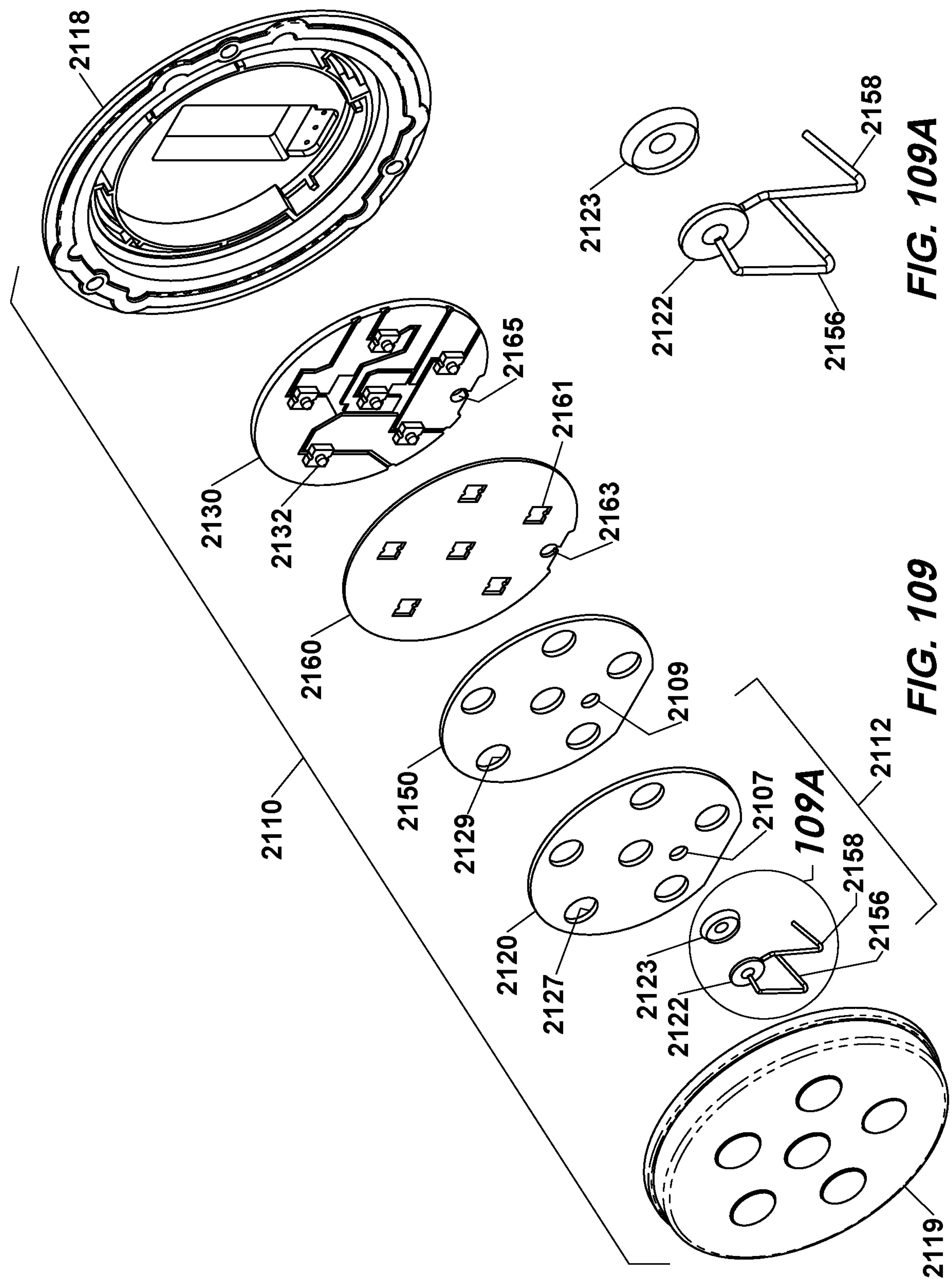

FIG. 109

FIG. 109A

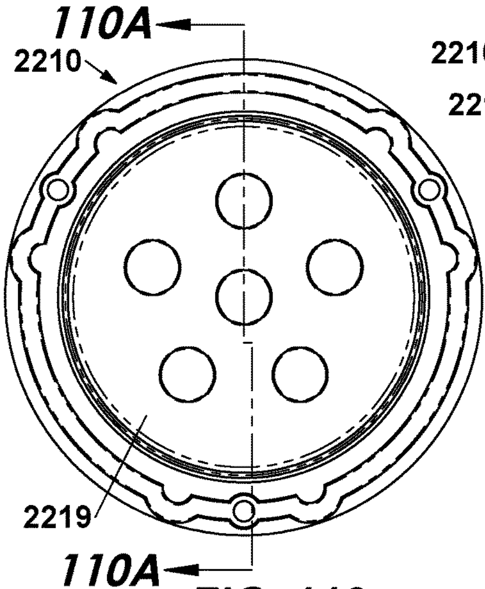

FIG. 110

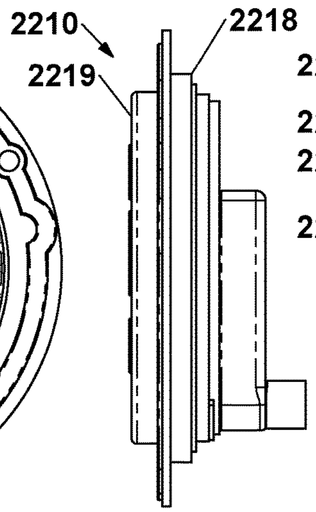

FIG. 111

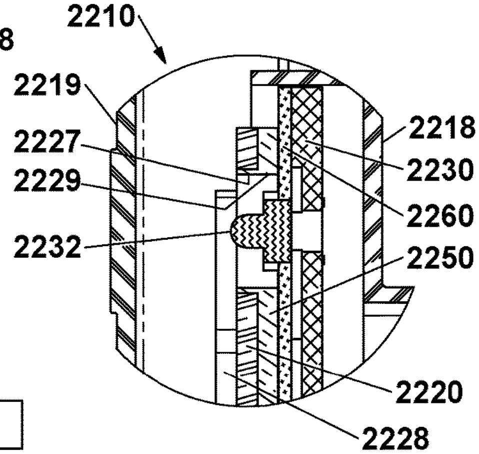

FIG. 110C

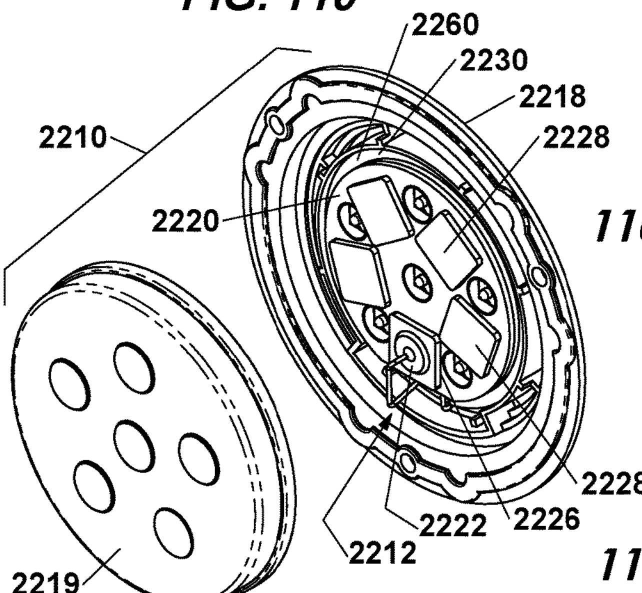

FIG. 112

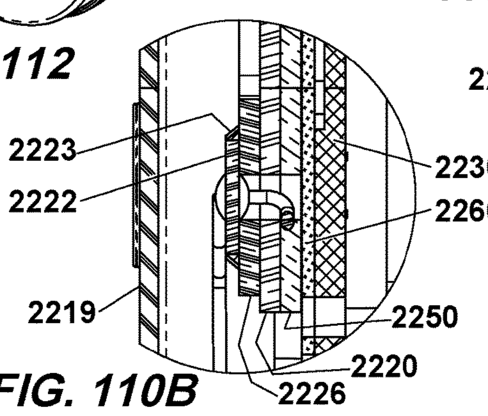

FIG. 110B

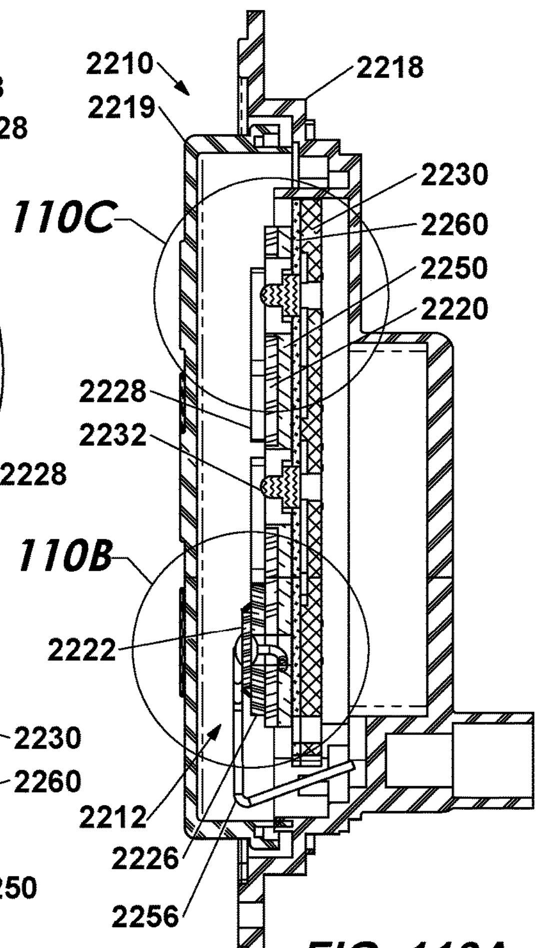

FIG. 110A

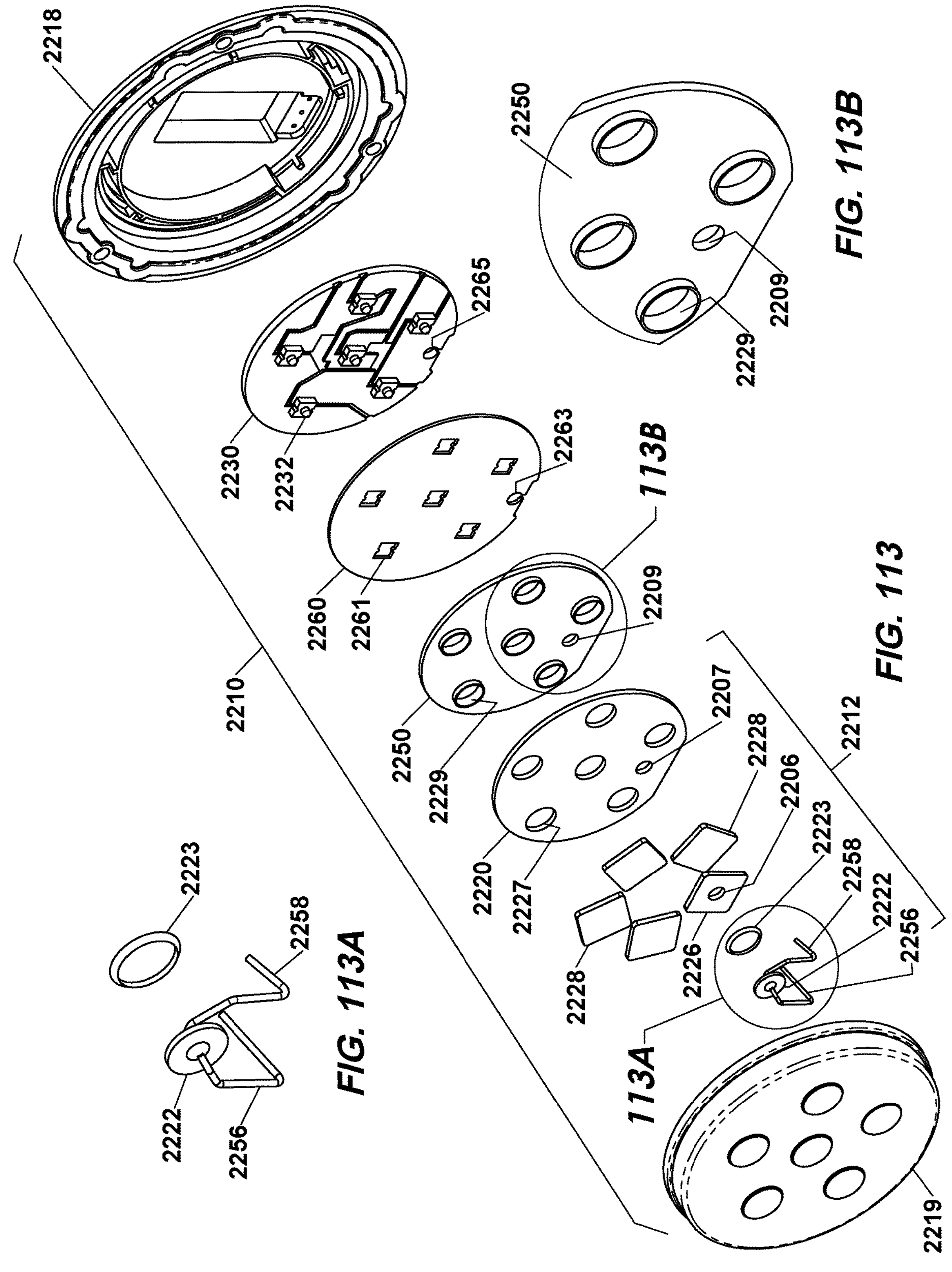

FIG. 113

FIG. 113A

FIG. 113B

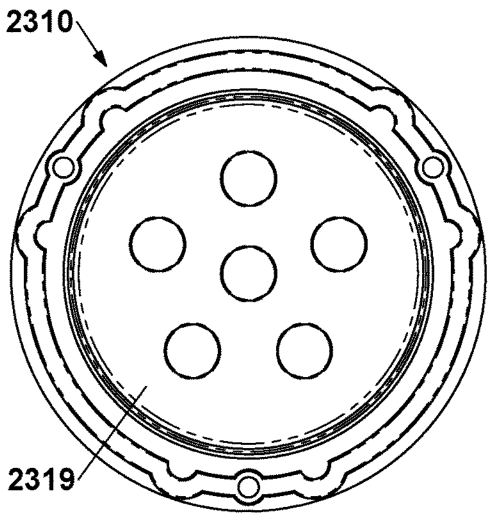

FIG. 114

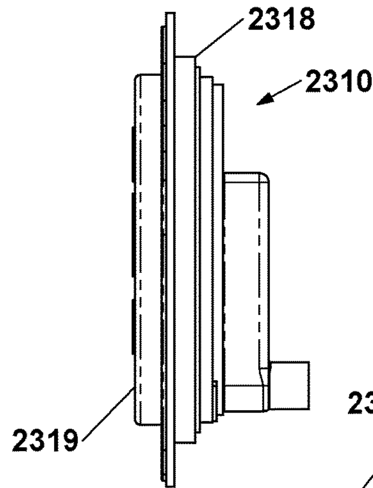

FIG. 115

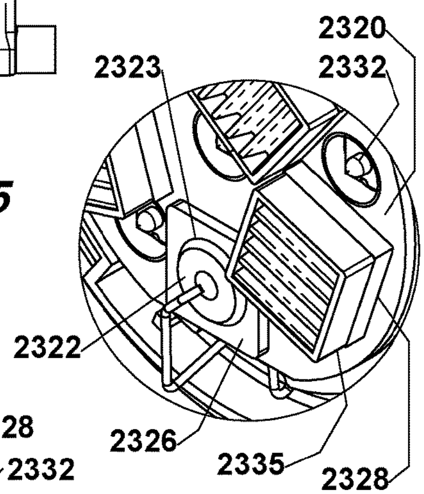

FIG. 116A

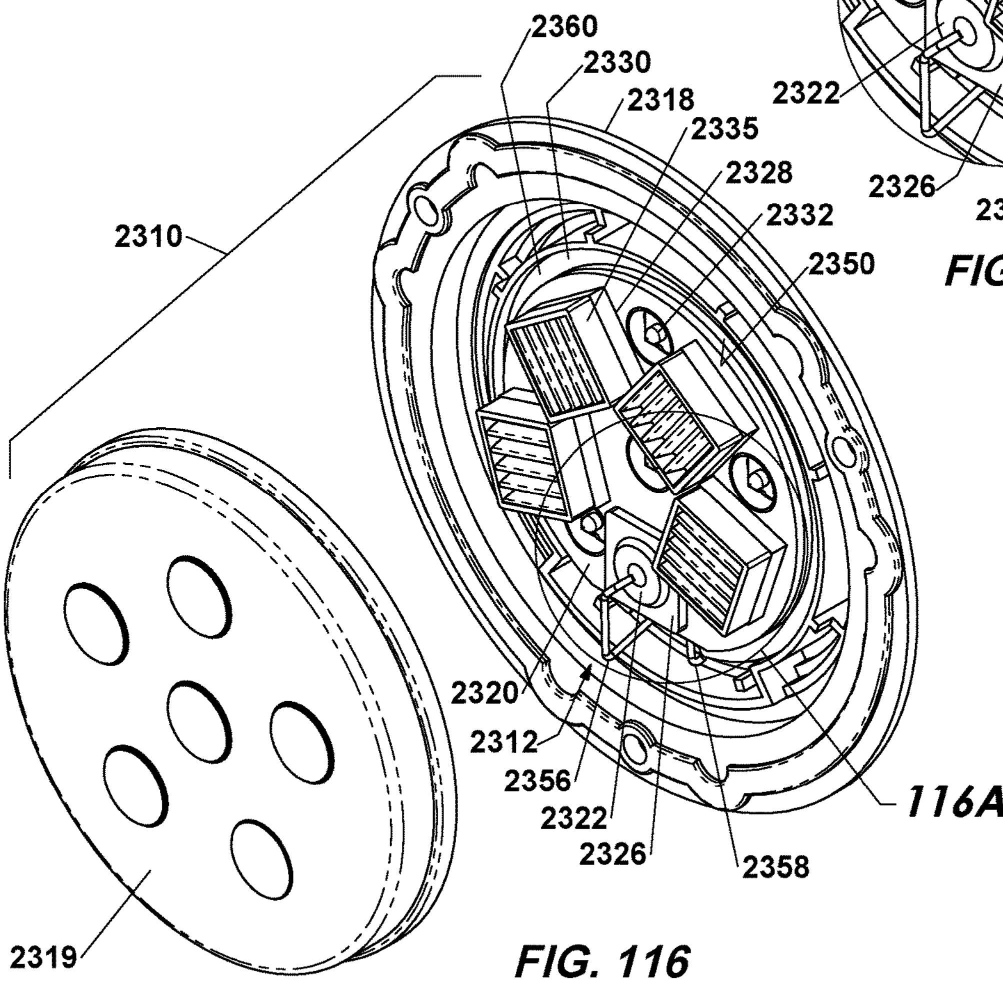

FIG. 116

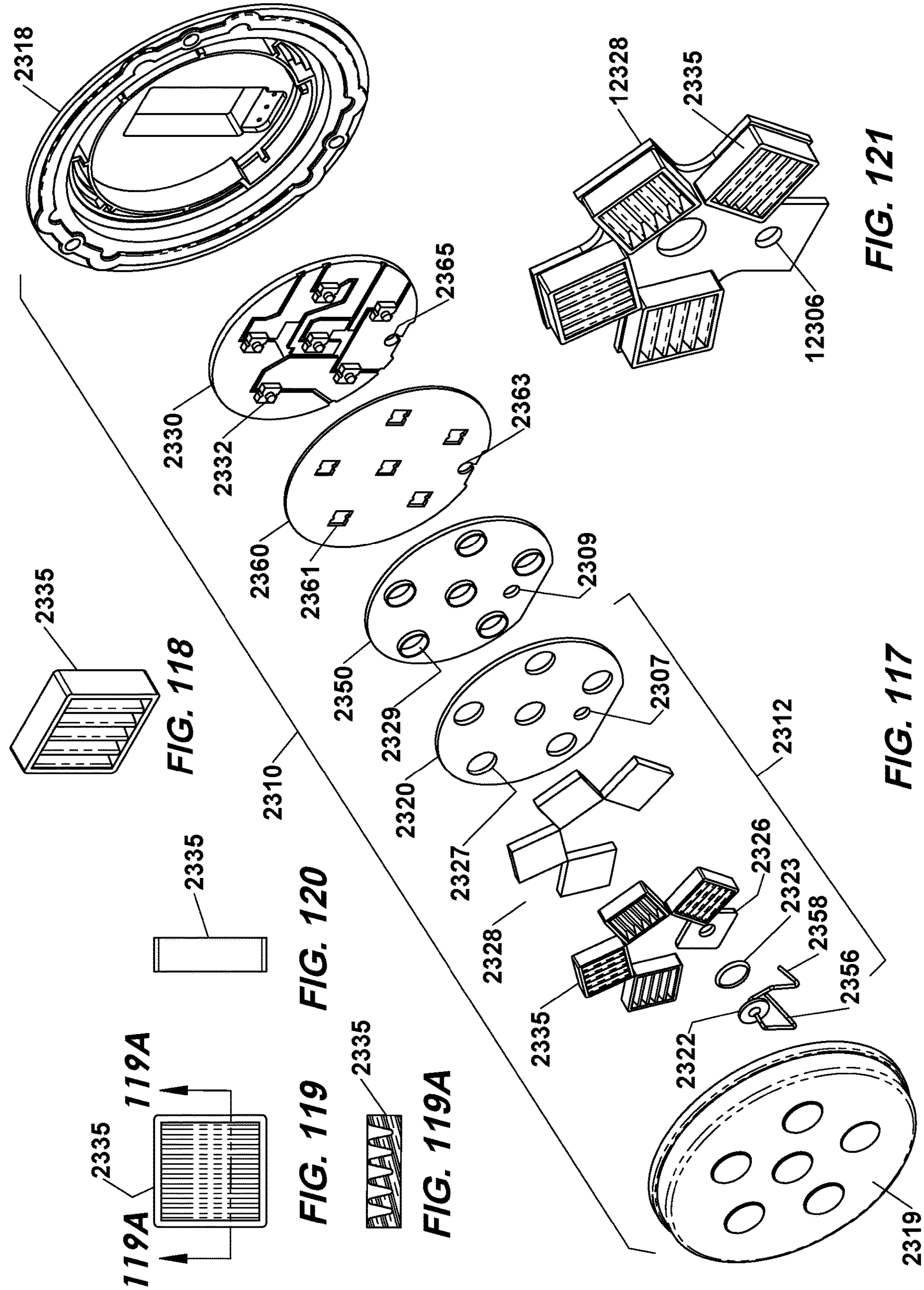

FIG. 117

FIG. 118

FIG. 119

FIG. 119A

FIG. 120

FIG. 121

40/47

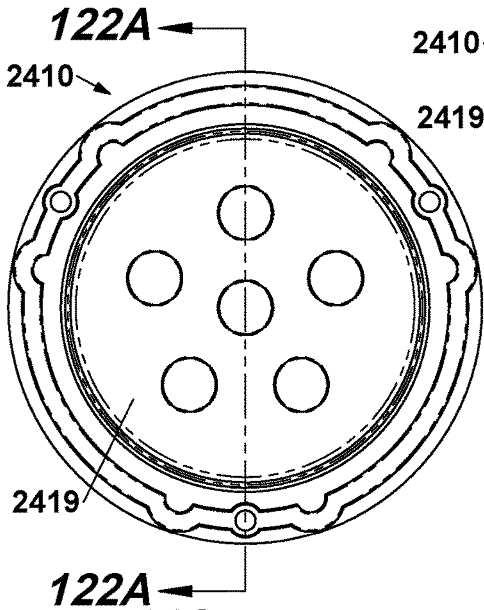

FIG. 122

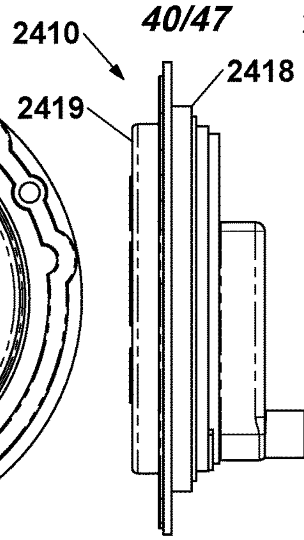

FIG. 123

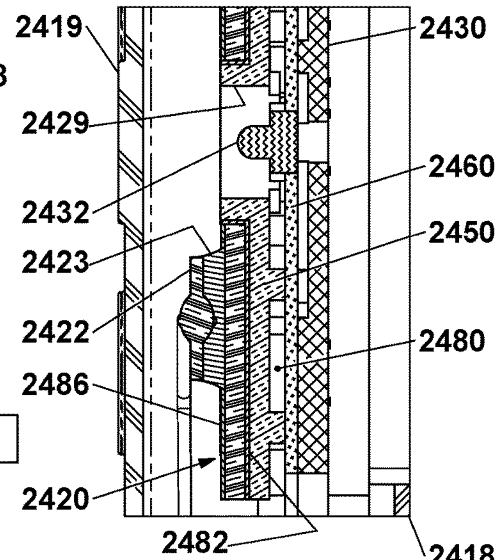

FIG. 122B

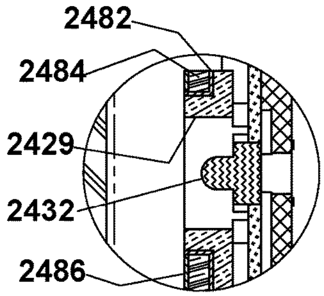

FIG. 122C

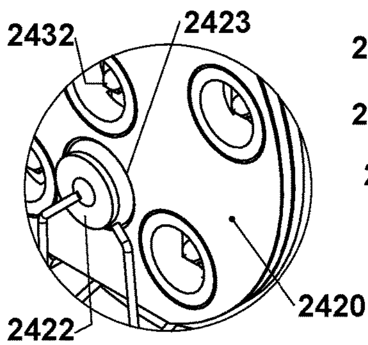

FIG. 124A

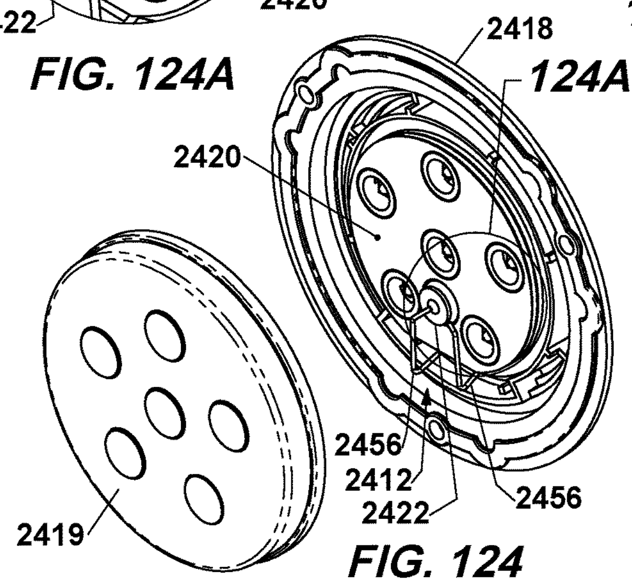

FIG. 124

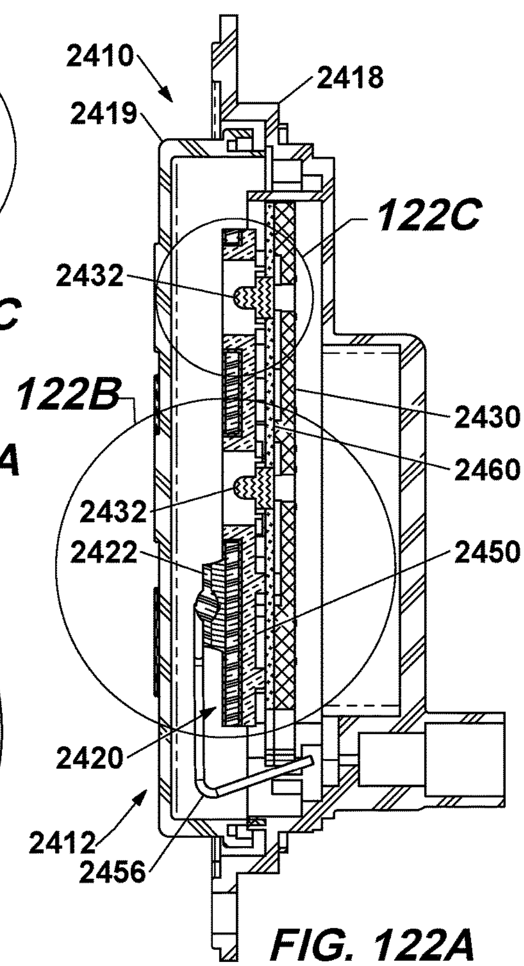

FIG. 122A

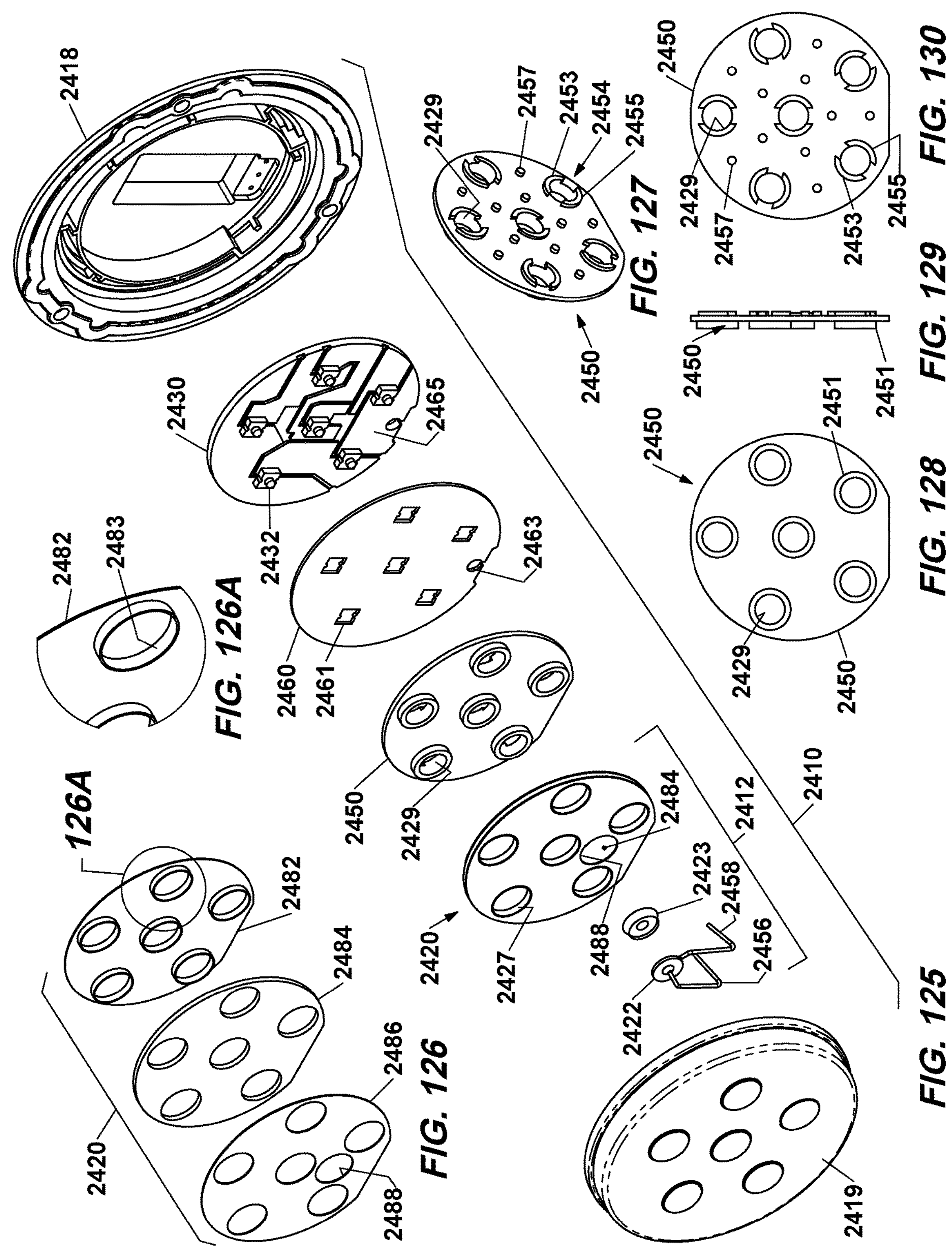

FIG. 125

FIG. 126

FIG. 126A

FIG. 127

FIG. 128

FIG. 129

FIG. 130

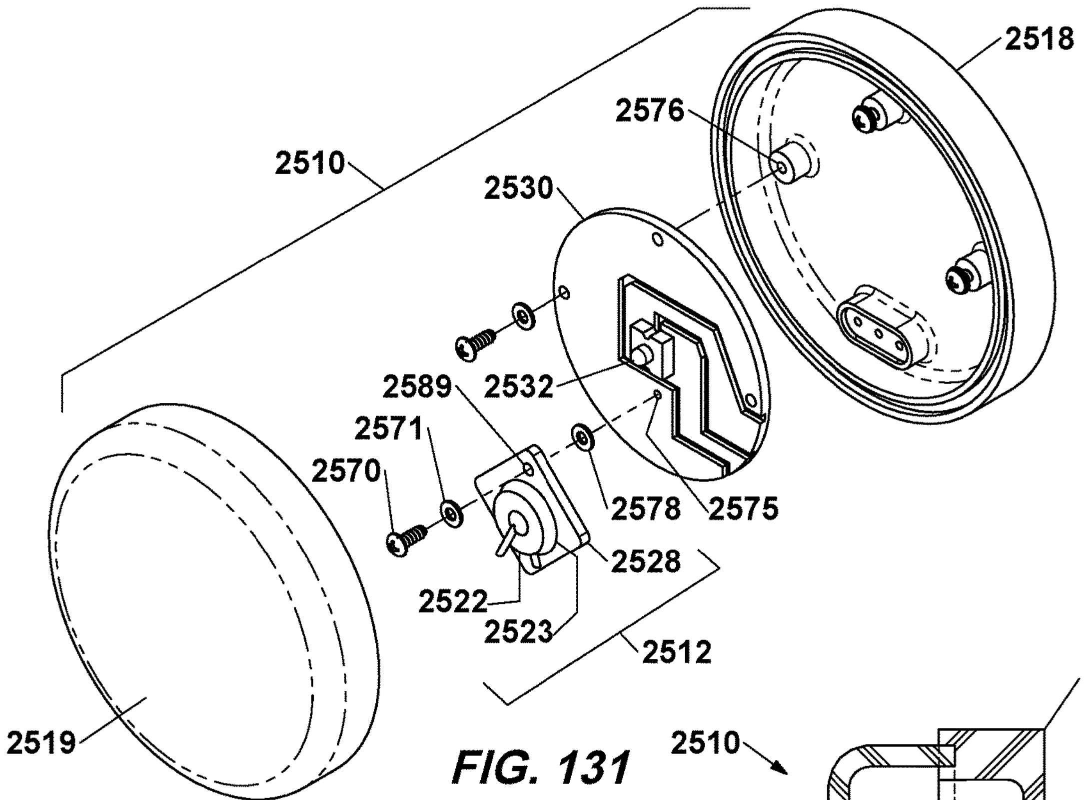

FIG. 131

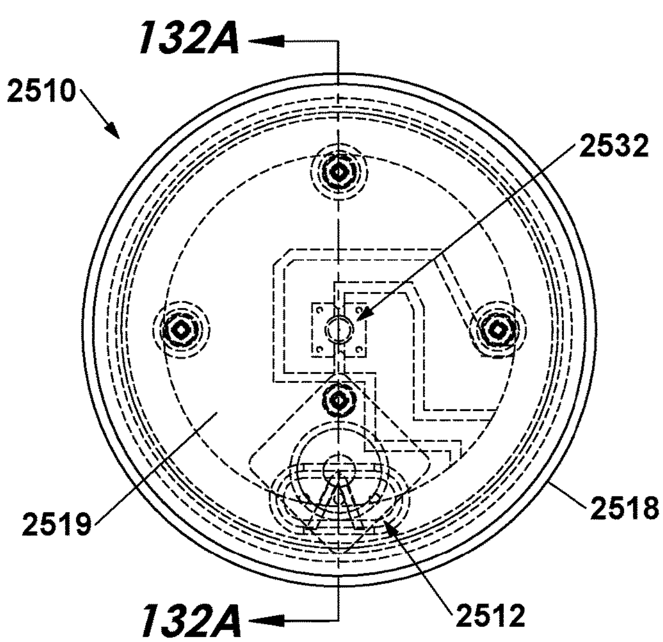

FIG. 132

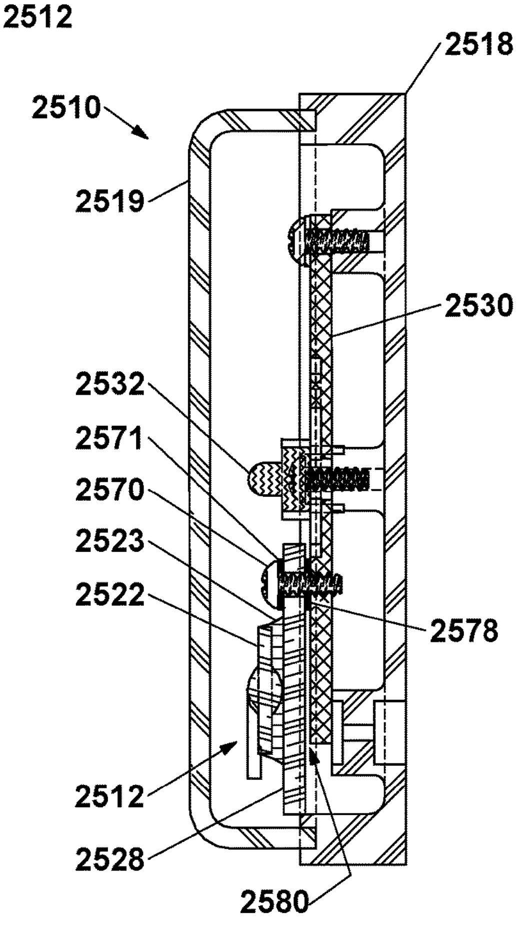

FIG. 132A

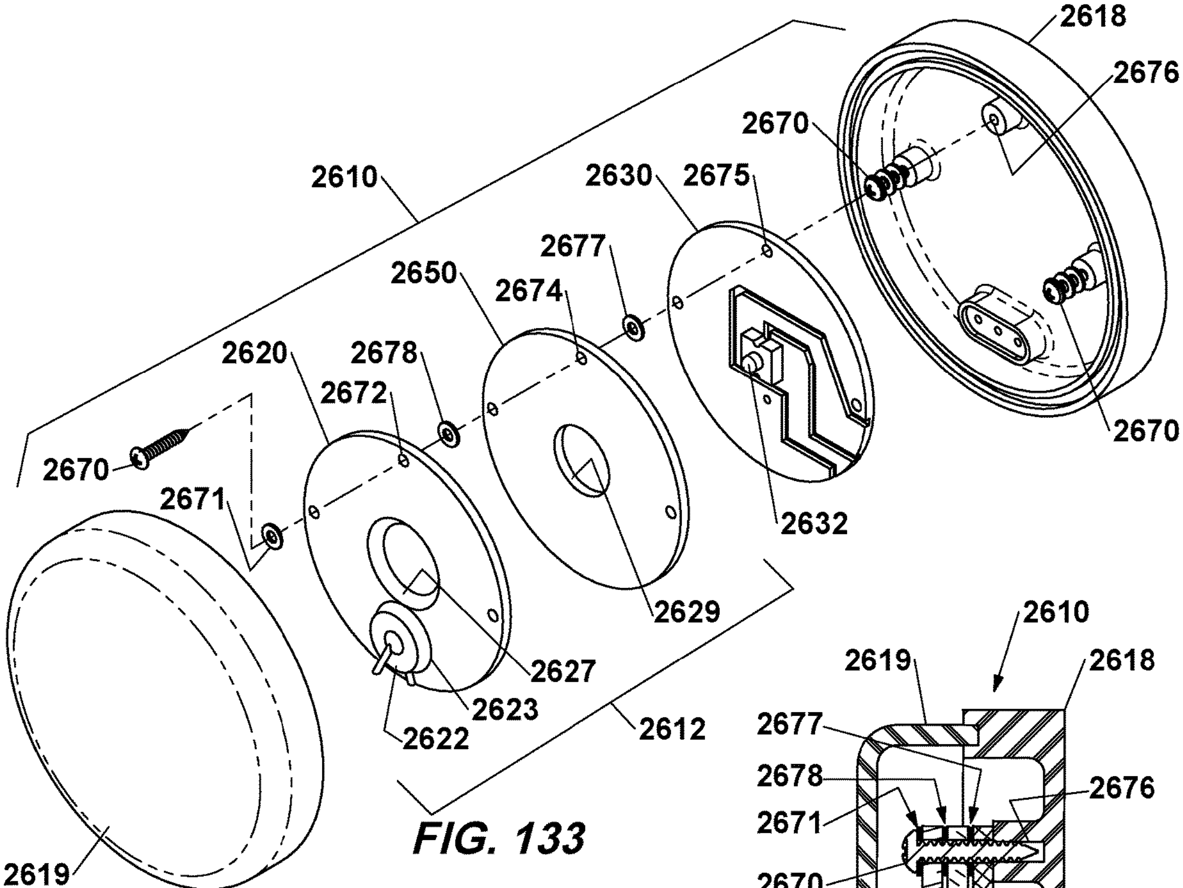

FIG. 133

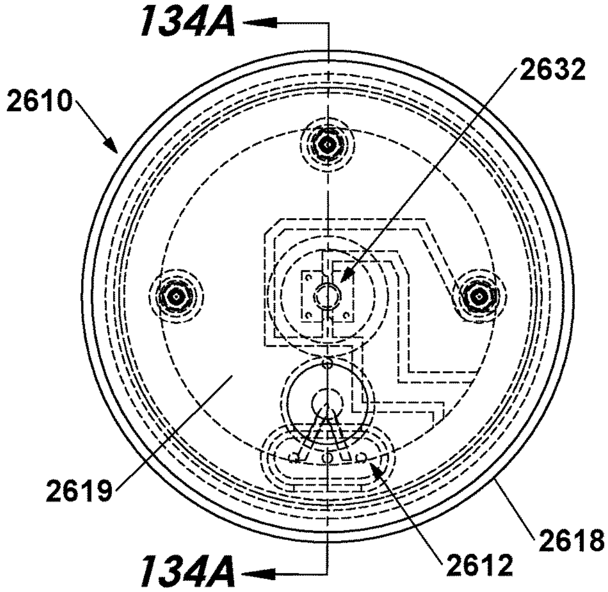

FIG. 134

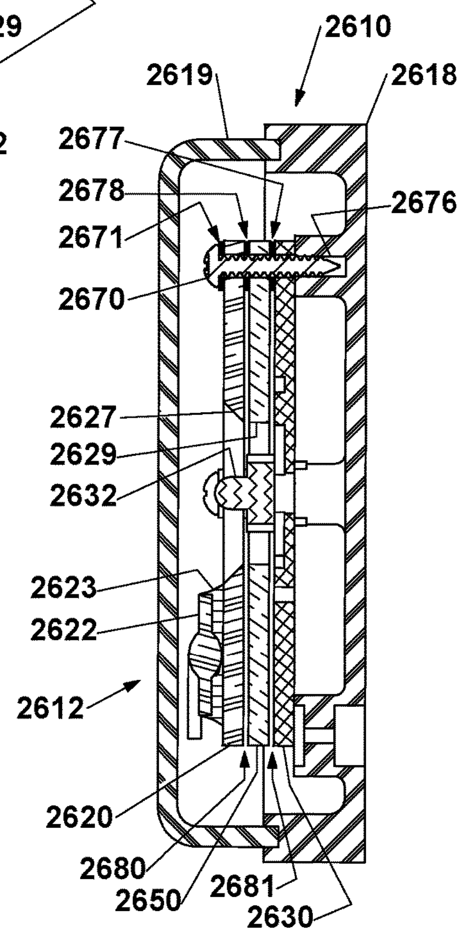

FIG. 134A

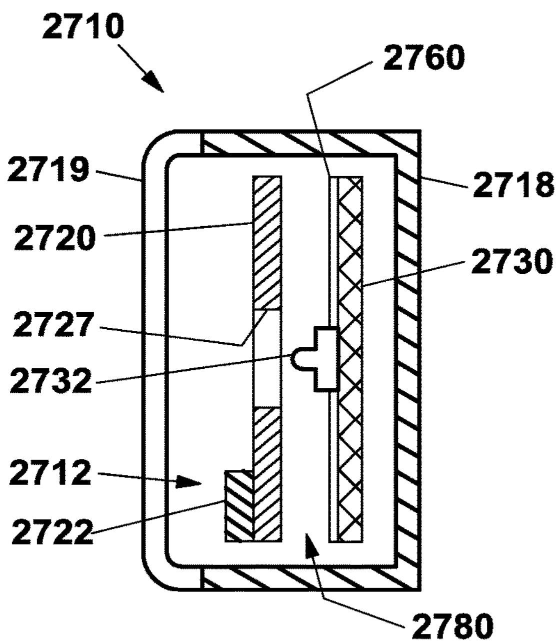

FIG. 135

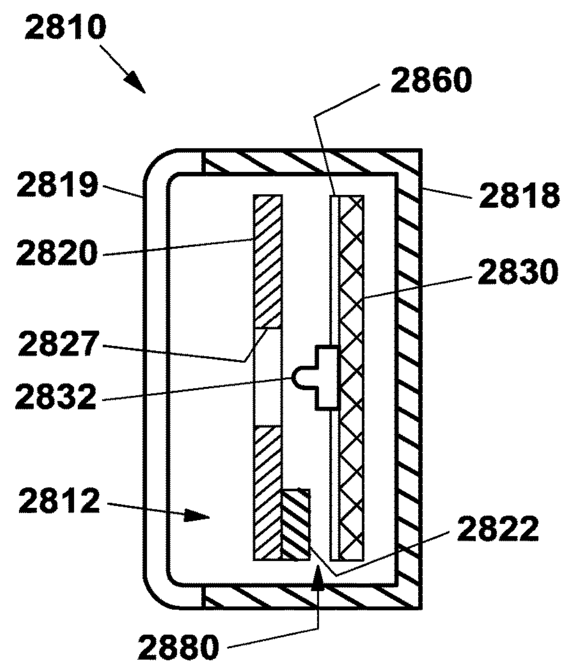

FIG. 136

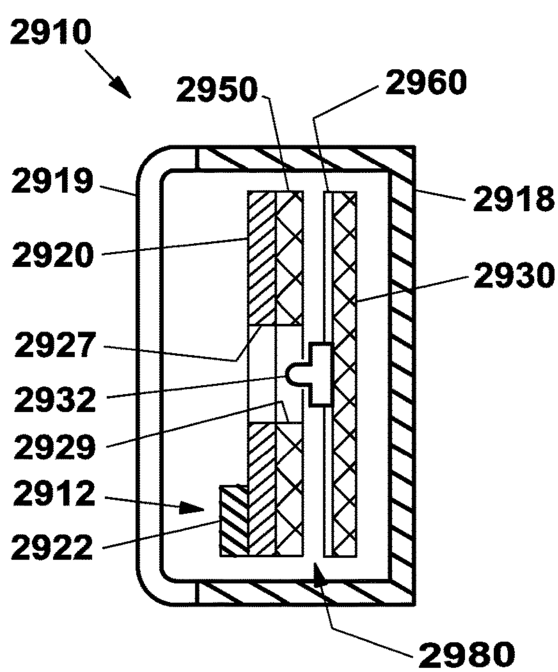

FIG. 137

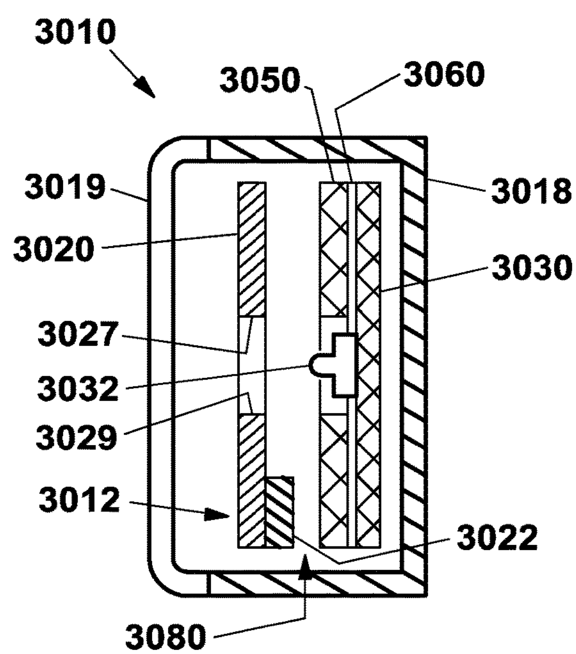

FIG. 138

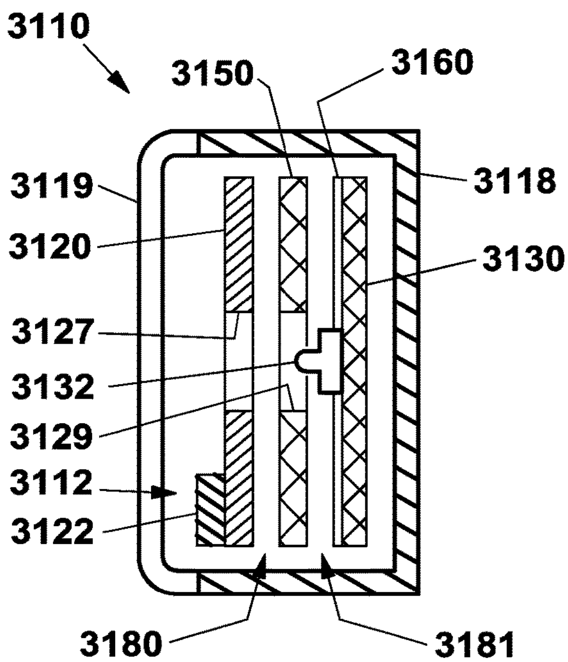

FIG. 139

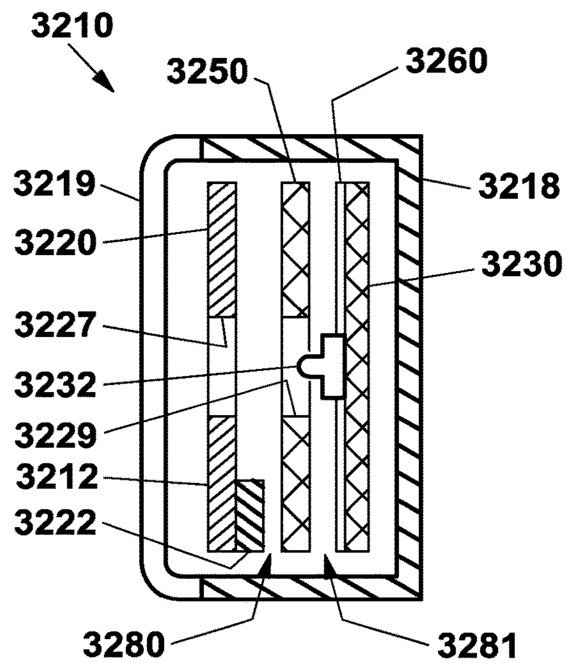

FIG. 140

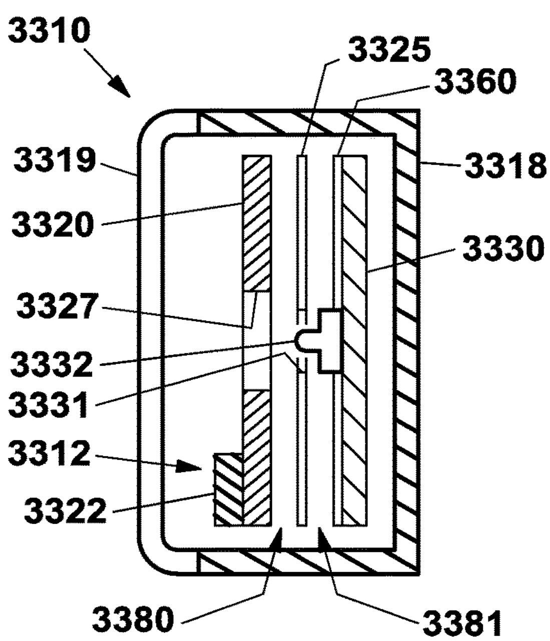

FIG. 141

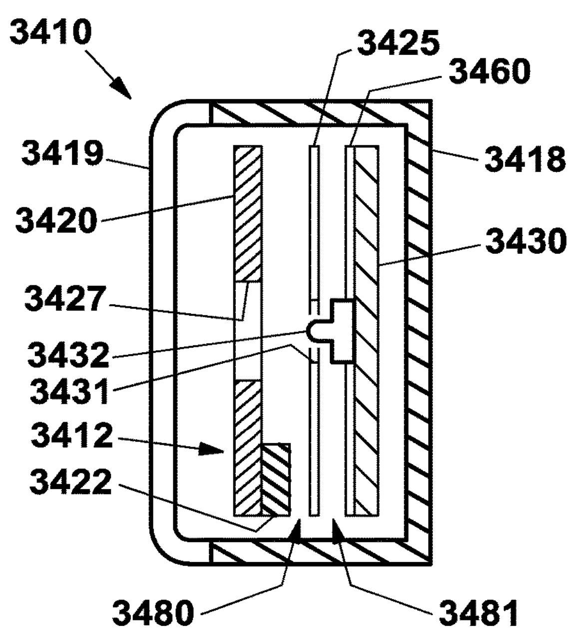

FIG. 142

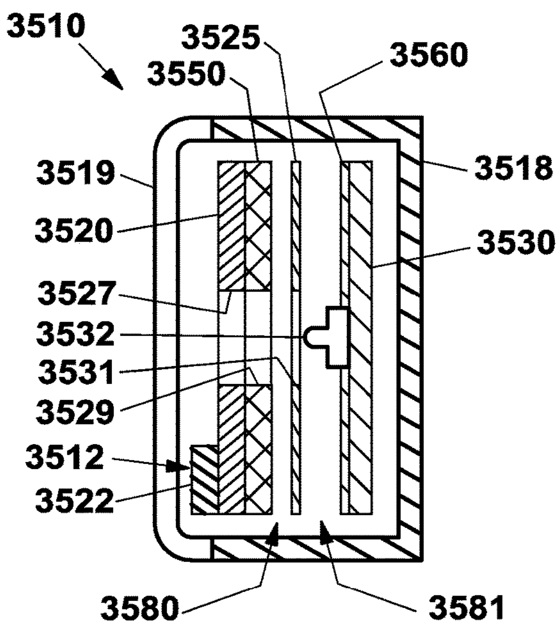

FIG. 143

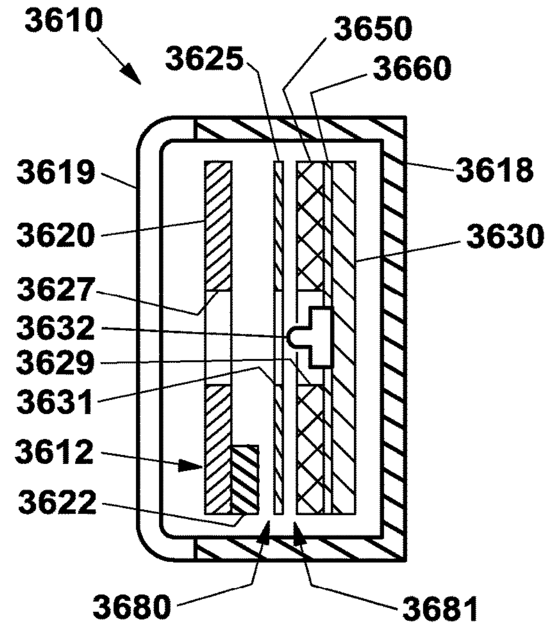

FIG. 144

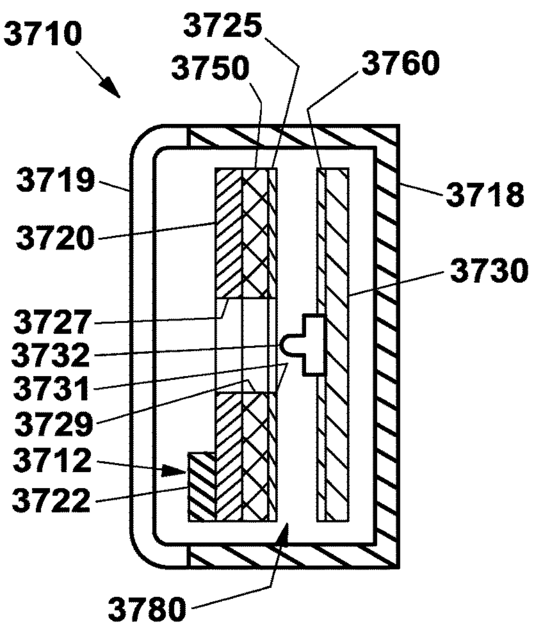

FIG. 145

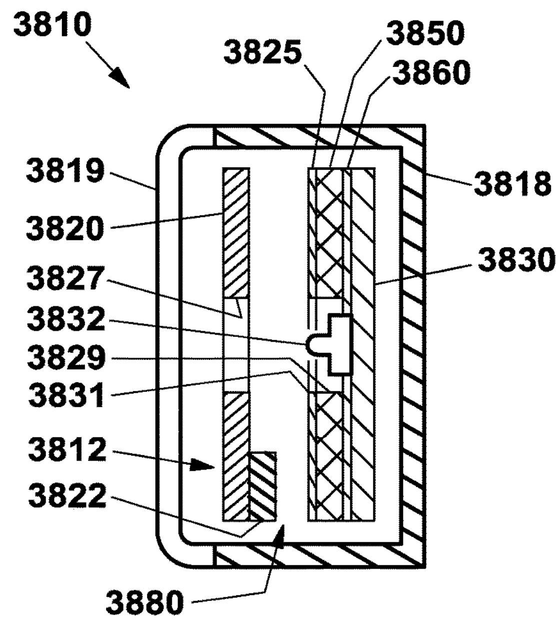

FIG. 146

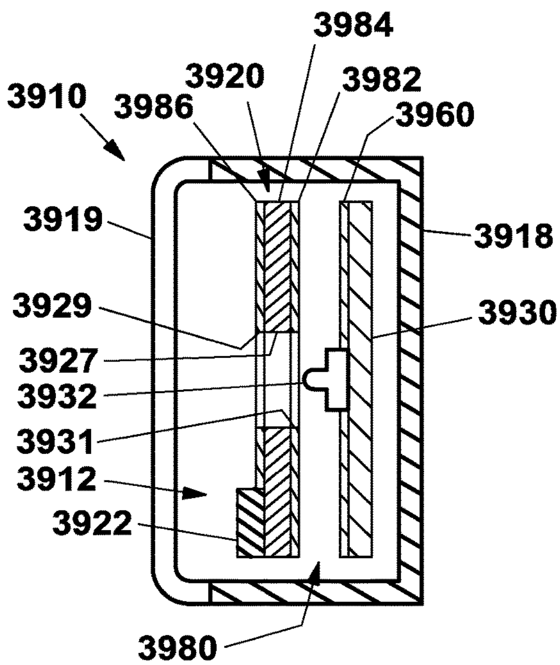

FIG. 147

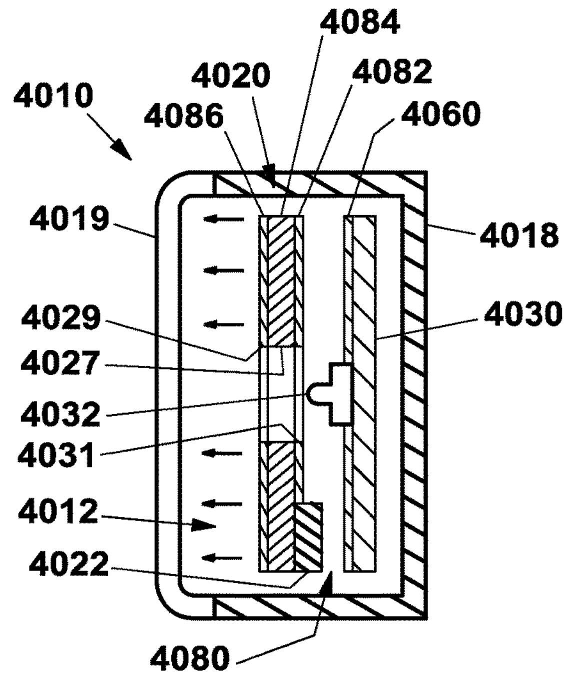

FIG. 148

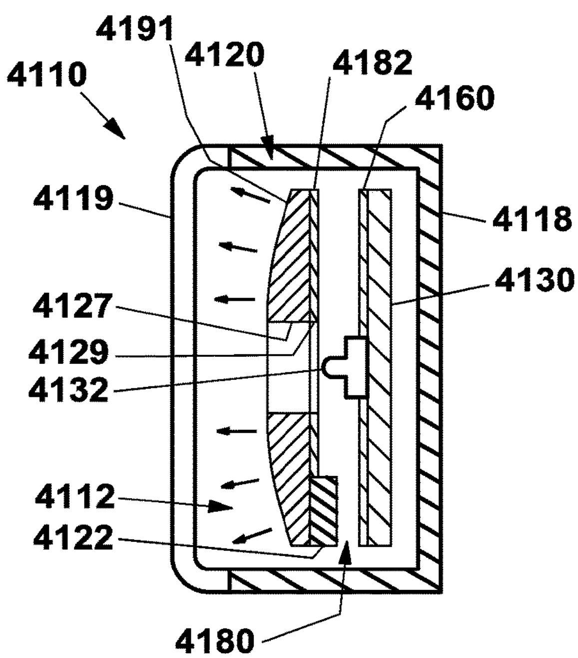

FIG. 149

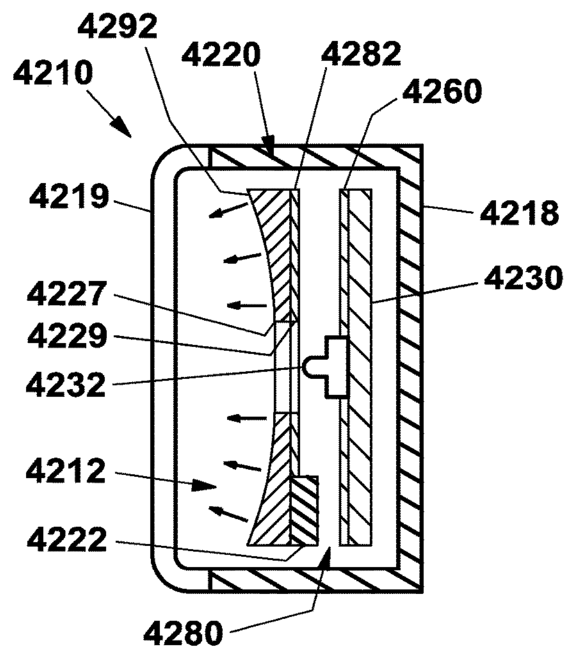

FIG. 150

HEAT SOURCE FOR VEHICLE ILLUMINATION ASSEMBLY AND METHOD

RELATED PATENT DATA

This patent application claims priority to U.S. Provisional Patent Application Ser. No. 62/531,441, which was filed Jul. 12, 2017, entitled "Heat Source for Vehicle Illumination Assembly and Method" and which is hereby incorporated by reference; this patent application also claims priority to U.S. Provisional Patent Application Ser. No. 62/597,028, which was filed Dec. 11, 2017, entitled, "Heat Source for Vehicle Illumination Assembly and Method" and which is hereby incorporated by reference; lastly, this patent application also claims priority to U.S. Provisional Patent Application Ser. No. 62/655,557, which was filed Apr. 10, 2018, entitled, "Heat Source for Vehicle Illumination Assembly and Method" and which is hereby incorporated by reference.

TECHNICAL FIELD

This disclosure pertains to heated housings having light, optical, and/or electromagnetic radiation transmission portions, or lenses for housing one or more of sensors, light sources, or radiation transmission sources and/or barriers for migrating moisture from the housing. More particularly, this disclosure relates to improved apparatus and methods for melting snow and ice and removing condensation from covers or lenses of lights, sensor housings, electromagnetic radiation emitter and detector housings having opaque or optically clear housings and/or lighting systems for mobile and stationary applications.

BACKGROUND OF THE DISCLOSURE

Techniques are known for heating a light transmission portion, or lens of a vehicle illumination system and for moisture permeable membranes provided in light housings. One technique involves providing a heating wire on a back surface of a cover element provided over a vehicle light. However, such a system does not necessarily provide thermal protection for overheating. The recent adoption of light emitting diode (LED) lighting systems, which generate very little heat compared to the historical and long-accepted use of incandescent filament bulb light sources, greatly increases the problem of snow and ice accumulating on the outer lens of such a lighting system, as well as condensate (liquid and frozen solid form) accumulating on the inner lens. Other systems use aluminum and metal heat sinks with Positive Temperature Coefficient (PTC) heaters to deliver heat to a lens of a lighting system in an effort to remove light-occluding precipitation from the front side or back side of the lens. However, modern LED vehicle illumination assemblies can have complex computer-generated reflectors, housings, and lens geometries that have relatively large and uniquely-shaped 3-dimensional lenses and internal volumes relative to many prior incandescent light source designs. Heat transfer largely by convection of the contained atmospheric gas within LED light housings can be slow or insufficient to deliver heat to the light transmissive portion, or lens to adequately and/or efficiently prevent or remove condensation, both frozen and liquid, that is otherwise occluding the lens. When the occlusion of any light transmissive vehicle lens does occur, a variety of potential and ongoing safety compromises and concerns may readily arise with any vehicle. This can significantly increase the likelihood of serious accidents, which can endanger the well-

being and lives of countless numbers of people. Furthermore, this can create an increased risk to vehicles and property of all kinds. Accordingly, further improvements are needed to better prevent removal of ice, snow and condensation and effectively enable removal of ice, snow and condensation from lenses of lights and vehicle illumination systems. This is especially important because of the recent and rapid adoption of LED light sources among nearly all types of vehicles which tend to not generate much heat during light production compared to traditional incandescent lights.

SUMMARY OF THE INVENTION

A heat source for either a vehicle illumination assembly or a sensor housing is provided with improved radiant and convective heat transfer that delivers heat to a light-transmissive portion of a vehicle illumination assembly, housing lens, or sensor housing covering to remove snow, frost, and/or condensation without overheating the lens and/or housing and can optionally migrate moisture from the housing. By heating the lens, accumulation of snow, ice, or vapor is mitigated or eliminated from a surface of the lens, thereby enabling light to transmit through the lens and mitigating light occlusion. Applications include lamps, bulbs, and/or sensors on conveyance devices, including vehicles, boats, planes, and trains, as well as sedentary structures, such as lamp posts, street lights, railroad crossing markers and lights, and airport ground and runway lighting systems.

According to one aspect, a heater is provided for a vehicle illumination assembly. The heater includes a heat transfer body, a heat source, and a mounting base. The heat transfer body has a top surface and a bottom surface. The top surface has a higher emissivity than the bottom surface. The heat source is affixed in heat transfer relation with the heat transfer body. The mounting base is configured to affix the heat transfer body within a housing of a vehicle illumination assembly to provide the top surface of the heat transfer body in radiant heat transfer relation with a light transmissible portion of the vehicle illumination assembly.

According to another aspect, a heater is provided for a vehicle illumination assembly having a heat source and a radiant heat transfer body. The radiant heat transfer body is affixed in heat transfer relation with the heat transfer body and has a top surface with at least one of a concave portion and a convex portion configured to respectively focus and spread radiant energy dissipation from the top surface.

According to yet another aspect, a heat source is provided for a vehicle illumination assembly having a positive temperature coefficient (PTC) heater, a radiant heat dissipating body, and a mounting base. The radiant heat dissipating body has at least one central thermally conductive contact portion configured to mate in thermally conductive relation with the PTC heater and a thin-walled body having a pair of opposed surfaces. The PTC heater is configured to communicate in thermally conductive relation with one of the pair of opposed surfaces. The mounting base communicates with a contact portion of the heat dissipating body and is configured to affix the heat source within a vehicle illumination assembly.

According to even another aspect, a method is provided for heating a light transmissive portion of a vehicle illumination assembly. The method includes: providing a ceramic heat dissipating body in thermally conductive relation with a PTC heater and a power supply; energizing the PTC heater with the power supply to heat the ceramic heat dissipating body; and transmitting heat through radiation from the ceramic radiating heat dissipating body to the light transmissive portion.

According to yet even another aspect, a vehicle electronics system is provided having an electronics device, a package, a radiant heat transfer body, and a heat source. The package has at least one wall configured to encapsulate the electronics device within a cavity and a light transmissible portion. The radiant heat transfer body and a heat source are provided in the package and configured to mitigate condensate occlusion from the light transmissible portion.

According to an even further aspect, an environmentally controlled vehicle electronics package is provided having a container, a radiant heat transfer body, and a heat source. The container has a wall forming an enclosure configured to encase an electronic component and a light transmissible portion. The radiant heat transfer body and the heat source are provided in the package. The heat source communicates with the body and is configured to mitigate condensate occlusion from the light transmissible portion

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the disclosure are described below with reference to the following accompanying drawings.

FIG. **1** is a perspective view of a tail light assembly with the lens removed showing a heat source with a ceramic radiant heat dissipative body and a PTC heater.

FIG. **2** is an exploded perspective view from above of the heat source and tail light assembly of FIG. **1** according to another aspect.

FIG. **3** is a front view of the assembled tail light assembly of FIGS. **1-2**.

FIG. **4** is a cross-sectional view of the heat source taken along line **4-4** of FIG. **3**.

FIG. **5** is a perspective view of an alternative construction heat source for use in the tail light assembly of FIGS. **1** and **2**.

FIG. **6** is a perspective view of another alternative construction heat source for use in the tail light assembly of FIGS. **1** and **2**.

FIG. **7** is a perspective view of a head light assembly with a heat source having an elongate ceramic radiant heat dissipative body with a cylindrical ceramic portion containing a PTC heater.

FIG. **8** is a front perspective view from above of the heat source of FIG. **7**.

FIG. **9** is a rear perspective view from above of the heat source of FIG. **7**.

FIG. **10** is a front exploded perspective view from above of the heat source of FIGS. **8-9**.

FIG. **11** is a left side view of the heat source of FIGS. **8-10**.

FIG. **12** is a front end view of the heat source of FIGS. **8-11**.

FIG. **13** is a vertical sectional view taken along line **13-13** of FIG. **12**.

FIG. **14** is a front perspective view of the PTC heater of the heat source of FIGS. **8-13**.

FIG. **15** is a rear perspective view of the PTC heater of FIG. **14**.

FIG. **16** is a right side view of the PTC heater of FIGS. **14-15**.

FIG. **17** is enlarged side view taken from encircled region **17** of FIG. **16**.

FIG. **18** is an exploded front perspective view of the PTC heater of FIGS. **14-17**.

FIG. **19** is a front perspective view of yet another heat source having a ceramic radiant heat dissipative body with an elongated cylindrical ceramic radiant heat dissipative body with a hemispherical head and an internal PTC heater.

FIG. **20** is a rear perspective view of the heat source of FIG. **19**.

FIG. **21** is an exploded front perspective view of the heat source of FIGS. **19-20**.

FIG. **22** is a left side view of the heat source of FIGS. **19-21**.

FIG. **23** is a front view of the heat source of FIGS. **19-22**.

FIG. **24** is a vertical sectional view of the heat source taken along line **24-24** of FIG. **23**.

FIG. **25** is a front perspective view of yet even another heat source having a longitudinally finned ceramic radiant heat dissipative body with an elongated cylindrical ceramic radiant heat dissipative body with a hemispherical head and an internal PTC heater.

FIG. **26** is a rear perspective view of the heat source of FIG. **25**.

FIG. **27** is a front perspective view of even yet another heat source having a circumferentially finned ceramic radiant heat dissipative body with an elongated cylindrical ceramic radiant heat dissipative body with a hemispherical head and an internal PTC heater.

FIG. **28** is a rear perspective view of the heat source of FIG. **27**.

FIG. **29** is a prior art perspective view from above of a headlight assembly with the lens removed showing an LED light source carried on a central support structure with a housing.

FIG. **30** is a perspective view from above of a headlight assembly with the lens removed showing an LED light source carried on a central support structure, or post within a housing and having even another heat source finned ceramic radiant heat dissipative body with a PTC heater.

FIG. **31** is a front right perspective view from above of the heat source of FIG. **30**.

FIG. **32** is a rear right perspective view from above of the heat source of FIG. **30**.

FIG. **33** is a front elevational view of the heat source of FIG. **30**.

FIG. **34** is a vertical sectional view of the heat source of FIG. **30** taken along line **34-34** of FIG. **33**.

FIG. **35** is a right front exploded perspective view from above of the heat source of FIG. **30**.

FIG. **36** is a right rear exploded perspective view from above of the heat source of FIG. **30**.

FIG. **37** is a plan view from above of the headlight assembly of FIG. **30**.

FIG. **38** is a vertical sectional view of the headlight assembly and heat source taken along line **38-38** of FIG. **37**.

FIG. **39** is a right elevational side view of the headlight assembly of FIG. **30**

FIG. **40** is a vertical sectional view of the headlight assembly and heat source taken along line **40-40** of FIG. **39**.

FIG. **41** is a front perspective view from above of three alternative heat sources for use in a light assembly.

FIGS. **42**A-**1** are respective front, side and sectional views taken along lines **42**A-**42**A, **42**B-**42**B, **42**C-**42**C, **42**D-**42**D, **42**E-**42**E, **42**F-**42**F, **42**G-**42**G, **42**H-**42**H, and **42**I-**42**I for each of the three heat sources of FIG. **41**.

FIG. **43** is an exploded rear perspective view from above of the third heat source of FIG. **40** with Detail A of encircled region A showing in enlarged view a ceramic head of the heat source.

FIG. **43**A is a detailed perspective view of the ceramic head of FIG. **43**.

FIG. **44** is an exploded front perspective view from above of the third heat source of FIG. **40** with Detail B of encircled region B showing in enlarged view a ceramic head of the heat source.

FIG. **44**A is a detailed perspective view of the ceramic head of FIG. **44**.

FIG. **45** is a front perspective view from above of a headlamp assembly with the front light transmissive lens portion removed showing a heat source and a pair of moisture permeable membrane ports provided in the housing to mitigate condensate occlusion of the light transmissive lens portion.

FIG. **46** is a partial exploded view of the headlamp assembly of FIG. **45**.

FIG. **47** is a front perspective view from above of another headlamp assembly with the front light transmissive lens portion removed showing three heat sources, a pair of plug moisture permeable membrane plugs, and a ducted moisture permeable membrane array of ports provided in the housing to mitigate condensate occlusion of the light transmissive lens portion.

FIG. **48** is a plan view from above of the headlamp assembly of FIG. **47** with vertical section A-A further showing the ducted moisture permeable membrane array of ports.

FIG. **48**A is a sectional view taken along line **48**A-**48**A of FIG. **48**.

FIG. **49** is a front elevational view of the headlamp assembly of FIG. **48**.

FIG. **50** is a right side view of the headlamp assembly of FIG. **49**.

FIG. **51** is an exploded perspective view from above of the headlamp assembly of FIGS. **47-50**.

FIG. **52** is a front component perspective view from above of one moisture permeable membrane plug of FIGS. **47-51**.

FIG. **53** is a front exploded perspective view of the plug of FIG. **52**.

FIG. **54** is a front elevational view of the plug of FIGS. **52-53**.

FIG. **54**A is a sectional view taken along line **54**A-**54**A of FIG. **54**.

FIG. **55** is a rear perspective view from above showing an alternate moisture permeable membrane plug for using in a light housing, such as a headlight, tail light, or marker light housing.

FIG. **56** is a front perspective view from above of the plug of FIG. **55**.

FIG. **57** is a left side elevational view of the plug of FIGS. **55-56**.

FIG. **58** is a front end view of the plug of FIGS. **55-57**.

FIG. **59** is a vertical sectional view of the plug of FIGS. **55-58** taken along line **59-59** of FIG. **57**.

FIG. **60** is a vertical sectional view of the plug of FIGS. **55-59** taken along the line **60-60** of FIG. **57**.

FIG. **61** is front exploded perspective view from above of a headlamp similar to that depicted in FIG. **30**

FIG. **62** is a front exploded perspective view from above of a modified headlamp similar to that depicted in FIG. **61** with the addition of a light transmissible inner lens divider that creates a smaller gas volume behind the light transmissible lens that is heated with a heat source.

FIG. **63** is a plan view from above of the headlight assembly of FIG. **30**.

FIG. **64** is a vertical sectional view of the headlight assembly and heat source taken along line **64-64** of FIG. **65**.

FIG. **65** is a right elevational side view of the headlight assembly of FIG. **30**.

FIG. **66** is a vertical sectional view of the headlight assembly and heat source taken along line **66-66** of FIG. **63**.

FIG. **67** is a front exploded perspective view from above of even another headlight assembly and heat source.

FIG. **68** is a rear perspective component view from above of the heat source of FIG. **67**.

FIG. **69** is a plan view from above of the heat source of FIG. **68**.

FIG. **69**A is vertical sectional view of the heat source taken along line **69**A-**69**A of FIG. **69**.

FIG. **70** is plan view from above of the headlight assembly and heat source of FIGS. **67-69**A.

FIG. **71** is a vertical sectional view of the headlight assembly and heat source taken along line **71-71** of FIG. **70**.

FIG. **71**A is an enlarge sectional view taken from the encircled region **71**A of FIG. **71**.

FIG. **71**B is an enlarged sectional view taken along line **71**B-**71**B of FIG. **71**A.

FIG. **72** is a rear perspective view from above of a combination heat source and moisture permeable membrane plug for use in a light housing or light assembly.

FIG. **73** is a rear exploded perspective view from above of the plug of FIG. **72**.

FIG. **74** is a vertical side view of the plug of FIGS. **72-73**.

FIG. **75** is a vertical sectional view of the plug taken along line **75-75** of FIG. **74**.

FIG. **76** is a vertical sectional view of the plug taken along line **76-76** of FIG. **74**.

FIG. **77** is a front exploded perspective view from above showing yet even another headlight assembly having a heat source.

FIG. **78** is a front perspective component view of a heat pipe used in the heat source of FIG. **77**.

FIG. **79** is a plan view from above of the heat pipe of FIG. **78**.

FIG. **80** is a front elevational view of the heat pipe of FIGS. **78-79**.

FIG. **80**A is a vertical sectional view of the heat pipe taken along line **80**A-**80**A of FIG. **80**.

FIG. **81** is a front elevational view of the headlamp and heat source of FIG. **77**.

FIG. **82** is a plan view of the headlamp and heat source of FIG. **81**.

FIG. **83** is a vertical sectional view of the headlamp and heat source taken along line **83-83** of FIG. **82**.

FIG. **84** is front perspective view from above of the headlamp and heat source of FIGS. **81-83**.

FIG. **85** is an exploded perspective view of one exemplary heated vehicle LED head light lens assembly configured for use on a housing assembly (not shown) having a threaded recessed port within the lens, a plug-shaped threaded heat source and a circumferential seal;

FIG. **86** is a front elevational view of the heated vehicle LED head light lens assembly of FIG. **85**;

FIG. **86**A is a side vertical sectional view of the heated vehicle LED head light lens assembly taken along line **86**A-**86**A of FIG. **86**;

FIG. **86**B is an enlarged partial cross-sectional view of the heated vehicle LED head light lens assembly taken from the encircled region **86**B of FIG. **86**A;

FIG. **87** is a perspective view of an exemplary vehicle LED head light assembly including the heated LED head light lens assembly of FIGS. **85**, **86**, **86**A, and **86**B and illustrating an ice scraper being used to scrape accumulated snow and/or ice from an outer surface of a light transmissible portion of the lens;

FIG. **88** is a perspective view of another exemplary LED tail light assembly for use on a snowmobile and having a plug-shaped threaded heat source;

FIG. **89** is an exploded perspective view of the snowmobile tail light assembly of FIG. **88**;

FIG. **90** is a vertical front elevational view of the tail light assembly of FIGS. **88** and **89**;

FIG. **90**A is a cross-sectional view of the tail light assembly of FIG. **90** taken along line **90**A-**90**A;

FIG. **91** is a front elevational view of the threaded-plug heat source assembly shown in FIGS. **90** and **90**A;

FIG. **91**A is a cross-sectional view of the threaded-plug heat source assembly of FIG. **91** including an electric PTC heater and conductor wires taken across line **91**A-**91**A in FIG. **91**;

FIG. **92** is a side elevational view of the threaded-plug heat source assembly of FIG. **91**;

FIG. **93** is a top end view of the threaded-plug heat source assembly of FIG. **92**;

FIG. **94** is a perspective view of an exemplary LED heated vehicle tail light assembly;

FIG. **94**A is an enlarged partial perspective view of the vehicle tail light assembly taken from encircled region **94**A of FIG. **94**;

FIG. **95** is a front view of the vehicle tail light assembly of FIG. **94**;

FIG. **95**A is a cross sectional view of the tail light assembly taken along line **95**A-**95**A of FIG. **95**;

FIG. **95**B is a cross sectional view of the tail light assembly taken along line **95**B-**95**B of FIG. **95**;

FIG. **96** is a right-side view of the vehicle tail light assembly of FIG. **95**;

FIG. **97** is an exploded perspective view of the vehicle tail light assembly of FIG. **94**;

FIG. **98** is a right-side view of one of two threaded plug heat source assemblies of FIG. **97** each including an electric PTC heater and conductor wires;

FIG. **99** is a front-end view of the threaded plug heat source assembly of FIG. **98**;

FIG. **99**A is a cross-sectional view of the threaded plug heat source assembly of FIG. **99** taken through line **99**A-**99**A;

FIG. **100** is perspective view of yet another exemplary heated vehicle LED tail light assembly;

FIG. **100**A is an enlarged partial perspective view of the heated vehicle tail light assembly of FIG. **100** taken from encircled region **100**A;

FIG. **101** is a front elevational view of the heated vehicle tail light assembly of FIG. **100**;

FIG. **101**A is a cross sectional view of the heated vehicle tail light assembly taken along line **101**A-**101**A of FIG. **101**;

FIG. **101**B is a cross sectional view of the heated vehicle tail light assembly taken along line **101**B-**101**B of FIG. **101**;

FIG. **102** is a right-side view of the heated vehicle tail light assembly of FIG. **101**;

FIG. **103** is an exploded perspective view of the heated vehicle tail light assembly of FIG. **100**;

FIG. **104** is a perspective view of one of the two threaded PTC heat source assemblies of FIG. **103** each including an electric PTC heater and conductor wires;

FIG. **105** is a front elevational view of the assembled heat source of FIG. **104**;

FIG. **105**A is a cross-sectional view of the assembled heat source of FIG. **105** taken along line **105**A-**105**A;

FIG. **106** is front view of even another exemplary heated vehicle LED tail light assembly;

FIG. **106**A is a vertical centerline-sectional view of the LED tail light assembly of FIG. **106** taken at line **106**A-**106**A;

FIG. **106**B is an enlarged partial sectional view of the heated tail light assembly of FIG. **106**A taken from encircled region **106**B;

FIG. **107** is a right-side view of the LED tail light assembly of FIG. **106**;

FIG. **108** is a partially exploded perspective view of the heated tail light assembly of FIGS. **106** and **107** with the light transmissible lens removed to show interior details of the heated tail light assembly;

FIG. **109** is an exploded perspective view of the heated tail light assembly of FIG. **108**;

FIG. **109**A is a close-up perspective view of the electric PTC heater and conductor wires assembly of FIG. **109**;

FIG. **110** is a front view of yet even another exemplary vehicle LED tail light assembly;

FIG. **110**A is a vertical centerline-sectional view of the heated tail light assembly of FIG. **110** taken along line **110**A-**110**A;

FIG. **110**B is an enlarged partial sectional view of the heated tail light assembly taken from encircled region **110**B of FIG. **110**A;

FIG. **110**C is an enlarged partial sectional view of the heated tail light assembly taken from encircle region **110**C of FIG. **110**A;

FIG. **111** is a right-side view of the heated tail light assembly of FIG. **110**;

FIG. **112** is a partially exploded perspective view of the heated tail light assembly of FIGS. **110** and **111** with the light transmissible lens removed to show the interior details of the heated tail light assembly;

FIG. **113** is an exploded perspective view of the heated tail light assembly of FIG. **112**;

FIG. **113**A is an enlarged perspective view of the PTC heat assembly of FIG. **113**;

FIG. **113**B is an enlarged partial perspective view of the thermal insulation member of the heated tail light assembly of FIG. **113**;

FIG. **114** is a front view of yet even another exemplary heated vehicle LED tail light assembly;

FIG. **115** is a right-side view of the heated tail light assembly of FIG. **114**;

FIG. **116** is a partially exploded perspective view of the LED tail light assembly of FIGS. **114** and **115** with the light transmissible lens removed to show the interior details of the heated tail light assembly;

FIG. **116**A is an enlarged perspective view of the heater assembly from the encircled region **116**A of FIG. **116**;

FIG. **117** is an exploded perspective view of the heated tail light assembly of FIG. **116**;

FIG. **118** is a close-up perspective view of one of the louvered ceramic heat dissipating devices from the heated tail light assembly of FIGS. **116**, **116**A, and **121**;

FIG. **119** is a front-end view of the louvered heat dissipating device of FIG. **118**;

FIG. **119**A is a cross-sectional view the louvered heat dissipating device of FIG. **119** taken along line **119**A-**119**A;

FIG. **120** is a right-side view of the louvered heat dissipating device of FIG. **119**;

FIG. **121** is a perspective view of an optional configuration array of louvered heat dissipating devices that is used in the exemplary heated vehicle LED tail light assembly of FIGS. **114-120**;

FIG. **122** is a front view of an even further exemplary heated vehicle LED tail light assembly;

FIG. **122**A is a vertical centerline-sectional view of the heated tail light assembly of FIG. **122** taken along line **122**A-**122**A;

FIG. **122**B is an enlarged detailed partial vertical centerline-sectional view of the heated tail light assembly taken from encircled region **122**B of FIG. **122**A;

FIG. **122**C is an enlarged detailed partial vertical centerline-sectional view of the heated tail light assembly taken from encircled region **122**C of FIG. **122**A;

FIG. **123** is a right-side view of the heated tail light assembly of FIG. **122**;

FIG. **124** is a partial exploded perspective view of the heated tail light assembly of FIGS. **122** and **123** with the light transmissible lens removed to show interior details of the heated tail light assembly;

FIG. **124**A is an enlarged partial perspective view of the PTC heater, electrical conductors, and LED port openings in the heated tail light assembly of FIG. **124**;

FIG. **125** is an exploded perspective view of the heated tail light assembly of FIG. **124**;

FIG. **126** is a further-exploded perspective view of the heat transmitting plate assembly of the heated tail light assembly of FIG. **125**;

FIG. **126**A is an enlarged partial perspective view of a thermal insulation layer of the heat transmitting plate assembly of FIG. **126**;

FIG. **127** is a rear perspective view of the thermal insulation layer of the heated tail light assembly of FIG. **125**;

FIG. **128** is a front plan view of the thermal insulation layer of FIG. **127**;

FIG. **129** is a side plan view of the thermal insulation layer of FIG. **128**;

FIG. **130** is a rear plan view of the thermal insulation layer of FIG. **127**;

FIG. **131** is an exploded perspective view of a yet even further exemplary heated vehicle LED clearance, or side marker light assembly including a heat source assembly;

FIG. **132** is a front plan view including hidden lines of the heated LED clearance, or side marker light assembly of FIG. **131**;

FIG. **132**A is a vertical centerline-sectional view of the heated clearance, or side marker light assembly of FIG. **132** taken along line **132**A-**132**A;

FIG. **133** is an exploded perspective view of another exemplary vehicle LED clearance, or side marker light assembly including a heat source assembly;

FIG. **134** is a front plan view including hidden lines of the heated clearance, or side marker light assembly of FIG. **133**;

FIG. **134**A is a sectional view of the heated clearance, or side marker light assembly of FIG. **134** taken along line **134**A-**134**A;

FIG. **135** is a simplified centerline-sectional view of a first exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source;

FIG. **136** is another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **137** is yet another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **138** is even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **139** is yet even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **140** is an even further simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **141** is yet even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **142** is a further simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **143** is yet even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **144** is even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **145** is yet another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **146** is yet even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **147** is a further simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **148** is yet a further simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**;

FIG. **149** is yet even a further simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**; and

FIG. **150** is even another simplified centerline-sectional view of a second exemplary heated LED light assembly including a housing with a light transmissible portion and a first heat generation and delivery source similar to that depicted in FIG. **135**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

LED (light emitting diode) vehicle illumination assemblies, or light enclosures for on-road or off-road typically do not have independent heat sources separate from the light source. LED heat source life expectancy can also be detrimentally affected by overheating. A series of temperature controlled heat sources for vehicle illumination assemblies are shown below in FIGS. **1-150**. These lights are independently controlled environments that power a heat source having a Positive Temperature Coefficient (PTC) heater and a ceramic radiant heat dissipating body configured to deliver heat via an optimized combination of radiation and convection to the light transmissive portion, or lens in a manner that imparts a constant temperature on the surface of the lens. Such configuration mitigates ice, fog and/or condensation build up on the inside or outside of the lens, mitigating or eliminating light occlusion even in the coldest climates or in high humidity environments where moisture can condense on the lens. An adaptable heating system is used to perform this task. PTC (Positive Temperature Coefficient) heating elements provide a mechanism where the heater is internally self-regulating, practically eliminating the need for an external power control or thermostat. The heating element filament will increase or decrease the resistive property (increasing the resistance decreases the current flow and heat and decreasing the resistance increases the current flow and heat) depending on it's own internal temperature in combination with it's own surrounding temperature. This enables the PTC heating element to self-regulate current flow through the device and in particular, heat output of the device within a pre-determined and usefully accurate range. Additionally, use of the PTC heating elements offers the useful advantage of inherent or built-in control of heat output and consumption of electrical current for more efficient power consumption than for regular, or prior design heating elements. Furthermore, new radiant heat transfer structures and components are implemented with the PTC heater. The prior design heating elements just turn on to the maximum heat, until an external thermostat turns it off by means of an additional control system or electronic circuitry. PTC heaters can be designed or otherwise pre-selected to operate within a desired range of temperatures and output heat characteristics for a given application offering inherent simplicity over previous methods. The PTC heater and ceramic radiant heat dissipating body is placed within the enclosure, allowing for increased radiative heat transfer to occur in combination with convective heat transfer (hot air rises and cold air will cycle down), and ensuring greater heat transfer to the lens. In one embodiment, the PTC heating element is electrically adapted or connected right into the existing light power circuitry, making installation of a heated light as simple as unplugging one and plugging in or adapting the other in its place.

Provision of increased radiative heat transfer over prior efforts via use of a ceramic radiant heat dissipative body provides enhanced ability to eliminate condensation from within and outside of a vehicle lens, both frozen and liquid (vapor). Radiant heat transfer and convective heat transfer are largely independent and unrelated mechanisms and both are optimized by the present designs. Radiant emissions (heat transfer) can occur in a vacuum whereas convective heat transfer cannot occur in a vacuum. This is because radiant heat transfer is purely black body radiation in accordance with the Stefan-Boltzmann law: $j^*=\epsilon\sigma T^4$, where: j^* is the radiant flux, or irradiance (Watts/meter^2), ϵ (<1) is the emissivity, σ is the Stefan-Boltzmann constant, and T is the absolute temperature of the body. Good emissivity typically means that the surface looks black, especially at the peak spectrum of the radiator, which depends on the temperature. Effective heat convection typically involves superior heat conductors (typically metal) with granular surface to achieve larger surface area in contact with the surrounding gas, or larger surface areas. The balancing between conductive heat transfer and radiant heat transfer is typically slight—very little to trade off because radiant heat dissipation is an order of magnitude larger than convective heat dissipation in air at one atmosphere pressure. This matter is different when dealing with higher density gas.

FIG. **1** illustrates one construction for a vehicle illumination system, or vehicle tail light **10** having a heat source **12** with a ceramic radiant heat dissipating body **20** (see FIG. **2**) and a custom PTC (positive temperature coefficient) heater unit **22** (see FIG. **2**), respectively, designed to keep the ambient temperature within the vehicle light **10** (such as a head light, tail light or marker light) at approximately 140 Degrees F. (60 Degress C). Heat source **12** is affixed to an LED printed circuit board **30** that is further affixed into a housing **18** and behind a lens **19**. This heat source **12** allows for the heat transfer to a lens, or light transmissive portion **19** to be hot enough to mitigate or eliminate condensation, either frozen or liquid, from occluding light transmission through the lens **19**. Although depicted on a vehicle tail light, it is understood that heat source **12** can be implemented on any other type of vehicle light, such as headlights, side marker lights, stop lights, non-powered safety reflectors, and stationary non-vehicle light fixtures.

As shown in FIG. **2**, vehicle tail light **10** includes further details in exploded perspective view of heat source **12** on PC board **30** of a light source **16** mounted within housing assembly **14** to housing **18** beneath lens **19**. More particularly, heat source **12** includes a rectangular thin walled ceramic plate **20** onto which a Positive Temperature Coefficient (PTC) heater **22** is adhesively affixed with a thermally transmissive heat resistant adhesive **23** (see FIG. **4**) to ceramic plate **20**. A threaded fastener, or screw **24** is received through a hole **44** drilled through ceramic plate **20**, through a spacer washer **45** and into a hole **46** within PC board **30** to rigidly secure heat source **12** onto PC board **30** in spaced-apart relation. In this configuration, heat source **12** is mounted centrally of an array of six individual light emitting diode (LED) illumination sources **32**, **34**, **36**, **38**, **40** and **42** each mounted onto a front face of PC board **30**. A pair of bridge conductive wire leads, or jumpers **26** and **28** are soldered between insulated conductive leads **56** and **58**, respectively, on opposite sides of PTC heater **22** and to ground and power leads on PC board **30** that feed power to the series of LED illumination sources **32**, **34**, **36**, **38**, **40** and **42**. Leads **56** and **58** are soldered to opposed surfaces, or termination poles of PTC heater **22**.

FIG. **3** illustrates vehicle illumination system **10** in front view showing a light transmission portion comprising a central cylindrical portion of lens **19** provided within the bounds of housing **18**.

FIG. **4** illustrates in vertical sectional view assembly details of vehicle illumination system **10**. More particularly, housing **14** forms an internal cavity between housing member **18** and lens **19** within which heat source **12** is rigidly affixed to PC board **30** and housing **18** via threaded fastener **24**. Solder bumps on opposed faces result from attachment of conductive leads (not shown). Thermally conductive and heat resistant adhesive **23** is used to affixed PTC heater **22** in thermally conductive relation with an outer surface **31** of the ceramic radiant heat dissipating body, or square ceramic thin plate **20**. An inner surface **33** of plate **20** is spaced apart from PC board **30** by a gap **25** define by the thickness of spacer washer **45**. In operation, heat source **12** is powered to supply heat into ceramic plate **20** which is proximate an inner surface of light transmissive portion **21** of lens **19**, imparting both radiant heat transfer, as well as convective heat transfer to the lens. Ceramic plate **20** has an emissivity higher than that found on earlier metal and anodized metal heat sink designs, above 0.75 and in the range of 0.9 to 0.95 which imparts a significant and greater radiant heat delivery to lens **19** to mitigate and/or eliminate condensation building on either inner or outer surfaces of lens **19** due to solid (frozen) or liquid condensation. In some cases, plate **20** can be formed of a ceramic that has surface pores that increase surface area for convective heat transfer. In other cases, plate **20** can be formed from porcelain. In yet other cases, plate **20** can be formed of a smooth surface ceramic material. It should be understood that the heated tail light assembly of FIGS. **1-4** depict and provides self-contained heated tail light with no further modification to the vehicle or electrical wiring onto which it is installed

FIG. **5** is a perspective view of an alternative construction heat source **112** for use in the tail light assembly of FIGS. **1** and **2**, or for use in any other form of vehicle illumination system. More particularly, a thin ceramic plate **120** has a mounting hole **144** drilled through one corner and a conductive lead hole **145** drilled through an opposite corner. A finned ceramic body **150** is adhesively affixed atop a top surface of ceramic plate **120** using a thermally conductive and heat resistant adhesive **123** provided along a bottom surface of rectangular base **154** of ceramic body **150**. Ceramic body **150** has an integrally formed radial array of parallel individual fins, such as fin **152**, also integrally formed of ceramic material. PTC heater **122** is affixed atop a top surface of ceramic plate **120** over lead hole **145** so that a bottom insulated conductive lead **146** can pass through ceramic plate **120** where a conductive end is soldered onto a bottom surface of PTC heater **122**. A bottom surface of PTC heater **122** is affixed atop a top surface of ceramic plate **120** using thermally conductive and heat resistant adhesive. A top insulated conductive lead **148** is soldered at a conductive end atop PTC heater **122** and insulated wire leads **146** and **148** join together at an electrical connector assembly **151** that mates with a complementary electrical connector assembly provided on the PC board (not shown). Such connector assembly **151** facilitates insertion, removal and repair/replacement.

As shown in FIG. **5**, plate **120** and fin body **150** are commercially available ceramic components available as Digi-Key Part Number 1168-1618-ND, for purchase from Digikey Electronics, 701 Brooks Avenue South, Thief River Falls, Minn. 56701 USA. One exemplary PTC heater **122** is commercially available from Mouser Electronics, 1000 North Main Street Mansfield, Tex. 76063 USA, using a PTC thermistor as a heating element. A metallized round disk PTC thermistor can be used by EPCOS/TDK, 12 Vdc, 3 ohms disc PTC heating, Series/Type: B59060, Mouser Part No. 871-B59060A0160A010, EPCOS/TDK Manufacturer Part No. B59060A0160A010. Alternatively, PTC heaters can have rectangular or square configurations. One suitable thermally conductive adhesive is Locktite 3761 UV light cured adhesive available from Henkel Corporation North America, 14000 Jamboree Road, Irvine, Calif. 92606 USA. Another suitable thermally conductive adhesive is available from Dymax Corporation (Headquarters), 318 Industrial Lane, Torrington, Conn. 06790 USA. Other suitable thermally conductive epoxy adhesives are available from Masterbond, 154 Hobart Street, Hackensack, N.J. 07601 USA. Further suitable thermally conductive adhesives are available as high temperature ceramic adhesives from Aremco Products Inc., 707 Executive Blvd., Valley Cottage, N.Y. 10989 USA.

FIG. **6** is a perspective view of another alternative construction heat source **212** for use in the tail light assembly of FIGS. **1** and **2**, or for use in any other form of vehicle illumination system. More particularly, heat source **212** comprises a PTC heater **222** adhesively affixed to a bottom surface of a unitary ceramic finned plate **220**. Plate **220** is commercially available as part number FCH252505T from AMEC Thermasol, Marcom House, 1-2 Steam Mill Lane, Great Yarmouth, Norfolk, NR31 0HP, United Kingdom. A central hole **245** is drilled through a square base plate **254** of finned plate **220**, between adjacent pairs of elongate rectangular fins **252**. Hole **245** is used to run a top insulated conductive lead **246** to a top surface of a PTC heater **222** where conductive end of the lead **246** is soldered to a top surface of PTC heater **222**, after which PTC heater **222** is adhesively affixed with a thermally conductive and heat resistant adhesive to a bottom surface of plate **254**. Another insulated conductive lead **248** with a conductive end is soldered to a bottom surface of PTC heater **222**. Insulated leads **246** and **248** terminate in an electrical connector **252**. Although shown as a flat plate with parallel fins **252**, it is understood that ceramic plate **220** can take on any other form including circular, rectangular, and curved surfaces having fins on one or more surfaces radiating in parallel, curved, angled or any other suitable configuration integrally formed from ceramic material to increase surface area and convective heat transfer while also providing improved radiative heat transfer by using relatively high emissivity ceramic material compared to metal, aluminum and anodized aluminum heat sinks.

FIG. **7** is a perspective view of a head light assembly **310** with a heat source **312** mounted, or rigidly affixed with a grommet in an aperture **346** of a housing **318** on a housing assembly **314** having a light transmissive portion **321** of a lens **319**. Heat source **312** has an elongate ceramic radiant heat dissipative body with a cylindrical ceramic portion containing a PTC heater.

FIG. **8** is a front perspective view from above of the heat source **312** of FIG. **7**. More particularly, heat source **312** includes a thin-walled ceramic cylindrical tube **320** affixed within a silicon grommet **324** at a proximal end with a PTC heater **322** affixed within the cylindrical tube **320** at a distal end with an endwall or bulkhead of thermally conductive heat resistant epoxy adhesive **323**. FIG. **9** is a rear perspective view from above of the heat source **312** and contained PTC heater **322** of FIGS. **7-8** further showing the flexible silicon rubber sealing grommet **324** affixed about ceramic tube **320**. FIG. **10** is a front exploded perspective view from above of the heat source **312** of FIGS. **8-9** showing the assembly of tube **320** within grommet **324** and the installation of PTC heater **322** within a square aperture **344** formed in a thermally conductive end wall **323** affixed within an inner surface **331** of tube **320** at a distal end. Insulated thermally conductive lead wires **356** and **358** pass through sealing apertures **361**, **363**, and **365** in respectively a cylindrical aluminum reflector plate **360**, a cylindrical insulator plate **362**, and a cylindrical silicon rubber end seal **364**. In operation, a distal end of PTC heater **322** and end wall **323** radiates and convectively delivers heat towards a lens and within a vehicle illumination assembly (not shown), while outer surface **333** further radiates and convectively delivers heat towards a lens and within a vehicle illumination assembly (not shown).

FIGS. **11-13** further illustrate ceramic tube **320** of heat source **312** coaxially received in sealing relation within silicon rubber grommet **324**. Grommet **324** is urged in assembly within a bore, or aperture formed in a wall portion of a vehicle illumination housing where the grommet **324** seals within the aperture. Further details of PTC heater **322** potted within or adhesively affixed within in a window or receptacle **344** of thermally conductive end wall **323** are shown in FIGS. **12** and **13** spaced from grommet **322**. According to one construction, end wall **323** is formed from a plug of thermally conductive adhesive, such as an epoxy adhesive. Optionally, end wall **323** can be formed from a ceramic filled adhesive. The PTC heating element of heater **322** delivers heat through end wall **323** to an inner surface **331** of ceramic tube **320** to radiate (and convect) heat from outer surface **333** of tube **320**.

FIG. **14** is a front perspective view of the PTC heater **322** of the heat source **312** of FIGS. **8-13**. More particularly, a square PTC body **366** has a pair of back and front insulated conductive leads **356** and **358**. As shown in FIG. **15-17**, lead **356** of heater **322** is affixed with solder at a conductive end to a back surface of PTC block **366**. As shown in FIG. **18**, lead **358** of heater **322** is electrically soldered to an L-shaped conductive plate comprising contiguous legs **372** and **374** that is further soldered to a front face of PTC block **366** via a cylindrical solder hole **376**. Electrically insulating pads **368** and **370** electrically isolate plate **372** from portions of PTC block **366** and adjacent conductive items including lead **356** to prevent undesirable shorting out between such conductive leads.

FIG. **19** is a front perspective view of yet another heat source **412** having a ceramic radiant heat dissipative body **420** with an elongated cylindrical ceramic radiant heat dissipative body **421** (see FIG. **21**) with a hemispherical, or semi-spherical head **444** and an internal PTC heater **422** (see FIG. **21**), similar in construction to PTC heater **322** in FIGS. **14-18**. A threaded retention base **424** made of plastic or metal has male threads that screw into a threaded boss, or bore in a vehicle illumination housing (not shown). A cylindrical silicon washer **425** (see FIG. **21**) of rectangular cross section seats about the threaded portion of base **424** to seal in assembly heat source **412** to the housing. PTC heater **422** mounts similar to PTC heater **312** of FIG. **10**) with insulated conductive wire leads **456** and **458** passing through respective sealing bores **461**, **463**, and **465** in reflector plate **460**, insulator plate **462**, and silicon rubber sealing end plate **464** which are adhesively affixed within body **420**. As shown in FIGS. **21-24**, ceramic radiant heat dissipative body **420** with elongate cylindrical body **421** is a commercially available piece from Ortech Advanced Ceramics, 6720 Folsom Blvd. Suite 219 Sacramento Calif. 95819 that is affixed with adhesive within an inner bore of base **424**. As shown in FIG. **24**, an end portion of hemispherical head **444** is filled with a block **423** of thermally conductive heat resistant adhesive and PTC heater **422** is affixed therein with such adhesive block **423**.

FIG. **25** is a front perspective view of yet even another heat source **512** having a longitudinally finned ceramic radiant heat dissipative body **520** comprising an elongated cylindrical ceramic radiant heat dissipative body with a hemispherical head **544**, a circumferential array of longitudinally extending radially outwardly extending integral fins **525** and an internal PTC heater (not shown) similar to the PTC heater **422** depicted in FIGS. **19-24** having insulated and electrically conductive wire leads **556** and **558** (see FIG. **26**). Base **524** is threaded and sealed similar to base **424** in FIG. **21**. Ceramic body **520** is adhesively affixed within an inner bore of base **524**.

FIG. **26** is a rear perspective view of the heat source **512** of FIG. **25**. More particularly, insulated conductive wire leads **556** and **558** exit through end plate **564** of heat source **512**. Threaded retention base **524** is affixed at a distal end of heat dissipative body **512** with a hemispherical head **544** provided at a proximal end, with fins **525** extending longitudinally along an outer surface therebetween.

FIG. **27** is a front perspective view of even yet another heat source **612** having a circumferentially finned ceramic radiant heat dissipative body **620** comprising an elongated cylindrical ceramic radiant heat dissipative body with a hemispherical head **644**, a longitudinally extending array of circumferential radially outwardly extending ring-shaped fins **625**, and an internal PTC heater (not shown) similar to the PTC heater **422** depicted in FIGS. **19-24** having insulated and electrically conductive wire leads **656** and **658** (see FIG. **28**). Base **624** is threaded and sealed similar to base **424** in FIG. **21**. Ceramic body **620** is adhesively affixed within an inner bore of base **624**.

FIG. **28** is a rear perspective view of the heat source **612** of FIG. **27**. More particularly, insulated conductive wire leads **656** and **658** exit through end plate **664** of heat source **612**. Threaded retention base **624** is affixed at a distal end of ceramic radiant heat dissipative body **620**, opposite hemispherical head **644** at a proximal end, with fins **625** extending longitudinally along an outer surface therebetween.

FIG. **29** is a prior art perspective view from above of a headlight assembly **710** with the lens **719** having a light transmissible portion **721** removed showing an LED light source **730** carried on a central support structure, or post **746** with a housing **718** of a housing assembly **714**.

FIG. **30** is perspective view from above of a headlight assembly **710'** with the lens **719** having a light transmissible portion **721** removed showing an LED light source **730** carried on a central support structure, or post within a housing **718** of a housing assembly **714** and having even another heat source **712** having a ceramic plate **720** and a finned ceramic radiant heat dissipative body **750** (see FIG. **31**) with a PTC heater **722** affixed to to post **746** with a threaded fastener **724**. A thermistor **727** provides further optional temperature feedback control to operation of the PTC heater **722** such that heat is only delivered when needed.

FIG. **31** is front right perspective view from above of the heat source **712** of FIG. **30**. More particularly, PTC heater **722** delivers a source of heat to ceramic plate **720** and further to finned ceramic radiant heat dissipative body **750** to deliver heat via radiation, conduction and convection to an inner surface of light transmissible portion **721** (see FIG. **30**). A thermistor **727** is electrically coupled with PTC heater **722** from an electrical power supply and vehicle wiring harness (not shown) to control and regulate power delivery to PTC heater **722**. Ceramic body **750** is affixed in thermally conductive relation via epoxy, or ceramic-filled epoxy, onto a front face of ceramic plate **720**, while PTC heater is likewise affixed in thermally conductive relation onto ceramic plate **720**. Outer surfaces, including an array of elongate fins, on body **750** conduct, convect, and radiate heat from body **750** into the cavity within housing assembly **714** and onto a back surface of lens **719** to dissipate and remediate accumulation of condensate (frozen and/or vapor) from lens **719** on both inner and outer surfaces. Threaded fastener **724** affixes plate **720** and body **750** onto post **746**. Optionally, body **750** can be formed from an anodized aluminum piece, such as an Aavid part number 799403B01500G available from Aavid, a thermal divison of Boyd Corporation, and are available for purchase from and are available for purchase through Digi-Key Electronics, 701 Brooks Avenue South, Thief River Falls, Minn. 56701 USA.

FIG. **32** is a rear right perspective view from above of the heat source **712** of FIG. **30** further showing body **520**, PTC heater **722** and thermistor **727** on L-shaped post **746**.

FIG. **33** is a front elevational view of the heat source **712** of FIG. **30**. Fastener **724** affixes plate **720** and body **750** to post **746** along with PTC heater **722**. Fastener **729** affixes plate **720** and body **750** to post **746** in addition or optionally to thermally conductive adhesive, or epoxy. Thermistor **727** is supported at a distal end of L-shaped bracket **746**, above plate **720** and body **750**.

FIG. **34** is a vertical sectional view of the heat source **712** of FIG. **30** taken along line **34-34** of FIG. **33**. Thermistor **727** is shown in sectional view affixed through a complementary through bore in L-shaped bracket **748** where it is affixed with epoxy adhesive. Optionally, thermistor **727** can be affixed with any form of fastener including mating threads, screws, bolts, rivets, or other bonding agents. Fastener **729** affixes body **750** and plate **720** together while fastener **720** secures such assembly onto post **746**. In this way, fastener **729** does not thermally conduct heat into a lower portion of post **746**. Furthermore, fastener **720** is received through ceramic plate **720** through an oversized bore, or hole and a thermally insulating washer is provided on the head of fastener **720** to thermally isolate plate **720** from post **746**. PTC heater **722** is provided spaced from such fasteners **729** and **724** to further thermally isolate heater **722** from post **746**. In this way, heat transfer from heater **722** is minimized to post **746** (and the accompanying LED light source which increases life expectancy of the LED light source.

FIG. **35** is a right front exploded perspective view from above of the heat source **712** of FIG. **30**. More particularly, an insulating silicon layer **717** is provided between ceramic plate **720** and surface **744** on post **746** in order to prevent heat transfer to post **746** and of the LED circuit board **730** where LED **732** (see FIG. **36**) might otherwise suffer reliability issued resulting from excessive heat buildup. Insulating bosses, or raised portions **747** and **749** each having a central bore and silicon insulating washer prevent heat transmission from ceramic plate **720** to surface **744** via threaded fasteners **724**. Thermistor **727** is affixed in assembly to post **740**, beneath LED circuit board assembly **730** which is further affixed in assembly to post **746** with three threaded fasteners **731**. Fastener **724** extends through washers **733** and **735** and through bores **743** and **747**, into threaded bore **748** in L-shaped bracket, or escutcheon **746**. In one case, washer **733** is a thermally conductive washer and washer **735** is a thermally insulating (non-conductive) washer. Threaded fastener **729** affixes finned body **750** onto ceramic plate and silicon insulating layer, or plate **717**, by threading into apertures **737** and **738**. Optionally, where fastener **729** is made from a thermally insulative material, fastener **729** can further thread into aperture **739** in post **746**, within surface **744**. PTC heater **722** is affixed to a front face of ceramic plate **720** with thermally conductive adhesive, or epoxy (such as ceramic-filled epoxy) over through-bore **745** so that a conductive lead from thermistor **727** passes through bores **749** and **740** to form an electrical in-series connection with a back surface of PTC heater **722**. In this way, thermistor **727** controls operation of PTC heater **722**. In one case, a positive coefficient thermistor **727** is used in order to shut down current to PTC heater **722** to prevent overheating. In an optional or additional case, a negative temperature thermistor can be used in order to shut down current to PTC heater **722** to prevent use during summer months where temperature is warm for cases where snow and ice accumulation is the design concern, or for bounding performance of the PTC heater under high and low temperature performance threshold conditions.

FIG. **36** is a right rear exploded perspective view from above of the heat source **712** of FIG. **30**. Assembly of block **750** with fastener **729** to plate **720** and layer **717** via bores **737**, **738** and (optionally) **739** is shown. Likewise, assembly of fastener **724**, washers **733** and **735**, plate **720**, layer **717**, and post **746** is detailed. One lead from thermistor **727** passes through hole **740** in bracket **746**, layer **717**, and plate **720** to electrically connect with a back surface of PTC heater **722**. Finally, LED board assembly **730** is shown affixed to a back surface of bracket **746** with three threaded fasteners. An electrical PC board connector assembly **741** for LED circuit board assembly **730** is also shown.

FIG. **37** is a plan view from above of the headlight assembly **710** of FIG. **30**.

FIG. **38** is a vertical sectional view of the headlight assembly **710** and heat source taken along line **38-38** of FIG. **37**. Heat source **712** of FIGS. **35** and **36** is shown installed in one exemplary headlight assembly **710**. Finned ceramic (or anodized aluminum) heat dissipative body **750** is shown supported proximate, but slightly spaced from an inner surface of lens **719** behind a light transmissive portion **721** of lens **719**.

FIG. **39** is a right elevational side view of the headlight assembly of FIG. **30**

FIG. **40** is a vertical sectional view of the headlight assembly **710** and heart source **712** taken along line **40-40** of FIG. **39** and showing the proximate positioning and orientation of finned ceramic heat dissipative body **750** adjacent to lens **719** for delivering heat via convection and radiation thereto to light transmissive portion **721**. Portion **721** can additionally, or optionally be optically clear for the case where optical or safety sensors are provided in the housing of headlight assembly **710** for use with self-driving sensing technologies, and such heater can be provided in a housing with a light transmissible (or optically transmissible) portion housing a sensor without any light source. Optionally, portion **721** can additionally or optionally be an opaque material where electromagnetic radiation can pass in either direction through the material for various types of sensor applications.

FIG. **41** is a front perspective view from above of three alternative heat sources **812**, **912**, and **1012** for use in a light assembly, such as a headlight, tail light or side marker light, or any light assembly shown in the present application. Heat source **812** had a plug **821** of potted ceramic adhesive that encases a PTC heater inside of a plastic threaded plug body **824**. Optionally, plug **821** can be a ceramic powder filled epoxy, an epoxy, or a cyanoacrylate epoxy that encases and conducts heat from the PTC heater to the distal open end of plug body **824** for directed delivery via convection and radiation to a lens surface or a ceramic reflecting body (see FIG. **71**B).

Heat source **912** of FIG. **41** includes a splined ceramic post **920** that is affixed atop a ceramic adhesive plug **921** that fills plug body **924** and encases a PTC heater therein.

Heat source **1012** of FIG. **41** includes a fluted ceramic end body **1020** having a stack of undulating cylindrical disk-shaped flutes that are affixed atop a ceramic adhesive plug **1021** that fills plug body **1024** and encases a PTC heater therein. Detail A of FIG. **43** shows in greater detail the geometry of end body **1020**.

FIGS. **42**A-**1** are respective front, side and sectional views taken along lines **42**A-**42**A, **42**B-**42**B, **42**C-**42**C, **42**D-**42**D, **42**E-**42**E, **42**F-**42**F, **42**G-**42**G, **42**H-**42**H, and **42**I-**421** for each of the three heat sources of FIG. **41**. More particularly, FIG. **42**A shows heat source **812** in end view, while FIG. **42**B shows heat source **812** in side view with plug **821** and plug body **824**. FIG. **42**C shows PTC heater **822** affixed in plug **820** and insulating thimble **823**. An annular radial outward ring or rib **825** on thimble **823** interfits within a complementary annular groove in plug body **824** (see FIG. **42**B).

FIG. **42**D shows heat source **912** in end view, while FIG. **42**E shows heat source **912** in side view with plug **921** and plug body **924** and splined ceramic post **920**. FIG. **42**F shows PTC heater **922** affixed in plug **921** and insulating thimble **923**. An annular radial outward ring or rib **925** on thimble **923** interfits within a complementary annular groove in plug body **924** (see FIG. **42**E), and splined ceramic post **920** extends beyond a distal end of plug **921**.

FIG. **42**G shows heat source **1012** in end view, while FIG. **42**H shows heat source **1012** in side view with plug **1021** and plug body **1024** and fluted ceramic end body **1020**. FIG. **42**I shows PTC heater **1022** affixed in plug **1021** and insulating thimble **1023**. An annular radial outward ring or rib **1025** on thimble **1023** interfits within a complementary annular groove **1027** in plug body **1024** (see FIG. **42**H), and fluted ceramic end body **1020** extends beyond a distal end of plug **1021**. A similar annular groove **1029** in thimble **1023** receives a similar complementary annular rib **1031** is potting material plug **1021**.

It is understood that epoxy potting material **821**, **921** and **1021** is not shown in FIGS. **42**A, **42**D, and **42**G, as well as FIGS. **42**C, **42**F, and **42**I in order to facilitate viewing of internal structure. However, voids are shown where the epoxy potting material is actually resident. In one case, ceramic powder is added to material **821**, **921** and **1021** to increase emissivity of such resulting material.

FIG. **43** is an exploded rear perspective view from above of the third heat source **1012** of FIG. **40** with FIG. **43**A of encircled region A showing in enlarged view a ceramic head **1020** of heat source **1012**. Ceramic head **1020** affixes via ceramic adhesive plug **1021** within silicon insulating thimble **1023** and further within plastic plug body **1024**. Annular ribs **1031** and **1025** interfit in complementary relations within annular grooves **1029** (see FIG. **44**) and **1027** (see FIG. **44**) to secure such parts together. Optionally, plug body **1024** can be metal or some other suitable structural material having either thermally insulative or thermally conductive properties, depending on the application and need to transfer or limit transfer of heat laterally. Insulated conductive leads, or wires **1056** and **1058** extend from connector plug **1051** through apertures in plug body **1024**, passing through apertures in thimble **1023** and apertures in plug **1021** to affix to opposed sides of PTC heater **1022**.

FIG. **44** is an exploded front perspective view from above of the third heat source **1012** of FIG. **40** with FIG. **44**A of encircled region B showing in enlarged view a ceramic head **1020** of the heat source **1012**. A plug of potted and cured ceramic adhesive **1021** encapsulates and conducts heat from a PTC heater **1022**, whereas an insulating silicon thimble **1023** prevents heat from transmitting to threaded plastic plug body **1024**. Annular ribs **1031** and **1025** interfit with grooves **1029** and **1027**, respectively to ensure secured assembly. Insulated conductive wires **1056** and **1058** are encased in conductive epoxy plug **1021** and connect to respective electrical leads on opposed surfaces of PTC heater **1022**. Connector plug **1051** enables direct connection to a power source for an LED light within a light housing. Ceramic head **1020** of FIG. **44**A includes opposed arcuate wings each with a radially extending aperture **1033** into which conductive epoxy from plug **1021** can interlock when formed to provide securement therebetween and thermal conductivity.

FIG. **45** is a front perspective view from above of a headlamp assembly **810** having a primary light well **829** and a secondary light well **827** with the front light transmissive lens portion removed showing a heat source **812** and a pair of moisture permeable membrane ports **860** provided in the housing to mitigate condensate occlusion of the light transmissive lens portion. Heat from heat source **812** is presently believed to create a thermal and vapor concentration mechanism that helps vaporize water in such housing and further helps to drive moisture from within such housing via ports **860**.

FIG. **46** is a partial exploded view of the headlamp assembly **810** of FIG. **45**. Each port **860** includes a cylindrical disk of moisture permeable membrane **861** affixed about an aperture **833** in housing **818** via a cylindrical strip **865** of double-back adhesive tape. One suitable class of moisture permeable membranes is available from GORE-TEX®. Other suitable moisture permeable membranes and fabrics, including coated semi-permeable fabrics can alternatively be used. An aperture **831** in housing **818** of headlamp assembly **810** receives heat source **812** (see FIG. **45**) in assembly. Although not shown herein, it is understood that a similar port and heat source can be provided in secondary well **827** as provided in primary well **829**. Optionally, wells **827** and **829** can be connected together via a port or passage.

FIG. **47** is a front perspective view from above of another headlamp assembly **10810** with a front light transmissive lens portion removed showing three heat sources **812** (see FIGS. **47**, **49**, **50** and **51**), a pair of moisture permeable membrane plugs **10870** in secondary well **10827**, and a ducted moisture permeable membrane array **10860** of ports **10835** (see FIG. **49**) provided in the housing **10818** to mitigate condensate occlusion of the light transmissive lens portion. As shown in FIG. **51**, a duct **10863** reduces dirt from collecting on moisture permeable membrane **10861** which is sealed with a double-sided adhesive strip **10865** onto housing **10818** around apertures **10835**. Air flow (including moisture) paths are shown by way of arrows in FIG. **47**. One suitable class of moisture permeable membranes is available from GORE-TEX®. Other suitable moisture permeable membranes and coated moisture permeable fabrics can alternatively be used. Plugs **10870** each include a disc of such moisture permeable member secured over a central bore of the plug with a ring strip of double-backed adhesive.

FIG. **48** is a plan view from above of the headlamp assembly **10810** of FIG. **47** with vertical section **48**A-**48**A in FIG. **48**A further showing the ducted moisture permeable membrane array **10860** of ports on assembly **10810**. Plugs **10870** are provided along an outboard portion of assembly **10810**.

FIG. **49** is a front elevational view of the headlamp assembly **10810** of FIG. **48**. Internally exposed moisture permeable membrane material on plugs **10870** and apertures **10835** can be seen internally.

FIG. **50** is a right side view of the headlamp assembly **10810** of FIG. **49**. The ducted side profile of array **10860** is shown affixed atop housing **10818** to facilitate migration of moisture via thermal and vapor differential membrane mechanisms.

FIG. **51** is an exploded perspective view from above of the headlamp assembly **10810** of FIGS. **47-50**. Apertures **10831** in secondary well **10829** each receive a respective heat source **812** in secured relation. Apertures **10833** each received a plug **10870** is secured relation. Physical apertures **10835** in housing **10818** expose moisture permeable membrane **10861** as affixed in sealed relation by strip **10865** of double-backed adhesive about an outer periphery of apertures **10835** with housing **10818** beneath duct cover **10863** which has a read edge opening. Ducted array **10860** comprises strip **10865**, duct cover **10863** and membrane **10861**.

FIG. **52** is a front component perspective view from above of one moisture permeable membrane plug **10870** of FIGS. **47-51** for use in a light housing, such as a headlight, tail light, or marker light housing. A cylindrical disk configuration of moisture permeable membrane **10879** is provided in the end of a threaded plug body. Such configuration is similar to a fuel or air filter. One suitable class of membranes is available from GORE-TEX®. A threaded end of plug **10870** is received in a thread hole of a light housing having one of the heat sources detailed herein in order to generate heat that helps drive moisture from the light housing via the moisture permeable membrane.

FIG. **53** is a front exploded perspective view of the plug **10870** of FIG. **52** showing threaded plug body **10871** having an inner bore **10877**, a cylindrical threaded end portion **10873** and a hexagonal tool flange **10875**. Moisture permeable membrane **10879** is adhesively affixed with a cylindrical strip **10881** of double-backed adhesive in a groove about bore **10877** of plug body **10871**.

FIG. **54** is a front elevational view of the plug **10870** of FIGS. **52-53** showing membrane **10879** with section A-A of FIG. **54**A further showing the plug **10870** in vertical sectional view showing moisture permeable membrane **10879** in edge view covering an entrance end of bore **10877** opposite and spaced from threaded end portion **10873**.

FIG. **55** is a rear perspective view from above showing an alternate moisture permeable membrane plug **1170** for use in a light housing, such as a headlight, tail light, or marker light housing. A baffled, or pleated cylindrical configuration (to increase surface area) of moisture permeable membrane **1161** is provided between a threaded plug end **1171** and a cap end **1173** which seal with each opposed end of membrane **1161**. Such configuration is similar to a fuel or air filter. One suitable class of membranes is available from GORE-TEX®. Plug end **1171** is received in a thread hole of a light housing having one of the heat sources detailed herein in order to generate heat that helps drive moisture from the light housing via the moisture permeable membrane.

FIG. **56** is a front perspective view from above of the plug **1170** of FIG. **55** further showing end **1171**, cap **1173** and membrane **1161**.

FIG. **57** is a left side elevational view of the plug **1170** of FIGS. **55-56**. More particularly, end **1171**, cap **1173**, and membrane **1161** are shown in side view.

FIG. **58** is a front end view of the plug **1170** of FIGS. **55-57**.

FIG. **59** is a vertical sectional view of the plug **1170** of FIGS. **55-58** taken along line **59-59** of FIG. **57** and showing end **1171**, cap **1173** and membrane **116** in sectional view.

FIG. **60** is a vertical sectional view of plug **1170** of FIGS. **55-59** taken along the line **60-60** of FIG. **57** showing the pleats configuration of membrane **1161** and plug **1170**.

FIG. **61** is front exploded perspective view from above of a headlamp, or vehicle illumination assembly **1310** similar to that depicted in FIG. **30**. Heat source **1312** includes a finned ceramic body (optionally an anodized finned body) that is heated with a PTC heater and is oriented to deliver radiant heat to lens **1319** (along with conduction and convection) to remove moisture occlusion from light transmissible portion **1321** of lens **1319**. A light transmissible inner lens divider **1323** is also provided in housing **1318**.

FIG. **62** is a front exploded perspective view from above of a modified headlamp **1310** similar to that depicted in FIG. **61**, further showing the addition of light transmissible inner lens divider **1323** before installation in housing **1318** to create a smaller gas volume behind the light transmissible lens **1319** that is heated with a heat source **1312**. Heat source **1312** includes a finned ceramic body and a PTC heater configured to deliver heat, both radiant and convective, to the reduced volume provided between lens **1319** and lens divider **1323**.

FIG. **63** is a plan view from above of the headlight assembly **1310** of FIG. **30** showing lens **1319** and housing **1318**.

FIG. **64** is a vertical sectional view of the headlight assembly **1310** and heat source **1312** taken along line **64-64** of FIG. **65**. More particularly, lens divider **1323** is shown disposed in housing **1318** behind heat source **1312** to subdivide the volume in housing **1318** which reduces volume of gas needed to be heated by source **1312** to convectively heat lens **1319**. In addition, source **1312** also heats lens **1319** via radiant and convective heat transfer.

FIG. **65** is a right elevational side view of the headlight assembly **1310** of FIG. **63** showing lens **1319** and housing **1318** in side view.

FIG. **66** is a vertical sectional view of the headlight assembly **1310** and heart source **1312** taken along line **66-66** of FIG. **63** and showing relative positions of lens divider **1323** relative to lens **1319** and housing **1318**.

FIG. **67** is a front exploded perspective view from above of even another headlight assembly **1410** and heat source **1412**. More particularly, heat source **1412** has a ceramic sloped and slightly hemispherical surface **1420** (see FIG. **68**) that directs radiant heat radially outward and upward in corresponding perpendicular directions from such surface. Another ceramic plate **1450** mounted onto post **1446** within housing **1418** opposite the surface **1420** and is also slightly hemispherically curved in order to further reflect back radiant heat in perpendicular directions that spread out radiant heat onto an inner surface of lens **1419** to remove moisture occlusion from inside and outside lens **1419** and from inside and outside lens divider **1423**. Divider **1423** is optional and can be removed in certain configurations. Further optionally, ceramic body **1420** (which is heated by an internal PTC heater (not shown—see FIG. **71**A) can be made from a potted epoxy, cyanoacrylate epoxy, or a filled epoxy, such as an epoxy filled with relatively high emissivity ceramic powder. Plug body **1424** (see FIGS. **67** and **68**) is mated in sealed engagement via elastomeric cylindrical sealing washer **1413** within a bore **1415** of lens **1419**. An edge aperture **1427** in lens divider **1423** encircles post **1446** in close proximity.

FIG. **68** is a rear perspective component view from above of the heat source **1412** of FIG. **67**.

FIG. **69** is a plan view from above of the heat source **1412** of FIG. **68** showing threaded plug **1424** and sloped, or three-dimensionally shaped end surface on ceramic body **1420**.

FIG. **69**A is vertical sectional view of the heat source **1412** taken along line **69**A-**69**A of FIG. **69** further showing plug **1424** and ceramic body **1420**.

FIG. **70** is a plan view from above of the headlight assembly **1410** of FIG. **67-69**A. More particularly, plug **1424** is shown installed in sealed engagement through lens **1419** relative to housing **1418**.

FIG. **71** is a vertical sectional view of the headlight assembly **1410** and heat source **1412** taken along line **71-71** of FIG. **70**. More particularly, lens divider **1423** subdivides a volume within housing **1418** behind lens **1419**. A ceramic plate **1450** is spaced apart in close proximity opposite sloped ceramic body **1420** so as to redirect radiant heat back onto the inner surface of lens **1419**. Plug **1424** is shown sealed to lens **1419** with resilient sealing washer **1413**.

FIG. **71**A is an enlarge sectional view taken from the encircled region **71**A of FIG. **71** showing washer **1413** and plut **1424** of heat source **1412** in enlarged greater detail. Likewise, ceramic plague **1450** is also shown in enlarged detail.

FIG. **71**B is an enlarged sectional view taken along line **71**B-**71**B of FIG. **71**A showing ceramic plate **1450** relative to lens divider **1423** behind lens **1419**.

FIG. **72** is a rear perspective view from above of a combination heat source **1512** and moisture permeable membrane plug heater **1520** for use in a light housing or light assembly by inserting the plug heater **1520** into a tapped hole in a light housing or lens.

FIG. **73** is a rear exploded perspective view from above of the combination moisture permeable membrane plug heat source **1512** and moisture permeable membrane plug heater **1520** of FIG. **72**. A PTC heater **1522** is potted in a threaded body **1524** using a ceramic adhesive plug **1521** inside of an insulating silicon thimble **1523** within threaded plastic body **1524**. A moisture permeable membrane **1561** is retained in a groove and about a front bore of body **1524** with a plastic ring retainer **1581** to provide for moisture delivery from within a light housing driven by elevated temperatures provided by PTC heater **1522**. Annular ribs **1527** and **1529** are captured in complementary annular grooves **1528** and **1525**, respectively to affix together such assembled components. A pair of longitudinal slots are provided in tubular plug **1521** to guide and retain cylindrical PTC heater **1522** therein. One suitable exemplary class of membranes is available from GORE-TEX®. Optionally, epoxy or a cyanoacrylate epoxy can be used to pot PTC heater **1522** in plug **1521**. Further optionally, ceramic powder can be used to fill and epoxy when making plug **1521**.

FIG. **74** is a vertical side view of combination moisture permeable membrane plug heat source **1512** and moisture permeable membrane plug heater **1520** of FIGS. **72-73**.

FIG. **75** is a vertical sectional view of the combination taken along line **75-75** of FIG. **74** and showing moisture permeable membrane **1561** with PTC heater **1522** shown within plug body **1524** to form a pair of opposed semi-cylindrical apertures **1590** and **1592**.

FIG. **76** is a vertical sectional view of the combination moisture permeable membrane plug heat source **1512** and moisture permeable membrane plug heater **1520** taken along line **76-76** of FIG. **74**. More particularly, retention ring, or affixing adhesive ring **1581** is shown affixing membrane **1561** within and about a central bore of plug body **1524**. PTC heater **1522** is affixed within a cylindrical conductive epoxy tubular plug **1521** within an insulating silicon thimble, or tube **1523**.

FIG. **77** is a front exploded perspective view from above showing yet even another headlight assembly **1610** having a heat source **1612**. Heat source **1612** is a plug heater similar to heat source **1412** of FIGS. **68-69**A. A plastic hollow heat pipe **1650** is shown having a central hole on a bottom surface adjacent heat source **1612**. Heat and air from adjacent source **1612** enters the lower central hole and migrates outwardly on each opposed hollow arm of heat pipe **1650** where a plurality of spaced apart holes and an end hole in each arm provide an exit for rising heat via convection currents. Lens divider **1523** is affixed within housing **1618** behind lens **1619**. Plug **1624** seals in threaded engagement via resilient o-ring washer **1613** within bore **1615** in lens **1619**.

FIG. **78** is a front perspective component view of heat pipe **1650** used in the heat source of FIG. **77**. Heat pipe **1650** includes an equi-spaced apart array of top edge holes **1652** and a central aperture **1654** for receiving plug **1624** (see FIG. **77**). Each opposed arm of heat pipe **1650** forms a hollow elongate tube and an air intake aperture **1656** draws in new air as heated air rises up via holes **1652** to heat lens **1619**. (of FIG. **77**). Aperture **1658** provides a routing path for power supply wires of heat source **1612**.

FIG. **79** is a plan view from above of the heat pipe **1650** of FIG. **78** showing the array of top-most spaced-apart heated air delivery holes **1652**.

FIG. **80** is a front elevational view of the heat pipe **1650** of FIGS. **78-79** showing central aperture **1654**, air intake hole **1656**, and wire clearance hole **1656**.

FIG. **80**A is a vertical sectional view of the heat pipe **1650** taken along line **80**A-**80**A of FIG. **80**.

FIG. **81** is a front elevational view of headlamp assembly **1610** and heat source **1612**. Heat source **1612** is a plug heater similar to heat source **1412** of FIGS. **68-69**A. A plastic hollow heat pipe **1650** is shown supplied with a source of heat from plug **1624**.

FIG. **82** is a plan view of the headlamp **1610** and heat source of FIG. **81** showing plug **1624** affixed in sealed relationship within lens **1619** opposite housing **1618**.

FIG. **83** is a vertical sectional view of the headlamp **1610** and heat source **1612** taken along line **83-83** of FIG. **82** showing lens divider **1623** subdividing a volume within housing **1618** behind lens **1619**. Plug **1624** is sealed with resilient synthetic rubber o-ring washer **1613** to lens **1619** aligned and seated with heat pipe **1650**.

FIG. **84** is front perspective view from above of the headlamp **1610** and heat source **1612** of FIGS. **81-83** showing lens divider **1623**, heat pipe **1650**, heated air outlet holes **1652**, plug **1624** and (omitted) lens **1619** having a light transmissive portion.

PTC (Positive Temperature Coefficient) heating elements provides a self-contained mechanism wherein the heater is self-regulating, eliminating the need for a thermostat or separate temperature sensor and feedback control loop arrangement. The PTC heating element, which is comparable to an electric resistive heating filament, will increase or decrease its own internal resistive property. Increasing the resistance decreases the current flow and heat, and decreasing the resistance increases the current flow and heat, depending on the internal temperature of the PTC material. This enables the PTC heating element to self-regulate current flow through the device and in particular, heat output of the device within a pre-determined and usefully accurate range. Additionally, use of the PTC heating elements offers the useful advantage of inherent or built-in control of heat output and consumption of electrical current for more efficient power consumption than for regular, or prior design heating elements. Furthermore, new radiative heat transfer structures are implemented with the PTC heater. The prior design heating elements just turn on to the maximum heat until a thermostat turns it off by means of an additional control system or electronic circuitry. Hence, the prior designs can cause undesirable heating and cooling fluctuations including cyclic or periodic heating and cooling. PTC heaters can be designed or otherwise pre-selected to operate within a desired range of temperatures and output heat characteristics at or approaching steady-state conditions for a given application offering inherent simplicity over previous methods. As implemented, a PTC heater and a ceramic radiant heat dissipating body is placed in the light housing enclosure, allowing for increased radiative heat transfer to occur in combination with convective heat transfer (hot air rises, and cold air will cycle downward), and therefore ensure greater heat transfer and concentration to the lens. In one embodiment, the PTC heating element is electrically adapted or connected right into the existing light power circuitry, making installation of a PTC heated light as simple as unplugging one and plugging in or adapting the other in its place. Optionally, alternate heat sources such as nichromium wire or resistive wire heaters can be used as a heat source either separately, or in combination with a PTC and/or thermistor component.

Provision of increased radiative heat transfer over prior efforts via use of a ceramic radiant heat dissipative body provides enhanced ability to eliminate condensation from within and outside of a vehicle lens, both frozen and liquid (vapor). Furthermore, provision of plug shaped PTC heaters in several configurations also provide the enhanced ability to eliminate condensate. Compact and simple to install, plug-shaped PTC heaters are especially useful in retro-fit applications of existing light housings already released to customers and in daily use. This feature is especially important where there are preferably none or at least minimal negative side effects or encroachment to the existing light-transmissible optics and geometries within the light housing. Radiant heat transfer and convective heat transfer are largely independent and unrelated mechanisms, and both are optimized by the present designs. Radiant emissions (heat transfer) can occur in a vacuum whereas convective heat transfer cannot occur in a vacuum. This is because radiant heat transfer is purely black body radiation in accordance with the Stefan-Boltzmann law: $j^*=\epsilon\sigma T^4$, where: j^* is the radiant flux, or irradiance (Watts/meter^2), ϵ (<1) is the emissivity, σ is the Stefan-Boltzmann constant, and T is the absolute temperature of the body. Desirable higher levels of emissivity (approaching values of 1) typically means that the surface looks black, especially at the peak spectrum of the radiator, which depends on the temperature. Effective heat convection typically involves superior heat conductors (typically metal) with granular surface finishes to achieve larger surface area in contact with the surrounding gas, or larger surface areas. The balancing between conductive heat transfer and radiant heat transfer is typically slight with very little to trade off because radiant heat dissipation is an order of magnitude larger than convective heat dissipation in air at one atmosphere pressure. The matter is different when dealing with higher density gas.

FIG. **85** illustrates one construction for a heated lens **1719** for a vehicle illumination system, or vehicle head light **1710** (see FIG. **87**) having a heat source **1712** with a radiant heat dissipating body **1720** including a plug-shaped heater **1708** with a positive temperature coefficient (PTC) heater unit **1722** (see FIG. **86**B), which in this example is designed to keep the ambient temperature within the vehicle light housing **1710** at approximately 140 Degrees F. (60 degrees C.) whenever electrical power is supplied to the heater from an electrical power source such as a vehicle power source. Heat source **1712** is affixed to a light transmissive portion **1721** of lens **1719** within a threaded bore **1715**. A plug assembly **1704** and a pair of insulated conductive leads **1756** and **1758** pass through bore **1715** in assembly. A flat, cylindrical sealing washer **1714** of flexible and thermally conductive material is provided between a plug body **1724** of heat dissipating body **1720** and a recessed circumferential seal surface **1713** of lens **1719** to provide a weatherproof seal there between. Heat source **1712** enables heat transfer to light transmissive portion **1721** of lens **1719** at a temperature high enough to mitigate or eliminate condensation, either frozen or liquid, from occluding light transmission through the lens **1719**. Although depicted on a vehicle head light, it is understood that heat source **1712** can be implemented on any other type of vehicle light, such as tail lights, side marker lights, clearance lights, stop lights and non-powered safety reflectors.

As shown in FIG. **86**, vehicle head light lens **1719** shows centered bottom placement of heat source **1712** in light transmissive portion **1721** of lens **1719**. According FIGS. **86** and **86**A, plug body **1724** is mated in threaded engagement within bore **1715** (see FIG. **85**) of lens **1719** at most flush with an outer surface of light transmissive portion **1721**. Optionally, plug body **1724** can be recessed relative to an outer surface of lens **1719** to provide a recessed heat source **1712** relative to an exterior surface of light transmissive portion **1721**. In assembly, connector plug **1704** and insulated conductive leads **1756** and **1758** are received through bore **1715** (see FIG. **85**) within a head light **1710** (see FIG. **87**) for connection to a power supply (not shown) within such head light assembly, as shown in FIG. **86**A.

FIG. **86**B shows in greater detail moisture proof sealed assembly of plug body **1724** on heat dissipating body **1720**. An outer surface of plug **1724** is shown recessed slightly below an outer surface of light transmissive portion **1721** on lens **1719**. More particularly, a resilient and thermally conductive flat cylindrical sealing washer **1714** is compressed in sealing engagement between a radially outwardly extending circumferential flange **1711** of plug body and recessed circumferential flange, or seal surface **1713** about threaded bore **1715** of lens **1719**. Radially outwardly extending circumferential flange **1711** compresses sealing washer **1714** against recessed circumferential sealing surface, or flange **1713** as cylindrical male threaded portion **1773** threads into engagement with a complementary female threaded portion **1717** of bore **1715**. An integrally molded centrally located flat tool slot **1705** enables threaded mating of plug body **1724** within threaded bore **1715** of lens **1719**. A cylindrical disk-shaped positive temperature coefficient (PTC) heater **1722** is affixed within a cylindrical bore, or recess **1734** within plug body **1724** using a thermally conductive material **1723**, such as an epoxy, filled epoxy, or other suitable adhesive or structural potting material. For example, filled epoxy can include one or more of aluminum or ceramic powder in order to respectively increase thermal conductivity and emissivity of the resulting filled epoxy for heat source **1712**. In some cases, it is desirable to have higher thermal conductivity between plug body **1724** and lens **1719**. In other cases, it is desirable to have higher radiant heat transfer (elevated emissivity values) with respect to material **1723**.

Optionally, one exemplary high thermal transfer epoxy adhesive potting material is a grey two-component, aluminum-filled epoxy system commercially available from Epoxies, Etc. (Innovative Bonding Solutions) through Epoxies.com, 21 Starline Way, Cranston, R.I. 02921, USA, available commercially as product number 70-3812 NC. This thermal epoxy system has a thermal conductivity of 4.5 W/m-K with an operating temperature range of −55 to 155 degrees C. (−131 to 311 degrees F.) once the two-part epoxy is fully cured after mixing. Rates of curing range from 15 to 20 minutes at 125 degrees C. (257 degrees F.) to 24 hours at 25 degrees C. (77 degrees F.) making this material suitable for use in production manufacturing settings. Additionally, this material passes NASA's outgassing requirements per ASTM standard E-595-07 making this particular potting material highly suitable for extreme environments.

One exemplary lens portion for element **1721** of subassembly **1719** that has been adapted and configured to accept a heated plug assembly is available for purchase and included as a part of 4"×6" (10 cm×15 cm) rectangular LED headlight assembly model number VHL-4X6DRL, manufactured and distributed by Maxxima, a division of Panor Corporation, 125 Cabot Court, Hauppauge, N.Y. 11788, USA.

It can be argued that current LED lighting technology is a victim of its own success when it comes to preventing and eliminating condensation, snow and ice from the lens of a light housing. For example, the reduced power consumption and heat output of the more recently introduced LED lights compared to the well-known greater power consumption and heat output of historic and long-familiar incandescent lights is about 10% of the energy required for incandescent. This difference tends to reinforce and emphasize the inherent problem with the inability of LED lights to prevent and eliminate condensation, snow and ice from accumulating and obstructing the lenses of a vehicle lighting system, and underlines the urgent need for a practical, viable and economically cost-effective solution to this problem.

One exemplary threaded plug for element **1724** is commercially available for purchase part from Thomas & Betts Corporation (A member of the ABB Group), 8155 T&B Boulevard, Memphis, Tenn. 38125, USA. Threaded plug component **1724** is a ½" (13 mm) nominal diameter threaded low-profile, generally flush-head hollow plastic plug used to seal unused threaded holes with commercially available Red Dot (brand) model number S5203E rectangular lamp holder cover. This rectangular lamp holder cover is typically used to support lighting fixtures that are specified for use in wet locations for both residential and commercial building wiring and lighting fixture applications.

While the exemplary threaded plug is composed of injection molded plastic material, it is understood that a custom manufactured threaded plug of a different material may be implemented. Optional materials and methods of manufacture may include, for example, a selectively preferred material that is both compatible with its intended long-term exposure to the environment while also providing the ability to readily conduct, transfer or radiate heat energy specifically and directly into the lens portion of a vehicle light. In addition to material thermal conductivity and radiation characteristics, storage of heat within a thermal mass is another factor or attribute defined by the specific heat capacity of different materials. A higher specific heat capacity or the ability to store heat can promote more stable or even heating of the lens throughout a variety of changing temperatures and environmental conditions. Therefore, custom tailored types of more thermally ideal plastics or composite materials are anticipated (beyond for example molded, cast or machined metals such as aluminum, stainless steel, or zinc, etc.), including various types of ceramic having preferred characteristic degrees of heat transfer, high emissivity, and specific heat capacity.

One exemplary plastic-molded polarized 2-wire bullet connector for element **1751**, further including flexibly-insulated 16-gauge or the like multi-strand copper conductor wires **1756** and **1758**, is commercially available for purchase from Wiring Products, Ltd., 135 Isidor Ct Ste B, Sparks, Nev. 89441, USA. Flexibly-insulated multi-strand copper conductor wires **1756** and **1758** are electrically bonded to conduct electricity, or otherwise can be electrically attached, bonded or connected to the opposite faces or poles of PTC heater **1722** preferably by typical heat-soldering processes and connection materials available for such purposes.

Optionally, insulated sold copper conductor wires may be utilized in place of multi-strand copper conductor wires **1756** and **1758**. Further optionally, electrically conductive insulated bus bar or braided material comprised of other electrically conductive metals and materials may be utilized and mechanically configured to resist both mechanical fatigue or chemical corrosion anticipated as a result of long-term exposure to both vibration and thermal expansion and contraction and the elements.

Optionally, a sealed water-proof polarized connector may be used (not shown) for element **1751**. One exemplary sealed water-proof connector is commercially available for purchase as Delphi part number 1210973, male 2-contact shroud half Weather Pack Connector, item number 38042. Further optionally, Delphi part number 12015792, female 2-contact tower half body Weather Pack Connector, item number 38043. Both optional connectors are commercially available for purchase from Waytek, Inc., 2440 Galpin Court, PO Box 690, Chanhassen, Minn. 55317, USA.

One exemplary heat source for element **1722** is a positive temperature coefficient (PTC) heater commercially available from Digikey Electronics, 701 Brooks Ave South, Thief River Falls, Minn. 56701 USA, as part number 223-1183-ND (manufacturer part number P5005C050S500H, Spectrum Sensors & Controls, Inc., 328 State Street, St. Mary's, PA 15857, USA). This is a small and compact round disk-shaped heater 0.50 inches (13 mm) in diameter by 0.050 inches (1.27 mm) in thickness, having a rating of 50 volts maximum input voltage and a switch temperature of 50 degrees C. (122 deg. F.). Electrical current resistance at 25 degrees (77 deg. F.) is rated at 5 ohms. Other optionally available switch temperatures of any desired value between a range of 40 degrees C. (104 deg. F.) and 150 degrees C. (302 deg. F.) may be selected accordingly by specified temperatures through correspondingly different part numbers. Switch temperatures can be generally defined as the nominal operating target temperature or design temperature range of a PTC heater.

Optionally, it is anticipated that PTC heaters may be manufactured to a specified switch temperature, and that custom PTC heaters may be made available in specified minimum or limited quantities for unique applications in instances where the desired temperatures should fall between commonly-available production PTC switch temperature values.

One exemplary adhesive and potting material for thermally conductive adhesive and potting material of element

1723 is available for purchase from Loctite™ (Adhesives Division of Henkel Corporation), 200 Elm Street, Stamford, Conn. 06902, USA as a Loctite adhesive number HY 4090 GY. This adhesive is a grey two-part liquid-gel compatible with most metals, plastics, and rubber materials and has a minimum and maximum operating temperature range of −40 degrees (−104 deg. F.) to 150 degrees (302 deg. F.). This temperature range is well within the anticipated working range of temperatures of the present device. This exemplary adhesive has a mechanical shear strength of 2420 psi and a tensile strength of 1025 psi. The strength of this material is well within the expected working loads of the present device.

Another exemplary adhesive and potting material for element **1723** is available for purchase from Aremco Products, Inc., 707-B Executive Boulevard, Valley Cottage, N.Y. 10989, USA as product part number 865 Ceramabond™ which is suitable for bonding ceramics to ceramics and ceramics to metals further including an aluminum nitride filler material to promote thermal conductivity characteristics between joined components as preferred.

FIG. **87** is a perspective view of an exemplary vehicle LED head light assembly **1710** including the heated LED head light lens assembly **1719** of FIGS. **85**, **86**, **86**A, and **86**B and illustrating an ice scraper **1703** being used to scrape accumulated snow and/or ice **1701** from an outer surface of a light transmissible portion **1721** of lens **1719** on housing **1718**. FIG. **87** shows one exemplary complete headlight assembly including the lens portion of a 4"×6" (10 cm×15 cm) rectangular LED headlight assembly model number VHL-4X6DRL, manufactured and distributed by Maxxima, a division of Panor Corporation, 125 Cabot Court, Hauppauge, N.Y. 11788, USA, as previously described. However, the lens **1719** has been modified with a threaded bore **1715** and recessed circumferential seal surface, or flange **1713** to accept in threaded engagement heat source **1712** in the form of a threaded heat dissipating body **1720** that is recessed (or at most flush) with an outer surface of lens **1719**. This design provides a distinct advantage such that a user will not snag an ice scraper **1703**, for example, on plug body **1720** when clearing ice from portion **1721** of lens **1719**. This greatly improves the often-difficult task of scraping and clearing snow and ice **1701** from the light transmissive portion **1721** of lens **1719** without potential physical damage to the plug-shaped heater **1708**, the lens **1719** or the ice scraper **1703**. Additionally, this flush design of the heat source makes simple cleaning and wiping of the lens convenient by avoiding a protrusion or obstacle at the face of the lens **1921**.

FIG. **88** is a perspective view of an exemplary LED tail light assembly **1810** for use on a snowmobile (not shown) and having a plug-shaped threaded heat source **1812**. More particularly, heat source **1812** comprises a heat dissipating body **1820** (see FIG. **89**) in the form of a cylindrical plug-shaped body **1824** (see FIG. **90**) that is affixed into a threaded bore **1815** (See FIG. **90**A) in a bottom wall of a lens **1819** of tail light **1810**.

As shown in FIGS. **88**, **89** and **90**A, tail light assembly **1810** includes a three-dimensional lens **1819** that is affixed to a rear light housing member **1818** to form a housing for encasing a printed circuit board **1830** having an array of light emitting diodes (LEDs) **1832** (see FIG. **89**). In one case, lens **1819** affixes to housing member **1818** with an ultrasonic plastic weld. In another case, lens **1819** affixes to housing member **1818** with a plurality of threaded fasteners. In yet another case, lens **1819** connects with snap fittings to housing member **1818**. For the case where lens **1819** is affixed to housing member **1832** with an ultrasonic weld, threaded plug body **1824** of heat source **1812** provides an aftermarket modification for heating a tail light assembly because an end user can cut, bore, machine, or drill a hole **1815** of appropriate diameter and tap a bore **1815** having female threads **1817** into lens **1819** and affixed a threaded plug-shaped heater **1809** as an aftermarket or retrofit modification without, for example, having to break the ultrasonic weld or disturb the sealed fastening mechanism or feature between lens **1819** and the rear light housing member **1818**.

FIG. **90** is a vertical front elevational view of the tail light assembly of FIGS. **88** and **89** showing threaded placement of plug body **1824** in a bottom face of lens **1819** on tail light **1810**. Heat dissipating body **1820** of heat source **1812** is inserted from the outside of lens **1819** with plug connector **1851** provided outside of tail light **1810** for connection to an external, complementary connector and vehicle power source (not shown).

FIG. **90**A is a cross-sectional view of the tail light assembly of FIG. **90** taken along line **90**A-**90**A depicting the assembled-together configuration of tail light **1810** with lens **1819** ultrasonically welded along an outer periphery to housing member **1818**. An array of LEDs, such as LED **1832**, emit light through lens **1819**. Heat dissipating body **1820** of heat source **1812** is threaded via cylindrical male threaded portion **1873** into female threaded portion **1817** of bore **1815** in lens **1819**. In this case, the radially outward extending circumferential flange **1811** of plug-shaped heat source body **1824** may simply contact the flat bottom surface of lens **1819**, thus providing a seal by simple mechanical contact. Optionally, contact adhesive, thermally conducive grease or thermally conductive adhesive may be used (not shown) to further ensure sealing out water and any foreign material. Plug-shaped heater **1809** transfers heat via conduction into lens **1819** via heat generated and transferred from PTC heater **1822** though thermally conductive adhesive, or epoxy **1823** provided in plug body **1824** for further heating within lens **1819** by a combination of conduction and convection. In some cases, epoxy **1823** is a filled epoxy with a ceramic powder filler that provides elevated emissivity for adhesive **1823** which enhances radiative heat transfer from a distal end of plug body **1824**. In other cases, thermally conductive fillers, such as aluminum powder, are added to increase conductivity. Even further, a combination of fillers that enhance conduction and convection, or one or the other, are added to an adhesive material, such as an epoxy or thermoset plastic or other suitable structural carrier material.

Optionally, it may be preferred to include and attach, when space allows, a small cylindrically-shaped finned heat sink (not shown) to the end portion of plug body **1824** attached to and in thermal communication with adhesive **1823**. One exemplary heat sink is commercially available through and can be purchased from Digikey Electronics, 701 Brooks Ave South, Thief River Falls, Minn. 56701 USA. This exemplary heat sink is manufactured by Aavid, a Thermal Division of Boyd Corporation under extruded collar model 3250, part number 325705B00000G, having an overall diameter of 12.70 mm (0.50 inches) and a height of 6.35 mm (0.25 inches) and an inside diameter of 8.07 mm (0.31 inches). This heat sink comprises black anodized aluminum and includes 15 radially outwardly extending fins each vertically aligned and oriented with the center cylindrical axis of the heat sink. In this way additional or more efficient heat transfer from the PTC heater **1822** to the interior portions of lens **1819** can be accomplished through the thermally conductive adhesive potting **1823** of plug-shaped heater **1808**.

FIGS. **88**, **89**, **90**, and **90**A show one exemplary snowmobile tail light assembly part number BRP 520001143 available from Bombardier Recreational Products (BRP), Inc. The housing is marked as ABS plastic while the lens is marked PMMA plastic, "Made in Mexico", 13.5V, TAIL 139 mW, STOP 2.6 W, Visteon VP-00146604. It is quite apparent from these product markings that the relatively low total wattage or power rating of the six LED's at only 139 milliwatts would be largely insufficient to readily melt any accumulation of snow and ice from the outer surface of a snowmobile tail light lens during freezing temperatures in snowy conditions. Likewise, the stop light total wattage or power rating is in fact higher than the tail lights, however the stop light is used only during braking of the vehicle on an intermittent basis, so the heat contribution is infrequent and insufficient to melt snow and ice. Therefore, it remains highly likely that an insufficient amount of heat can be generated to maintain the outer light transmissible portion of the lens **1821** free and clear of all accumulations of snow and ice. In this case, there exists a likelihood that snow and ice will continue to accumulate and obstruct the visibility of tail and brake light warning information to others, creating a vehicle, traffic and operator safety hazard unless an additional heat source **1812** is provided within the LED tail light housing of tail light **1810**.

FIG. **91** is a front elevational view of the threaded-plug heat source **1812** shown in FIGS. **90** and **690**A. More particularly, heat source **1812** of FIGS. **91** and **92** comprises a plug-shaped heater **1809** that provides a heat dissipating body **1820** with a threaded plug body **1824**. An electrical connector plug **1804** enables removable electrical connection of a PTC heater **1822** (see FIG. **91**A) via insulated conductive wire leads **1856** and **1858** with a complementary plug (not shown) provided to a vehicle wiring harness and electrical power supply (not shown).

As shown in cross-sectional view in FIG. **91**A, heat dissipating body **1820** is configured to transfer heat via conduction through threaded portion **1873** to a vehicle lens **1819** (see FIG. **90**A) and a combination of radiation, conduction and convection via an outer end portion of plug shaped heater **1808** from a thermal heat transfer material **1823**, such as a cured epoxy adhesive material or cement that encases and otherwise encapsulates PTC heater **1822** within cylindrical bore, or recess **1834** of plug body **1824**. In one case plug body **1824** is constructed from a heat resistant plastic material. In another case, plug body **1824** is constructed from a ceramic material having a high emissivity capable of significant radiative heat transfer, in addition to thermal conduction into a vehicle heated lens.

FIG. **93** is a top end view of the threaded-plug heat source **1812** of plug-shaped heater **1809** with heat transfer material, or epoxy **1823** removed from the top end portion to show PTC heater **1822**.

The threaded plug heater assembly **1812** in FIGS. **91**, **91**A, **92** and **93** is nearly identical to the threaded plug heater assembly **1712** in previous FIGS. **85**, **86**, **86**A, **86**B and **87** with the exception that the insulated conductive wire leads **1856** and **1858** and electrical connector plug **1851** exit the threaded plug body **1824** in an opposite direction.

FIG. **94** is a perspective view of another exemplary LED heated vehicle tail light assembly, or tail light **1910**. More particularly, a tail light lens **1919** is shown in exploded view removed from an oval or oblong housing body **1918**. In assembly, lens **1919** of tail light **1910** is affixed to housing member **1918** with ultrasonic welding, fasteners, or adhesive, as shown in FIG. **96**. A heat sources **1912** includes a pair of plug bodies **1924** provided in spaced apart relation about a central light source aperture **1927** and **1929** provided in a heat dissipating body, or thermal heat transfer plate **1920** and a thermal insulating body, or insulating plate **1950**. A light emitting diode (LED) light source **1932** is supported in housing **1918** on an LED board **1931** separate from a PC board **1930** and configured to emit a source of light through apertures **1927** and **1929** for transfer through a light transmissive portion of lens **1919**. Plug bodies **1924** transfer heat to heat dissipating body **1920** for delivery to lens **1919**, as well as directly to lens **1919** to remove light-occluding precipitation from lens **1919** in the form of ice, frost, condensate or water, as shown in FIG. **94**A.

Heat transfer can occur as one or more of conduction, convection and/or radiation through lens **1919** of tail light **1910**, as shown in FIG. **95**. In one form, plate **1920** of FIGS. **94** and **94**A is a thermally conductive aluminum plate. In another form, plate **1920** is a thermally conductive aluminum plate having a first or outer surface having a high emissivity coating, such as a ceramic coating, or an anodized aluminum coating that faces and is placed in thermally radiant communication with the lens, and the second, or inner (or back) side has a lower emissivity surface, such as a polished aluminum surface. In even another form, plate **1910** is a ceramic plate that is heated by plug bodies **1924** and distributes the accumulated heat over time to a greater extent as radiant heat transfer, but with conduction and convection to a lesser extent that from an aluminum plate.

As shown in FIGS. **94**A and **94**A, a slight gap **1980** is provided between heat dissipating plate, or body **1920** and insulating plate **1950**. More particularly, a circumferential shoulder **1911** is provided on plug body **1924** enlarged relative to cylindrical threaded portion **1973** and sized slightly larger than heat source clearance bore, or hole **1915** in plate **1920**. Clearance bore **1915** is sized to receive threaded portion **1973** in assembly. Plug body **1924** is adhesively affixed via an epoxy or other suitable adhesive material to an outer surface of insulating plate **1950**. Heat source **1912** is configured in spaced apart relation from an inner surface of lens **1919** with a plug of cured heat transfer material **1923**, or epoxy, that encases PTC heater **1922** in thermally conductive relation therein to transfer heat to inner surface of lens **1919** via one or more of conduction, convection and/or radiation. PTC heater draws power from printed circuit (PC) board **1930** (of FIG. **10**A) along with LED **1932**, while LED **1932** is supported separately by LED board **1931**. Insulating board, or insulation plate **1950** can be formed of any suitable insulating material for resisting one or more of conduction, convection, and/or radiation. For example, an adhesive backed foam can be used to form insulation plate **1950**. Optionally, a fiberglass insulating plate that insulates against conductive/convective heat transfer can be used having a reflective top aluminum foil surface that also insulates against radiant heat transfer.

Further optionally, an abrasion-resistant high-temperature silicone foam may be utilized. One exemplary foam insulation sheet is available from McMaster-Carr, 600 N County Line Rd., Elmhurst. Ill. 60126-2034 under catalog part number 9158T22. This exemplary foam is ⅛ inch (3.17 mm) in thickness, has a nominal operating temperature range of −65 to 390 degrees F. (−18 to 199 degrees C.), a density of 13 lbs/cubic foot (208 kg/cubic meter), and R-value of 0.3. It is further foreseeable that a wide range of other flexible, semi-flexible, semi-rigid, and rigid insulating foams and materials are available for use from this source and other distributors and manufacturers which are comprised of various different materials, each having their own specific design specifications and criteria as may be needed for specific or special thermal insulating applications.

FIG. **95**B depicts the orientation of LED light source **1932** on PC board **1930** centrally within and housing **1918** on an LED board **1931** for transmission of light through apertures **1927** and **1929** and a light transmissible portion of lens **1919** on tail light **1910**. Heat dissipating body **1920** transfers heat via conduction from heat sources, or plug bodies **1924** to lens **1919** via radiation, conduction, and/or convection. Insulating plate **1950** serves to protect LED light **1932** and PC board **1930** from exposure from excessive heat from heat dissipating body **1920** that might otherwise reduce life expectancy.

FIG. **97** is an exploded perspective view of the vehicle tail light assembly of FIGS. **94-96** further illustrating construction and assembly details of tail light **1910**. More particularly, plug bodies **1924**, insulated conductive wire leads **1956** and **1958**, and heat dissipating body **1920** cooperate to provide a heat source **1912** affixed within a housing formed between housing member **1918** and lens **1919**. Thermal insulating plate **1950** includes a pair of cylindrical apertures, or bores **1909** configured to enable through passage of pairs of wire leads **1956** and **1958**. Each plug body **1924** is concentrically inserted into a complementary bore **1915** provided on either side of a light aperture **1927** in plate **1920**. Optionally, the bore **1915** may be smooth (as shown), or threads may be produced by self-tapping by a specially-designed and configured threaded plug **1924**, or threads (not shown) may be otherwise optionally provided in bore **1915** by a separate machining or tapping process or operation. A corresponding light aperture **1929** is provided between bores **1909** in insulating plate **1950**. Printed circuit board **1930** is mounted in housing member **1918** with fasteners (not shown) or adhesive. LED light **1932** is mounted centrally of housing member **1918** within a central region of apertures **1927** and **1929**. LED light source **1932** is mounted to and in thermal communication with LED printed circuit (PC) board **1933** and metal LED heat sink **1916** for the purpose of dissipating any excess heat produced by LED light source **1932**. It may be noted that heat sink **1916** is a component of the original design for dissipating excess heat from LED **1932** to improve reliability.

Additionally, with reference to FIGS. **94-97** circuit board **1930**, LED circuit board **1933**, LED heat sink **1916**, and the inside base portion of housing **1918**, a layer of clear potting, coating or otherwise clear weatherproofing circuit board coating material is provided to generally encases and seals these components from the effects of possible environmental contaminants and water (not shown). One exemplary potting and encapsulating compound is a general purpose, water-clear, hard, two-part epoxy product number 832WC commercially available from MG Chemicals, Burlington, Ontario, Canada.

FIGS. **98**, **99**, and **99**A illustrate in greater detail plug body **1924** and wire leads **1956** and **1958** of heat source **1912** (of FIG. **97**). FIGS. **99** and **99**A show placement of cylindrical disk-shaped PTC heater **1922** within a cylindrical bore of plug body **1924** within heat transfer epoxy, or material **1923**. FIG. **99** omits epoxy material **1923** to facilitate viewing of PTC heater **1922** approximately centrally oriented within plug body **1924**.

As shown in FIGS. **97-99**A, threaded plug heater assembly **1912** is very much like the threaded plug heater assembly **1812** shown in previous FIGS. **90**, **91-91**A**-92** and **93**. In this case, the two-pole electrical connector **1804** (From FIGS. **90**, **91-91**A, **92** and **93**) is absent. Instead, electrical wire leads **1956** and **1958** are connected directly to positive and negative power connections at the circuit board **1930** (of FIG. **97**) or a suitable alternate power connection is provided within the assembled light housing member **1918**.

One exemplary LED vehicle tail light shown in FIGS. **94**, **94**A, **95**, **95**A, **95**B, **96** and **97** is available for purchase from Truck-Lite Company, LLC, 310 East Elmwood Avenue, Falconer, N.Y. 14733, USA. It is understood that such light is then modified to add the heat source. Such tail light (without the heat source) is generally described as a Model Super 66, red oval, 1 diode, stop, turn, or tail light sold under four catalog part numbers; 66050R, 66250R, 66085R, and 66885R depending upon the choice of polycarbonate or acrylic plastic lens material in combination with additional product specifications and characteristics. Each of these exemplary LED vehicle tail lights includes a red translucent plastic lens in accordance with DOT SAE standards S2, I6, P2 and T and further include a single LED lighting element rated for 12 volts DC with a minimum amperage of 0.03 amps and a maximum amperage of 0.47 amp. The nominal size of these light assemblies are 2 inches by 6 inches (50 mm×152 mm) with the actual overall size being 6.5 inches (165 mm) long by 2¼ inches (57 mm) wide by 1⅝ inches (41 mm) in height including the 3-conductor female electrical plug connection at the back of the light housing. Based upon the electrical input specifications provided, the Truck-Lite Model 66 LED tail light exhibits a minimum power rating of 0.36 watts (where I×V=P) and a maximum power rating of 5.64 watts. It worth noting that the maximum power rating of 5.65 watts may typically occurs only during intermittent instances where the brighter and therefore higher-power brake lights are activated during the slowing of a vehicle or when a vehicle is temporarily stopped on a roadway with the brake pedal depressed. Given this range of power dissipation and the intermittent duty cycle of the LED tail and brake light, it is highly unlikely and generally proven that sufficient heat is generated within the enclosed and sealed LED light assembly during its normal operation to effectively melt a significant accumulation of snow or ice from the outside surface of the lens. This is especially important and likely in conditions of ambient air temperatures at or below freezing during winter driving conditions with ambient air temperatures falling to extreme sub-zero levels in far-northern climates. The likelihood for continued snow and ice obstruction of the tail and brake light lens is very likely to create a vehicle, traffic and operator safety hazard unless an additional heat source is provided within the LED light housing to solve this problem.

FIG. **100** is a perspective view of yet another exemplary LED heated vehicle tail light assembly (as shown in previous FIGS. **94** through **97** available for purchase as Model Super 66 from Truck-Lite Company, LLC, 310 East Elmwood Avenue, Falconer, N.Y. 14733, USA), or tail light **2010**. More particularly, a tail light lens **2019** is shown in exploded view removed from an oblong housing body **2018**. In assembly, lens **2019** of tail light **2010** is affixed to housing member **2018** with ultrasonic welding, fasteners, or adhesive, as shown in FIG. **102**. A heat sources **2012** includes a pair of PTC heaters **2022** provided in spaced apart relation about a central light source aperture **2027** and **2029** provided in a heat dissipating body, or thermal heat transfer plate **2020** and a thermal insulating body, or insulating plate **2050**. A light emitting diode (LED) light source **2032** is supported in housing **2018** on an LED board **2033** that is separate from a PC board **2030** and is configured to emit a source of light through apertures **2027** and **2029** for transfer through a light transmissive portion of lens **2019**. PTC heaters **2024** transfer heat to heat dissipating body **2020** for delivery to lens **2019**, as well as directly to lens **2019** to remove light-occluding precipitation from lens **2019** in the form of ice, frost, condensate or water, as shown in FIG. **100**A. A circumferential bead of thermally conductive adhesive, or epoxy **2023** affixed each PTC heater **2022** onto plate **2020**, as shown in FIG. **100**A. Optionally, a layer of thermally conductive grease or paste (not shown) can be provided between a cylindrical inner face of PTC heater **2022** and plate **2020** within bead **2023**

Heat transfer can occur as one or more of conduction, convection and/or radiation through lens **2019** of tail light **2010**, as shown in FIGS. **101**A and **101**B. In one form, plate **2020** of FIGS. **100**, **100**A, **101**A and **101**B is a thermally conductive aluminum plate. In another form, plate **2020** is a thermally conductive aluminum plate having a first or outer surface having a high emissivity coating, such as a ceramic coating, or an anodized aluminum coating and the back side has a lower emissivity surface, such as a polished aluminum surface. In even another form, plate **2020** is a ceramic plate that is heated directly by PTC heaters **2022** and distributes the accumulated heat over time to a greater extent as radiant heat transfer, but with conduction and convection to a lesser extent that from an aluminum plate.

As illustrated in FIGS. **100**A, **101**A and **101**B heat dissipating body, or plate **2020** is nested in direct contact with insulating plate **2050**. More particularly, a thin layer of adhesive (not shown) is provided between plate **2020** and plate **2050**. Each PTC heater **2022** is adhesively affixed via an outer circumferential ring **2023** of epoxy or other suitable adhesive material to an outer surface of plate **2020**. In one case, a thermally conductive grease (or paste as previously described) is provided within ring **2023** and between a back surface of PTC heater **2022** and a front surface of plate **2020**. Heat source **2012** is configured in spaced apart relation from an inner surface of lens **2019** with a circumferential ring **2023** of cured heat transfer material, or epoxy, that engages PTC heater **2022** in thermally conductive relation (via either physical contact or through thermally conductive grease or paste) to transfer heat to inner surface of lens **2019** via one or more of conduction, convection and/or radiation. PTC heater draws power from printed circuit (PC) board **2030**. Insulating board, or plate **2050** can be formed of any suitable insulating material for resisting one or more of conduction, convection, and/or radiation. For example, an adhesive backed foam can be used to form insulated plate **2050** as previously described in FIGS. **94-97**. Optionally, a fiberglass insulating plate that insulates against conductive/convective heat transfer can be used having a reflective top aluminum foil surface that also insulates against radiant heat transfer and provides reduced emissivity across insulating air gap **2080** as previously described in FIGS. **94-97**.

FIG. **101**B depicts the orientation of LED light source **2032** on PC board **2033** centrally within housing **2018** on an LED board **2033** for transmission of light through apertures **2027** and **2029** and a light transmissible portion of lens **2019** on tail light **2010**. Heat dissipating body **2020** transfers heat via conduction from heat sources, or PTC heaters **2022** to lens **2019** via radiation, conduction, and/or convection. Insulating plate **2050** and air gap **2080** serves to protect LED light **2032** and PC board **2030** from exposure from excessive heat that might otherwise reduce life expectancy of LED light source **2032**.

FIG. **103** is an exploded perspective view of the vehicle tail light assembly of FIGS. **100-102** further illustrating construction and assembly details of tail light **2010**. More particularly, PTC heaters **2022**, insulated conductive wire leads **2056** and **2058**, and heat dissipating body **2020** cooperate to provide a heat source **2012** affixed within a housing formed between housing member **2018** and lens **2019**. Thermal insulating plate **2050** includes a pair of cylindrical apertures, or bores **2009** configured to enable through passage of pairs of wire leads **2056** and **2058**. Each PTC heater **2022** is affixed with a circumferential ring **2023** of conductive adhesive on either side of a light aperture **2027** in plate **2020**. In one case, thermally conductive grease or paste is provided within ring **2023**, between a back surface of PTC heater **2022** and a front surface of plate **2020**. A pair of keyhole shaped bores **2007** are provided in plate **2020** to enable passage of insulated conductive wire leads **2056** and **2058**. A corresponding light aperture **2029** is provided between bores **2009** in insulating plate **2050**. Printed circuit board **2030** is mounted in housing member **2018** with fasteners (not shown) or adhesive. LED light **2032** is mounted centrally of housing member **2018** within a central region of apertures **2027** and **2029** on an LED PC board **2033**. LED light source **2032** is mounted to an in thermal communication with LED PC board **2033** and LED heat sink **2016** for dissipating any excess heat produced by LED light source **2032**. Again, it may be noted that heat sink **2016** is a component of the original design for dissipating excess heat from LED **2032** to improve reliability.

Additionally, with reference to FIGS. **94-97** circuit board **1930**, LED circuit board **1933**, LED heat sink **1916**, and the inside base portion of housing **1918**, a layer of clear potting, coating or otherwise clear weatherproofing circuit board coating material is provided to generally encases and seals these components from the effects of possible environmental contaminants and water (not shown). One exemplary potting and encapsulating compound is a general purpose, water-clear, hard, two-part epoxy product number 832WC commercially available from MG Chemicals, Burlington, Ontario, Canada.

FIGS. **104**, **105**, and **105**A illustrate in greater detail heat source **2012** and wire leads **2056** and **2058** of heat source **2012** (of FIG. **103**).

As shown in FIGS. **103-105**A, heat source **2012** is somewhat like the threaded plug heater assembly **1812** shown in previous FIGS. **91-91**A-**92** and **93**. In this case, the two-pole electrical connector **1804** (From FIGS. **91-93**) is absent from wire leads **2056** and **2058** leading from PTC heater **2022**. Instead, electrical wire leads **2056** and **2058** are connected directly to positive and negative power connections at the circuit board **2030** (of FIG. **103**) or a suitable alternate power connection is provided within the assembled light housing member **2018**. Also absent is the plug-shaped heat source body **1824** and **1924** of FIGS. **90** through **99**A.

Tail light **2010** of FIGS. **100-103** is constructed using the same Truck-Lite tail light as the Model Super 66 shown and describes with reference to previous FIGS. **94-97**.

FIG. **106** is front view of even another exemplary heated vehicle LED shown as a round tail light **2110** having a light transmissible lens **2119**. As shown in FIG. **107**, tail light **2110** includes a housing formed by joining together lens **2119** with housing member **2118** about an entire outer periphery using either fasteners (not shown), ultrasonic welding, or adhesive. FIG. **106**A illustrates in vertical centerline cross section internal components of tail light **2110**. Housing member **2118** cooperates in assembly with light transmissible lens **2119** to form a housing that contains an array of LED light sources **2132** and a heat source **2112** configured to transfer heat to remove/prevent moisture-based condensate from otherwise accumulating on inner or outer surfaces of lens **2119** and occluding the lens. It is understood that such construction can also include vents and moisture permeable membranes for the housing (penetrating the housing envelope not shown) that help evacuate moisture from within the housing. It also helps equalize air or gas pressure between the interior portion of the light housing and atmospheric pressure outside the light housing as pressures will vary due to changes in weather barometric pressure, temperature, ground elevation or altitude when combined with a heat source, such as the present heat sources detailed within this disclosure. Heat source **2112** includes a disc-shaped PTC heater **2122** affixed with thermally conductive adhesive, or epoxy to an outer surface of a heat dissipating body, or plate **2120**. In one case, plate **2120** is a thermally conductive aluminum plate. In another case, plate **2120** is a ceramic plate. In yet another case, plate **2120** is a thermally conductive aluminum plate **2120** having a ceramic coating on an outer, or first surface and a lower emissivity inner, or second surface such as a polished aluminum surface. A ceramic coating has a higher emissivity than a polished aluminum surface, therefore the ceramic coating increases radiative heat transfer. Radiative heat transfer does not heat up air molecules within the light housing, and excess heat buildup can have a negative effect on LED performance and reliability over time. An insulating layer, or panel **2150** is affixed via adhesive to a back surface of plate **2120**, and both are adhesively affixed onto a weatherproof clear coating **2160** atop a PC board **2130** as previously described with FIGS. **94** through **103**. One suitable insulating layer is an adhesive backed foam material such as an adhesive backed polyethylene foam as previously described.

FIG. **106**B shows the spacing and orientation between heat dissipating body **2120** relative to lens **2110** and one selected LED light source **2132**. Lens **2110** is shown affixed to housing member **2118**. Heat dissipating body **2120** and insulating layer **2150** each have a respective light clearance aperture **2127** and **2129** that mitigates heat transfer to LED light source **2132** and PC board **2130**, while also allowing for light transmission from LED light source **2132** through light transmissible lens **2119**. Insulating layer, or foam piece **2150** has an adhesive layer on opposed surfaces to enable affixation onto both weatherproof coating **2160** and plate **2120**. Optionally, insulating layer, or foam piece **2150** may be selectively formed from one or more of various types of materials having the desired thermal insulating properties and mechanical characteristics as previously described in FIGS. **94** through **103**.

FIG. **108** further illustrates heat source **2112** adhesively mounted onto or in proximity to weatherproof coating **2160** on PC board **2130** between housing member **2218** and lens **2110** of tail light **2110**. Optionally, heat source **2112** can be affixed with clips and/or fasteners or other suitable mechanical support structures to PC board **2130** or housing member **2118**. Heat dissipating body **2120** is shown encompassing an array of LED lights **2132**. PTC heater **2122** is adhesively affixed onto an outer surface of body **2120**, optionally with a surface application of thin thermally conductive adhesive (not shown) between PTC heater **2022** and heat dissipating body **2120** and/or a circumferential bead of thermally-conductive potting material **2132**.

Further optionally, thermally conductive grease or paste maybe used in place of the thermally conductive adhesive or in combination with any foreseeable mechanical fastener or adhesive attachment to support PTC heater **2022** to heat dissipating body **2120**. One exemplary thermally conductive paste is available as Omegatherm™ 201, High Temperature and High Thermally Conductive Paste, available from Omega Engineering, Inc., 800 Connecticut Ave., Suite 5N01, Norwalk, Conn., USA 06854. This material is a thick, grey, smooth paste that wets most surfaces and will not harden during long exposure to elevated temperatures. It is rated for continuous use between −40 and 200 degrees C. (−104 and 392 degrees F.).

Tail light **2110** is shown in exploded perspective view in FIG. **109**. Lens **2119** cooperates with housing member **2118** to encase heat source **2112**, insulating layer **2150**, weatherproofing layer **2160**, and printed circuit (PC) board **2130**. Heat source **2112** include PTC heater **2122** which is affixed with a circumferential arrangement of thermally conductive adhesive, or epoxy **2123** to an outer surface of heat dissipating body **2120**. A clearance bore **2107** is provided in body **2120** and a similar clearance bore **2109** is provided in insulating layer **2150** to optionally enable passage of insulated conductive lead **2158** on a backside of PTC heater **2122** through bodies **2120** and **2150**. Leads **2156** and **2158** then extend radially outwardly (see FIG. **109**A) for passage through aperture **2163** and **2165** in layer **2160** and PC board **2130**, respectively. Apertures **2127**, **2129** and **2161** in layers **2120**, **2150** and **2160**, respectively provide clearance for LED light sources **2132** on PC board **2130**.

FIGS. **106-130** shows several exemplary heat source embodiments implemented on a commercially available LED vehicle tail light available for purchase from Truck-Lite Company, LLC, 310 East Elmwood Avenue, Falconer, N.Y. 14733, USA generally described as a 6 LED Super 44 stop, turn and tail light assembly under two catalog part numbers; 44302R and 44982R having either a polycarbonate or acrylic lens housing and mounting flange. These are designed to operate at 12 to 14 volts DC at 0.03 amps and 0.3 amps for two modes of illumination; tail light illumination and brake light illumination respectively. Anticipated power consumption at 12 volts is 0.36 watts and 3.6 watts respectively.

FIG. **110** is front view of even another exemplary heated vehicle LED shown as a round tail light **2210** having a light transmissible lens **2219**. As shown in FIG. **111**, tail light **2210** includes a housing formed by joining together lens **2219** with housing member **2218** about an entire outer periphery using either fasteners (not shown), ultrasonic welding, or adhesive. FIG. **110**A illustrates in vertical centerline cross section internal components of tail light **2210**. Housing member **2218** cooperates in assembly with light transmissible lens **2219** to form a housing that contains an array of LED light sources **2232** and a heat source **2212** configured to transfer heat to remove/prevent moisture-based condensate from otherwise accumulating on inner or outer surfaces of lens **2219** and occluding the lens. It is understood that such construction can also include vents and moisture permeable membranes for the housing (penetrating the housing envelope not shown) that help evacuate moisture from within the housing and equalize air or gas pressure between the interior portion of the light housing and atmospheric pressure outside the light housing as pressures will vary arising due to changes in weather barometric pressure, temperature, ground elevation or altitude when combined with a heat source, such as the present heat sources detailed within this disclosure. Heat source **2212** includes a disc-shaped PTC heater **2222** affixed with thermally conductive adhesive, or epoxy to an outer surface of a heat dissipating body, or plate **2220**. An array of discrete square ceramic plates **2226** and **2228** (tile-shaped ceramic heart source body, or plate **2226** includes a clearance hole **2206** for an insulated conductor PTC wire lead) are each affixed in a circumferential array to an outer surface of plate **2220** using thermally conductive adhesive, or epoxy. In one case, plate **2220** is a thermally conductive aluminum plate. In another case, plate **2220** is a ceramic plate. In yet another case, plate **2220** is a thermally conductive aluminum plate **2220** having a ceramic coating on an outer, or first surface and a lower emissivity inner, or second surface such as a polished aluminum surface. A ceramic coating has a higher emissivity than a polished aluminum surface, therefore the ceramic coating increases radiative heat transfer. The particular advantage of radiative heat is that radiative heat transfer does not directly heat up air molecules within the light housing, and excess heat buildup inside a light housing can have a negative effect on LED performance and reliability over time. An insulating layer, or panel **2250** is affixed via adhesive to a back surface or in proximity of plate **2220**, and both are adhesively affixed onto a weatherproof clear coating **2260** atop or in proximity to PC board **2230**. One suitable insulating layer is an adhesive backed foam material as previously described.

FIG. **110**B illustrates in enlarged cross sectional view placement of PTC heater **2222** atop ceramic plate **2226** via a circumferential array of thermally conductive adhesive, or epoxy **2223** to heat lens **2219**. Tile-shaped heat source body **2226** is a ceramic plate that is affixed with thermally conductive adhesive, or epoxy onto an outer surface of heat dissipating body **2220**. An insulating layer of adhesive backed foam **2250** is then affixed to a back side of plate **2220**. A back side of insulating layer **2250** is adhesively affixed onto a front surface of weatherproofing layer **2260** atop PC board **2230**.

FIG. **110**C shows the spacing and orientation between heat dissipating body **2220** relative to lens **2219** and one selected LED light source **2232**. Lens **2219** is affixed to housing member **2218**. Heat dissipating body **2220** and insulating layer **2250** each have a respective light clearance aperture **2227** and **2229** that mitigates heat transfer to LED light source **2232** and PC board **2230**, while also allowing for light transmission from LED light source **2232** through light transmissible lens **2219**. Insulating layer, or foam piece **2250** has an adhesive layer on opposed surfaces to enable affixation onto both weatherproof coating **2260** and plate **2220**. Ceramic plates **2226** and **2228** are affixed to an outer surface of plate **2220** using thermally conductive adhesive, or epoxy.

FIG. **112** further illustrates heat source **2212** adhesively mounted onto weatherproof coating **2260** on PC board **2230** between housing member **2218** and lens **2219** of tail light **2210**. Optionally, heat source **2212** can be affixed with clips and/or fasteners or other suitable mechanical support structures to PC board **2230** or housing member **2218**. Heat dissipating body **2220** is shown encompassing an array of LED lights **2232** and PTC heater **2222** is adhesively affixed onto an outer surface of a square ceramic plate **2223** that is adhesively affixed with thermally conductive adhesive, or epoxy to an outer surface of body **2220** also with a thermally conductive adhesive (not shown). Furthermore, a circumferential array of additional square ceramic plates **2228** are adhesively affixed with thermally conductive adhesive, or epoxy to an outer surface of body **2220**.

Tail light **2210** is shown in exploded perspective view in FIG. **112**. Lens **2219** cooperates with housing member **2218** to encase heat source **2212**, insulating layer **2250**, weatherproofing layer **2260**, and printed circuit (PC) board **2230**. Heat source **2212** includes PTC heater **2222** which is affixed with a circumferential arrangement of thermally conductive adhesive, or epoxy **2223** to an outer surface on a square ceramic tile heat source body **2226** that is adhesively affixed with thermally conductive adhesive, or epoxy to an outer surface of heat dissipating body **2220**. A further circumferential array of square ceramic tiles **2228** are affixed to an outer surface of plate **2220** with thermally conductive adhesive, or epoxy. An insulated conductor clearance bore **2206** is provided in tile-shaped heat source body **2226** for passage of insulated conductor lead **2258**. An insulating conductor clearance bore **2207** is also optionally provided in heat dissipating body **2220** and a similar clearance bore **2209** is provided in insulating layer **2250** to enable passage of insulated conductive lead **2258** on a backside of PTC heater **2222** through bodies **2220** and **2250**. Leads **2256** and **2258** then extend radially outwardly (see FIG. **29**A) for passage through aperture **2263** and **2265** in layer **2260** and PC board **2230**, respectively. Apertures **2227**, **2229** and **2261** in layers **2220**, **2250** and **2260**, respectively provide clearance for LED light sources **2232** on PC board **2230**. FIG. **29**B illustrates provision of insulating ferrules, or cylindrical bore apertures **2229** on insulating layer **2250** which serve to thermally protect individual LED light sources **2232** from heat being transmitting from body **2220** and plates **2226** and **2228** so as to increase usable life and increase reliability and longevity of LED lamps **2232** otherwise being degraded by exposure to the long-term effects of elevated temperatures from heat dissipating body **2220**.

FIG. **114** is front view of even another exemplary heated vehicle LED shown as a round tail light **2310** having a light transmissible lens **2319**. As shown in FIG. **115**, tail light **2310** includes a housing formed by joining together lens **2319** with housing member **2318** about an entire outer periphery using either fasteners (not shown), ultrasonic welding, or adhesive. A heat source **2312** shown in FIG. **116** is configured to transfer heat to remove/prevent moisture-based condensate from otherwise accumulating on inner or outer surfaces of lens **2319** and occluding the lens. It is understood that such construction can also include vents and moisture permeable membranes for the housing (penetrating the housing envelope not shown) that help evacuate moisture from within the housing. This also helps equalize air or gas pressure between the interior portion of the light housing and atmospheric pressure outside the light housing as pressures will vary due to changes in weather barometric pressure, temperature, ground elevation or altitude when combined with a heat source, such as the present heat sources detailed within this disclosure. Heat source **2312** includes a disc-shaped PTC heater **2322** affixed with thermally conductive adhesive, or epoxy to an outer surface of square tile-shaped ceramic plate, or heat source body **2326** that is further affixed with thermally conductive adhesive, or epoxy to a heat dissipating body, or plate **2320**. An array of discrete square ceramic plates **2326** and **2328** (plate **2326** includes a clearance hole, or bore **2306** for an insulated conductor PTC wire lead) are each affixed in a circumferential array to an outer surface of plate **2320** using thermally conductive adhesive, or epoxy. Furthermore, individual louvered ceramic bodies **2335** are affixed with thermally conductive adhesive atop each plate **2326** and **2328** (see FIG. **32**A). In one case, plate **2320** is a thermally conductive aluminum plate. In another case, plate **2320** is a ceramic plate. In yet another case, plate **2320** is a thermally conductive aluminum plate **2320** having a ceramic coating on an outer, or first surface and a lower emissivity inner, or second surface such as a polished aluminum surface. A ceramic coating has a higher emissivity than a polished aluminum surface, therefore the ceramic coating increases radiative heat transfer. Radiative heat transfer does not heat up air molecules within the light housing, and excess heat buildup can have a negative effect on LED performance and reliability over time. An insulating layer, or panel **2350** is affixed via adhesive to a back surface of plate **2320**, and both are adhesively affixed onto a weatherproof clear coating **2360** atop a PC board **2330**. One suitable insulating layer is an adhesive backed foam material such as adhesive backed polyethylene foam as previously described.

FIG. **116**A illustrates in enlarged partial perspective view placement of PTC heater **2322** atop ceramic plate **2326** via a circumferential array of thermally conductive adhesive, or epoxy **2323** to heat lens **2319** (see FIG. **30**). Ceramic plate **2326** is affixed with thermally conductive adhesive, or epoxy onto an outer surface of heat dissipating body **2320**. An insulating layer of adhesive backed foam **2350** is then affixed to a back side of plate **2320**. A back side of insulating layer **2350** is adhesively affixed onto a front surface of weatherproofing layer atop PC board (similar to the construction in FIG. **117**).

FIG. **116** further illustrates heat source **2312** adhesively mounted onto weatherproof coating **2360** on PC board **2330** between housing member **2318** and lens **2319** of tail light **2210**. Optionally, heat source **2312** can be affixed with clips and/or fasteners or other suitable mechanical support structures to PC board **2330** or housing member **2318**. Heat dissipating body **2320** is shown encompassing an array of LED lights **2332** and PTC heater **2322** is adhesively affixed onto an outer surface of a square ceramic plate **2323** that is adhesively affixed with thermally conductive adhesive, or epoxy to a square ceramic plate **2326** which is further affixed with thermally conductive adhesive, or epoxy to an outer surface of body **2320**. Furthermore, a circumferential array of additional square ceramic plates **2328** are adhesively affixed with thermally conductive adhesive, or epoxy to an outer surface of body **2320**. Individual louvered ceramic bodies **2335** are even further affixed onto outer surfaces of each ceramic plate **2328**, as shown in FIGS. **116** and **116**A.

Tail light **2310** is shown in exploded perspective view in FIG. **117**. Lens **2319** cooperates with housing member **2318** to encase heat source **2312**, insulating layer **2350**, weatherproofing layer **2360**, and printed circuit (PC) board **2330**. Heat source **2312** include PTC heater **2322** which is affixed with a circumferential arrangement of thermally conductive adhesive, or epoxy **2323** to an outer surface on a square ceramic tile **2326** that is adhesively affixed with thermally conductive adhesive, or epoxy to an outer surface of heat dissipating body **2320**. A further circumferential array of square ceramic tiles **2328** are affixed to an outer surface of plate **2320** with thermally conductive adhesive, or epoxy. A louvered ceramic body **2335** is affixed with thermally conductive adhesive, or epoxy to an outer surface of each tile **2328**. A clearance bore **2306** is provided in tile **2326** for passage of lead **2358**. An insulated conductor clearance bore **2307** is also provided in body **2320** and a similar insulated conductor clearance bore **2309** is provided in insulating layer **2350** to enable passage of insulated conductive lead **2358** on a backside of PTC heater **2322** through bodies **2320** and **2350**. Leads **2356** and **2358** then extend radially outwardly for passage through aperture **2363** and **2365** in layer **2360** and PC board **2330**, respectively. Apertures **2327**, **2329** and **2361** in layers **2320**, **2350** and **2360**, respectively provide clearance for LED light sources **2332** on PC board **2330**. FIG. **117** illustrates provision of insulating ferrules, or cylindrical bore apertures **2329** on insulating layer **2350** which serve to thermally protect individual LED light sources from heat being transmitting from body **2320** and plates **2326** and **2328** so as to increase usable life and increase reliability and longevity of LED lamps otherwise being degraded by exposure to the long-term effects of elevated temperatures.

FIGS. **118**-**120** illustrate geometric details of louvered ceramic body **2335** having angled, or louvered outer surfaces that impart directional radiation heat transfer from a relatively high emissivity ceramic body capable to render direction tailoring of radiant heat delivery from a heat source to a light/optical transmissive lens or cover.

FIG. **121** is an alternative configuration component to be substituted for ceramic plates **2323** and **2328**, and louvered ceramic bodies **2335**. More particularly, a unitary ceramic plate **12328** has a star shaped configuration of radially outwardly extending arms on which individual louvered bodies **2335** are affixed with thermally conductive adhesive. A clearance bore **12306**, analogous to clearance bore **2306** (in FIG. **117**) is also provided.

The heat sources of the devices depicted in FIGS. **114**-**121** include a ceramic body, or heatsink (or heat spreader) **2335** having a part number TG-CJ-20-20-6-PF manufactured by T-Global Technology Limited, 1 & 2 Cosford Business Park, Central Park, Lutterworth, Leicestershire LE17 4UQQ U.K. and can be purchased from Digikey Electronics, 701 Brooks Ave South, Thief River Falls, Minn. 56701 USA. Heat spreader **2335** is made of a proprietary sintered ceramic material. Dimensions are 0.78 inches (20 mm) by 0.78 inches (20 mm) square by 0.23 inches (6 mm) in overall thickness and includes 6 louvers or convolutions that provide a significant increase of radiant heat dissipating and emitting surface area compared to a flat surface of the same overall square dimensions. Additionally, according to a "Table of Emissivity of Various Surfaces" published by Mikron Instrument Company, Inc., (Mikron Vertretung Schweiz, Transmetra haltec GmbH, Postfach 174 CH-8203 Schaffhausen), (www.transmetra.ch) aluminum maintains an emissivity within a range of between 0.022 to 0.095 for a temperature range of 25 to 100 degrees C. (77 to 212 deg. F.) for generally unoxidized, polished, and highly polished commercially available sheet stock. While compared with ceramic, ceramic has a relatively high coefficient of emissivity in the range of 0.90 to 0.94 between a temperature range of approximately 20 to 93 degrees C. (68 to 199 deg. F.). Since the emissivity of ceramic is considerably greater than that of unoxidized polished aluminum by a factor of approximately 9:1, the use of ceramic as a strategically-placed heat emitter, being oriented and directed toward the interior portion of a lens within light housing, provides a much greater benefit and maintains a distinct advantage over simply providing an aluminum radiant heat emitter alone.

Furthermore, another key aspect is the comparison of thermal conductivity (i.e. heat conduction within materials) between aluminum and ceramic. According to a publication entitled "The Thermal Conductivity of Ceramics", Sep. 1, 1999, by Clemens J. M. Lasance; Design, Materials, Compounds, Adhesives, Substrates, Number 3, Technical Data, Test & Measurement, Volume 5; "The problem with the thermal conductivity of ceramics is the dependence on the composition, grain size, and manufacturing process, which make it rather difficult to obtain a reliable value from literature only. Looking at the values quoted in various handbooks, papers and data sheets, two things are observed: 1) large variations exist; and 2) many authors seem to copy values from the same, but untraceable sources."

According to a listing entitled "Thermal Conductivity of Common Materials and Gases", published at Engineering ToolBox, (2003). [online] and available at: https://www.engineeringtoolbox.com/thermal-conductivity-d_429.html, the thermal conductivity of aluminum is in the range of 205-215 W/(Mk) while the thermal conductivity of heat sink or heat dissipater **2329** as previously described is published as being in the range of only 40 to 51 W/(Mk). Therefore, the ability to transfer or conduct heat is approximately 4 times greater for the aluminum heat body **2330** than it is for the ceramic heat sink or heat dissipater **2335**. The distinct advantage of using the aluminum heat body **2330** is to readily and efficiently transfer and conduct heat from the heat source or PTC heater **2322** to the remote locations of the ceramic heat sink or heat dissipater **2329** that away from the single PTC heater **2322**, where the heat energy can then enter the ceramic bodies **2329** and then be more efficiently radiated by the ceramic bodies toward the interior portion of the lens **2319**. Optionally, other highly thermally conductive materials may be used for the thermal conduction body **2320** such as copper. Copper has an even higher thermal conductivity at approximately 401-400 W/(Mk). However, while this is effectively double the thermal conductivity of aluminum, a disadvantage is met with respect to the increased weight and cost of copper compared to cheaper and lighter aluminum being used as a thermal conduction body **2330**. FIG. **37** shows an optional design and configuration of the thermal conduction body **12328** utilizing less material and a corresponding reduction in weight. This "cut-away design geometry" would be an advantage if heavier copper was used and a comparable further weight reduction advantage when aluminum is used.

As shown in FIG. **117**, ceramic squares **2328** are attached to both the thermally conductive body **2330** and the corresponding array of heat sinks or heat dissipaters **2335** by thermally conductive adhesive (not specifically shown). FIG. **121** shows an alternate configuration with the array of heat sinks or heat dissipaters **2335** are understood to be securely attached with thermally conductive adhesive (not specifically shown) or a combination of conductive adhesive along the outside perimeter of heat dissipating device, or heat dissipaters **2335** and thermally conductive grease or paste previously described between the interior mating surfaces.

Further and optionally, thermally conductive adhesive tape may be used in place of thermal adhesive or high thermal transfer epoxy. One exemplary thermally conductive tape is provided by t-Global Technology Ltd. and can be purchased from Digikey as part number Li-98 and Li-98C. Different thicknesses of the thermally conductive tape are available as 0.15, 0.20 and 0.25 inch thickness (3.81, 5.08 and 6.35 mm respectively). Thermal conductivity ranges from 0.95 W/mK for part number Li-98 to 1.8 W/mK for part number Li-98C. Pre-cut shapes and geometric patterns are available through Digikey by special order for customized-shape manufacturing requirements. The working temperature range for this thermally conductive adhesive tape is −30 to 120 degrees C. (−86 to 248 degrees F.) including a tensile strength ranging from 200 to 400 psi (metric conversion here).

FIG. **122** is front view of even another exemplary heated vehicle LED shown as a round tail light **2410** having a light transmissible lens **2419**. FIG. **38**A shows tail light **2410** in vertical centerline-sectional view with lens **2419** affixed to housing member **2418** about an entire outer periphery using either fasteners (not shown), ultrasonic welding, or adhesive. A heat source **2412** is configured to transfer heat to remove/prevent moisture-based condensate from otherwise accumulating on inner or outer surfaces of lens **2419** and occluding the lens. It is understood that such construction can also include vents and moisture permeable membranes for the housing (penetrating the housing envelope not shown) that help evacuate moisture from within the housing. This construction also helps equalize air or gas pressure between the interior portion of the light housing and atmospheric pressure outside the light housing as pressures will vary arising due to changes in weather barometric pressure, temperature, ground elevation or altitude when combined with a heat source, such as the present heat sources detailed within this disclosure. Heat source **2412** includes a disc-shaped PTC heater **2422** affixed with thermally conductive adhesive, or epoxy to an outer surface of a heat dissipating body, or plate **2420**. In one case, plate **2420** is a thermally conductive aluminum plate. In another case, plate **2420** is a ceramic plate. In yet another case, plate **2420** is a thermally conductive aluminum plate **2420** having a ceramic coating on an outer, or first surface and a lower emissivity inner, or second surface such as a polished aluminum surface. A ceramic coating has a higher emissivity than a polished aluminum surface, therefore the ceramic coating increases radiative heat transfer. Radiative heat transfer does not heat up air molecules within the light housing, and excess heat buildup can have a negative effect on LED performance and reliability over time. An insulating layer, or panel **2450** is affixed via adhesive to a back surface of plate **2420**, and both are adhesively affixed onto a weatherproof clear coating **2460** atop a PC board **2430**. One suitable insulating layer is an adhesive backed foam material such as an adhesive back polyethylene foam. PC board **2430** supports an array of LED light sources **2432**.

FIG. **122**B shows LED light source **2432** in a circumferential port, or ferrule **2451** defined by insulated grommet **2429**. LED light source **2432** is affixed to PC board **2430**, and a weatherproof coating **2460** is provided atop PC board **2430**. PTC heater **2422** is affixed with thermally conductive adhesive, or epoxy **2423** to heat dissipating body **2420** within the light housing provided between lens **2419** and housing member **2418**. Heat dissipating body **2420** comprises an aluminum plate **2484** (see FIG. **42**) having a high emissivity outer surface coating **2486**, such as a ceramic coating, and a lower emissivity radiant barrier coating, or finish **2482** such as a polished aluminum surface.

FIG. **124**A illustrates in enlarged partial perspective view placement of PTC heater **2422** atop heat dissipating body, or plate **2420** via a circumferential bead of thermally conductive adhesive, or epoxy **2423** to heat lens **2419** (see FIG. **122**A, **122**B). An insulating layer of adhesive backed foam **2450** is then affixed to a back side of plate **2420**. A back side of insulating layer **2450** is adhesively affixed onto a front surface of weatherproofing layer **2460** atop PC board **2430** (similar to the construction in FIGS. **110-117**).

FIG. **124** further illustrates placement of heat source **2412** between housing member **2418** and lens **2419** of tail light **2410** so as to present a large surface area via heat dissipating body **2420** for removing any condensation from lens **2419**. Heat source **2412** is affixed within housing member **2418** using adhesive. Optionally, heat source **2412** can be affixed with clips and/or fasteners or other suitable mechanical support structures to PC board **2430** (see FIG. **38**A) or housing member **2418**. As shown in FIG. **40**A, heat dissipating body **2420** is shown encompassing an array of LED lights **2432** and PTC heater **2422** is adhesively affixed onto an outer surface body **2420** with thermally conductive adhesive, or epoxy. Individual insulated light wells, or ports **2429** to reduce heat transfer from plate **2420** to each LED light source **2432** in an effort to reduce temperatures at LED light source **2432**. FIG. **122**C illustrates in greater detail the orientation of LED light source **2432** centrally of insulated bore, or ferrule **2429** within bore **2427** (shown in FIG. **125**) so as to insulate heat transfer from bore **2427** to LED light source **2432**.

Tail light **2410** is shown in exploded perspective view in FIG. **125**. Lens **2419** cooperates with housing member **2418** to encase heat source **2412**, insulating layer **2450**, weatherproofing layer **2460**, and printed circuit (PC) board **2430**. Heat source **2412** include PTC heater **2422** which is affixed with a circumferential arrangement of thermally conductive adhesive, or epoxy **2423** to an outer surface of heat dissipating body **2420**. A cylindrical mounting surface port **2488** is provided in a front surface coating of body **2420** to expose a high thermally conductive core material **2484** of body **2420** that mates in thermally conductive relation with PTC heater **2422** via thermally conductive adhesive, or epoxy **2423**. Insulated conductive wire leads **2456** and **2458** extend from PTC heater **2422** extend radially outwardly from **2422** with optional for passage of wire lead **2458** through apertures **2463** and **2465** in layer **2460** and PC board **2430**, respectively. Apertures **2427**, **2429** and **2461** in layers **2420**, **2450** and **2460**, respectively provide clearance for LED light sources **2432** on PC board **2430**. FIG. **125** illustrates provision of insulating circumferential ports, ferrules, or cylindrical bore apertures **2451** on insulating layer **2450** that define bores **2429** which serve to thermally protect individual LED light sources from heat being transmitting from body **2420** and plates **2423** and **2428** so as to increase usable life and increase reliability and longevity of LED lamps otherwise being degraded by exposure to the long-term effects of elevated temperatures.

FIG. **126** illustrates details of heat dissipating body **2420** comprising a laminate having a central highly thermally conductive core **2484** with a front, or first surface **2486** and a back, or second surface **2482**. Front surface **2486** has a higher emissivity than does back surface **2482**. In one case, core **2484** is a thermally conductive plate of aluminum having a front surface **2486** with a coating or sheet of ceramic material. Rear surface **2482** is a low emissivity radiant barrier coating. Optionally, rear surface **2482** is a highly polished aluminum surface on the backside of core **2484** including the inner surfaces corresponding to apertures **2483**. FIG. **126**A illustrates how a circumferential ring, or ferrule is formed using the rear surface **2482** of low emissivity radiant barrier coating, or layer to concentrically line the bore **2427** (of FIG. **125**). In this way, a low emissivity thermal coating would be applied directly to the central highly thermally conductive core material **2482** or optionally, a separately-formed component represented by layer **2483**, could be adhesively bonded to core **2482** using thermally conductive adhesive, epoxy, grease, paste or by a technique of similar material bonding processes to achieve the preferred thermal control and performance properties of heat dissipating body **2420**.

FIGS. **127-130** illustrate in greater detail the construction of insulation plate **2450**. More particularly, plate **2450** is constructed from a structural insulation, such as a rigid structural foam insulating foam material. Plate **2450** includes an array of through bores **2429** that are defined by circumferential ports, or ferrules **2451** provided on a front face of plate **2450**, as shown in FIGS. **128** and **129**. An array of semi-arcuate stands **2453** and **2455** cooperate to form individual air vents, or passages **2454** on a back surface of plate **2450**. Additionally, an array of integral posts, or fingers **2457** extend a same height as stands **2453** and **2455** to form an air gap **2480** between insulating panel **2450** and weatherproof clear coating, or layer **2460** on PC board **2430** to facilitate cooling air flow through ports **2427**, **2429**, and air passages **2454**. These structural features related to promoting convection air-flow help to cool LED lights **2432** (see FIG. **125**) when they are in operation.

FIG. **131** is an exploded perspective view of a yet even further exemplary heated vehicle LED clearance, or side marker light **2510** including a heat source **2512** that is affixed onto a PC board **2530** using a threaded fastener, or mounting screw **2570** and washers **2571** and **2573** into a threaded bore **2575** in PC board **2530** which supports LED light source **2532**. Heat source **2512** includes a PTC heater **2522** that is affixed with a cylindrical ring of thermally conductive adhesive, or epoxy **2523** onto a square ceramic plate **2528**. PC board **2530** is affixed with fasteners, clips and/or adhesive or other suitable mechanical support structures within housing member **2518**, beneath light transmissible lens **2519**.

FIG. **132** is a front plan view including hidden lines of the heated LED clearance, or side marker light **2510** of FIG. **131**. More particularly, lens **2519** combines in assembly with housing member **2518** to encase an LED light source **2532** and a heat source **2512**. FIG. **132**A shows in vertical centerline-sectional view further internal details of heat source **2512** in clearance, or side marker light **2510**. More particularly, lens **2519** and housing member **2518** encase heat source **2512** and LED light source **2532**. Heat source **2512** is affixed with threaded fastener, or mounting screw **2570** to PC board **2530** and washers **2571** and **2578** entrap ceramic plate **2528**, with washer **2578** providing for air gap **2525** from PC board **2530**. PTC heater **2522** is affixed to a top surface of plate **2528** using thermally conductive adhesive, or epoxy **2523**.

FIGS. **131-132**A show a simplified concept design for a side marker or clearance light assembly with a single LED at the center of the housing assembly provided for illustration purposes showing a simple square ceramic component available for purchase from Digikey. A small hole **2589** has been machined through an upper corner of the square ceramic **2528** providing a mechanical mounting point for engagement with a small threaded mounting screw **2570** threaded into threaded hole **2575** at LED circuit board **2530**. A spacer washer **2578** provides and air gap or air space **2580** to provide a conductive thermal break between heat source **2512** and LED circuit board **2530**. Heat source **2512** includes a PTC heater **2522**, a ceramic tile **2528** providing a heat dissipating body or mass, and a thermally conductive adhesive **2532** that mechanically secures PTC heater **2522** in thermal communication with ceramic tile **2528**. An insulating air gap **2580** shown in FIG. **132**A provides a thermal conduction break to promote non-overheating of the LED electronics at LED circuit board **2530**.

FIG. **133** is an exploded perspective view of a yet even further exemplary heated vehicle LED side marker light **2610** including a heat source **2612** that is affixed onto housing member **2618** using three threaded fasteners, such as threaded fastener **2670** and washers **2671**, **2678** and **2677**, through bore **2672** in heat dissipating body **2620**, through a bore **2674** in insulating plate **2650**, a bore **2675** in PC board **2630**, and into a threaded bore **2676** in housing member **2618** which supports LED board **2630** and LED light source **2632**. Heat source **2612** includes a PTC heater **2622** that is affixed with a cylindrical ring of thermally conductive adhesive, or epoxy **2623** onto a square ceramic plate **2628**. PC board **2630** is affixed with fasteners, clips and/or adhesive or other suitable mechanical support structures within housing member **2618**, beneath light transmissible lens **2619**. Heat source **2612** includes a PTC heater **2622** affixed with a cylindrical ring of thermally conductive adhesive, or epoxy **2623** to an outer surface of a heat dissipating body **2620**. Body **2620** includes a central light aperture **2627** that has a frustoconical shape. This geometry helps to reflect any incident heat and light from the LED light source **2632** away from the LED light source **2632** and toward lens **2619**, contributing toward maintaining reduced temperatures at the LED light source **2632**.

Additionally, this geometry provides a wider path of projection of light from the LED **2632** to the lens **2619** for increased light output. Insulating piece **2650** includes a central light aperture **2629** configured to allow clearance of LED light source **2632** in assembly for light to pass through lens **2619**. According to one construction, plate **2620** is formed from a ceramic plate having a large thermal mass. Three washers **2678** serve to form an air gap, or space between heat dissipating body **2620** and insulation plate **2650** in assembly, thus providing a conductive thermal break between heat dissipating body **2620** and insulation plate **2650**.

FIG. **134** is a front plan view including hidden lines of the heated LED side marker light **2610** of FIG. **133**. More particularly, lens **2619** combines in assembly with housing member **2618** to encase an LED light source **2632** and a heat source **2612**. FIG. **134**A shows in vertical centerline-sectional view further internal details of heat source **2612** in side marker light **2610**. More particularly, lens **2619** and housing member **2618** encase heat source **2612** and LED light source **2632**. Heat source **2612** is affixed with a thermally conductive adhesive **2623**, or epoxy to an outer surface of ceramic plate or heat dissipating body **2620**. Fasteners **2670** cooperate with washers **2671**, **2678**, and **2677** to affix ceramic plate **2620**, insulating plate **2650** and PC board **2630** to boss **2676** of housing member **2618**. Washers **2671**, **2678**, and **2677** provide air gaps **2680** and **2681** between respective components for cooling. Light apertures **2627** and **2629** in plates **2620** and **2650** enable clearance for LED light source **2632** to deliver light through heated lens **2619**.

FIG. **134**A shows a sectional view of a simplified concept design for a side marker or clearance light **2610** of FIG. **134** having a single LED **2632** with section view taken at line **134**A-**134**A of FIG. **134**. As previously described, air gaps **2680** and **2681** together provide a pair of thermal conduction breaks in series to promote non-overheating of the LED electronics at LED circuit board **2630**. Optionally, it would be anticipated to provide additional corresponding insulation plates **2650** or thermal barriers (not shown), additional corresponding washers **2678** and **2677**, (not shown) and additional corresponding air gaps to **2680** and **2681** (not shown) to increase the number of conductive thermal breaks and further reduce the likelihood of over-heating the LED **2632** and LED circuit board **2630**.

FIG. **135** is a simplified centerline-sectional view of a first exemplary heated LED light **2710** including a housing formed by a housing member **2718** and a light transmissible lens **2719** having a light transmissible portion and a first heat source **2712**. Heat source **2712** includes a PTC heater **2722** affixed with adhesive in thermally conductive relation with an outer, or front surface of a thermally conductive body **2720** in the form of a cylindrical aluminum plate or other thermally conductive material. An insulating air gap **2780** is provided between a back surface of plate **2720** and a printed circuit (PC) board **2730** to limit heat transfer to board **2730**. A weatherproofing layer of clear plastic, or polymer **2760** protects a front surface of PC board **2730**. LED light source **2732** is affixed to board **2730** and is located centrally of a round aperture **2727** in plate **2720**.

FIG. **136** is another simplified centerline-sectional view of a second exemplary heated LED light **2810** including a housing formed by a housing member **2818** and a light transmissible lens **2819** having a light transmissible portion and a first heat source **2812**. Heat source **2812** includes a PTC heater **2822** affixed with adhesive in thermally conductive relation with an inner, or rear surface of a thermally conductive body **2820** in the form of a cylindrical aluminum plate or other thermally conductive material. An insulating air gap **2880** is provided between a back surface of plate **2820** and a printed circuit (PC) board **2830** to limit heat transfer to board **2830**. A weatherproofing layer of clear plastic, or polymer **2860** protects a front surface of PC board **2830**. LED light source **2832** is affixed to board **2830** and is located centrally of a round aperture **2827** in plate **2820**.

FIG. **137** is yet another simplified centerline-sectional view of a third exemplary heated LED light **2910** including a housing formed by a housing member **2918** and a light transmissible lens **2919** having a light transmissible portion and a first heat source **2912**. Heat source **2912** includes a PTC heater **2922** affixed with adhesive in thermally conductive relation with an outer surface of a thermally conductive body, or plate **2920** in the form of a cylindrical aluminum plate or other thermally conductive material. A thermal insulation layer, or insulation plate **2950** is adhesively affixed to a back surface of plate **2920**. An insulating air gap **2980** is provided between a back surface of insulation plate **2950** and a printed circuit (PC) board **2930** to limit heat transfer to board **2930**. A weatherproofing layer of clear plastic, or polymer **2960** protects a front surface of PC board **2930**. LED light source **2932** is affixed to board **2930** and is located centrally of a round aperture **2927** in plate **2920** and a round aperture **2929** in insulating layer **2950**.

FIG. **138** is even another simplified centerline-sectional view of a fourth exemplary heated LED light **3010** including a housing formed by a housing member **3018** and a light transmissible lens **3019** having a light transmissible portion and a first heat source **3012**. Heat source **3012** includes a PTC heater **3022** affixed with adhesive in thermally conductive relation with an inner surface of a thermally conductive body, or plate **3020** in the form of a cylindrical aluminum plate or other thermally conductive material. A thermal insulation layer, or plate **3050** is adhesively affixed to a top surface coating **3060** on a printed circuit board **3030**. An insulating air gap **3080** is provided between a front surface of plate **3050** and a back surface of plate **3020** to limit heat transfer to board **3030**. A weatherproofing layer of clear plastic, or polymer **3060** protects a front surface of PC board **3030**. LED light source **3032** is affixed to board **3030** and is located centrally of a round aperture **3027** in plate **3020**.

FIG. **139** is yet even another simplified centerline-sectional view of a fifth exemplary heated LED light **3110** including a housing formed by a housing member **3118** and a light transmissible lens **3119** having a light transmissible portion and a first heat source **3112**. Heat source **3112** includes a PTC heater **3122** affixed with adhesive in thermally conductive relation with an outer surface of a thermally conductive body, or plate **3120** in the form of a cylindrical aluminum plate or other thermally conductive material. A thermal insulation layer, or plate **3150** is interposed in spaced-apart relation between a printed circuit board **3130** and plate **3120**. An insulating air gap **3180** is provided between a front surface of plate **3150** and a back surface of plate **3120** to limit heat transfer to board **3130**. Another insulating air gap **3181** is provided between a rear face of plate **3150** and a weatherproofing surface **3160** of clear plastic, or polymer on PC board **3130**. LED light source **3132** is affixed to board **3130** and is located centrally of a round aperture **3127** in plate **3120** and a round aperture **3129** in plate **3150**.

FIG. **140** is an even further simplified centerline-sectional view of a sixth exemplary heated LED light **3210** including a housing formed by a housing member **3218** and a light transmissible lens **3219** having a light transmissible portion and a first heat source **3212**. Heat source **3212** includes a PTC heater **3222** affixed with adhesive in thermally conductive relation with an inner surface of a thermally conductive body, or plate **3220** in the form of a cylindrical aluminum plate or other thermally conductive material. A thermal insulation layer, or plate **3250** is interposed in spaced-apart relation between a printed circuit board **3230** and plate **3220**. An insulating air gap **3280** is provided between a front surface of plate **3250** and a back surface of plate **3220** to limit heat transfer to board **3230**. Another insulating air gap **3281** is provided between a rear face of plate **3250** and a weatherproofing surface **3260** of clear plastic, or polymer on PC board **3230**. LED light source **3232** is affixed to board **3230** and is located centrally of a round aperture **3227** in plate **3220** and a round aperture **3229** in plate **3250**.

FIG. **141** is yet even another simplified centerline-sectional view of a seventh exemplary heated LED light **3310** including a housing formed by a housing member **3318** and a light transmissible lens **3319** having a light transmissible portion and a first heat source **3312**. Heat source **3312** includes a PTC heater **3322** affixed with adhesive in thermally conductive relation with an outer surface of a thermally conductive body, or plate **3320** in the form of a cylindrical aluminum plate or other thermally conductive material. A thermal reflective shielding foil layer, or radiation energy shield **3325** is interposed in spaced-apart relation between a printed circuit board **3330** and plate **3320**. An insulating air gap **3380** is provided between a front surface of layer **3325** and a back surface of plate **3320** to limit heat transfer to board **3330**. Another insulating air gap **3381** is provided between a rear face of layer **3325** and a weatherproofing surface **3360** of clear plastic, or polymer on PC board **3330**. LED light source **3332** is affixed to board **3330** and is located centrally of a round aperture **3327** in plate **3320** and a round aperture **3331** in plate **3325**.

FIG. **142** is a further simplified centerline-sectional view of an eighth exemplary heated LED light **3410** including a housing formed by a housing member **3418** and a light transmissible lens **3419** having a light transmissible portion and a first heat source **3412**. Heat source **3412** includes a PTC heater **3422** affixed with adhesive in thermally conductive relation with an inner surface of a thermally conductive body, or plate **3420** in the form of a cylindrical aluminum plate or other thermally conductive material. A thermal reflective shielding aluminum foil layer, or radiation energy shield **3425** is interposed in spaced-apart relation between a printed circuit board **3430** and plate **3420**. An insulating air gap **3480** is provided between a front surface of layer **3425** and a back surface of plate **3420** to limit heat transfer to board **3430**. Another insulating air gap **3481** is provided between a rear surface of layer **3425** and a weatherproofing surface **3460** of clear plastic, or polymer on PC board **3430**. LED light source **3432** is affixed to board **3430** and is located centrally of a round aperture **3427** in plate **3420** and a round aperture **3431** in plate **3425**.

FIG. **143** is yet even another simplified centerline-sectional view of a ninth exemplary heated LED light **3510** including a housing formed by a housing member **3518** and a light transmissible lens **3519** having a light transmissible portion and a first heat source **3512**. Heat source **3512** includes a PTC heater **3522** affixed with adhesive in thermally conductive relation with an outer surface of a thermally conductive body, or plate **3520** in the form of a cylindrical aluminum plate or other thermally conductive material. An insulating plate, or foam layer **3550** is adhesively affixed to a back surface of plate **3520**. A thermal reflective shielding aluminum foil layer, or radiation energy shield **3525** is interposed in spaced-apart relation between a printed circuit board **3530** and layer **3550**. An insulating air gap **3580** is provided between a front surface of layer **3525** and a back surface of layer **3550** to limit heat transfer to board **3530**. Another insulating air gap **3581** is provided between a rear surface of layer **3525** and a weatherproofing surface **3560** of clear plastic, or polymer on PC board **3530**. LED light source **3532** is affixed to board **3530** and is located centrally of a round aperture **3527** in plate **3520**, a round aperture **3529** in plate **3550**, and a round aperture **3531** in shield layer **3525**.

FIG. **144** is even another simplified centerline-sectional view of a tenth exemplary heated LED light **3610** including a housing formed by a housing member **3618** and a light transmissible lens **3619** having a light transmissible portion and a first heat source **3612**. Heat source **3612** includes a PTC heater **3622** affixed with adhesive in thermally conductive relation with an inner surface of a thermally conductive body, or plate **3620** in the form of a cylindrical aluminum plate or other thermally conductive material. An insulating plate, or foam layer **3650** is adhesively affixed to a front surface of weatherproofing surface **3660** of clear plastic, or polymer on PC board **3630**. A thermal reflective shielding aluminum foil layer, or radiation energy shield **3625** is interposed in spaced-apart relation between a rear surface of body **3620** and layer **3650**. An insulating air gap **3680** is provided between a rear surface of body **3620** and a front surface of shield **3625** to limit heat transfer to board **3630**. Another insulating air gap **3681** is provided between a rear surface of layer **3625** and a weatherproofing surface **3660** of clear plastic, or polymer on PC board **3630**. LED light source **3632** is affixed to board **3630** and is located centrally of a round aperture **3627** in plate **3620**, a round aperture **3631** in layer **3625**, and a round aperture **3629** in plate **3650**.

FIG. **145** is yet another simplified centerline-sectional view of a eleventh exemplary heated LED light **3710** including a housing formed by a housing member **3718** and a light transmissible lens **3719** having a light transmissible portion and a first heat source **3712**. Heat source **3712** includes a PTC heater **3722** affixed with adhesive in thermally conductive relation with an outer surface of a thermally conductive body, or plate **3720** in the form of a cylindrical aluminum plate or other thermally conductive material. An insulating plate, or foam layer **3750** is adhesively affixed to a back surface of plate **3720**. A thermal reflective shielding aluminum foil layer, or radiation energy shield **3725** is adhesively affixed to a back surface of foam layer **3750**. An insulating air gap **3780** is provided between a rear surface of layer **3725** and a front surface of a weatherproofing surface **3760** of clear plastic, or polymer on PC board **3530**. LED light source **3732** is affixed to board **3730** and is located centrally of a round aperture **3727** in plate **3720** and a round aperture **3729** in plate **3750**. Finally, an aperture **3731** is provided in layer **3725**.

FIG. **146** is yet even another simplified centerline-sectional view of a twelfth exemplary heated LED light **3810** including a housing formed by a housing member **3818** and a light transmissible lens **3819** having a light transmissible portion and a first heat source **3612**. Heat source **3812** includes a PTC heater **3822** affixed with adhesive in thermally conductive relation with an inner surface of a thermally conductive body, or plate **3820** in the form of a cylindrical aluminum plate or other thermally conductive material. An insulating plate, or foam layer **3850** is adhesively affixed to a front surface of weatherproofing surface **3860** of clear plastic, or polymer on PC board **3830**. A thermal reflective shielding aluminum foil layer, or radiation energy shield **3825** is adhesively affixed on a front surface of layer **3850**. An insulating air gap **3880** is provided between a rear surface of body **3820** and a front surface of shield **3825** to limit heat transfer to board **3830**. A rear surface of layer **3825** is adhesively affixed to a front surface of layer **3850**. LED light source **3832** is affixed to board **3830** and is located centrally of a round aperture **3827** in plate **3820**, a round aperture **3831** in layer **3825**, and a round aperture **3829** in plate **3850**.

FIG. **147** is a further simplified centerline-sectional view of a thirteenth exemplary heated LED light **3910** including a housing formed by a housing member **3918** and a light transmissible lens **3919** having a light transmissible portion and a first heat source **3912**. Heat source **3912** includes a PTC heater **3922** affixed with adhesive in thermally conductive relation with an outer, or front surface of a thermally conductive body **3920** including a highly conductive thermal core or plate **3984**, in the form of a cylindrical aluminum central plate **3984** or other thermally conductive material having an outer, or first surface layer **3986** and an inner, or second surface layer **3982**. First surface layer **3986** has a higher emissivity than second surface layer **3982**. Optionally, the thermal conductivity of core or plate **3984** is greater than the thermal conductivity of the outer first surface **3986**. The absence of layer **3986** between the mating surfaces of **3984** and PTC **3922** is provided to help maximize heat transfer between core or plate **3984** and PTC heater **3922**, thus improving efficiency. An insulating air gap **3980** is provided between a back surface of plate **3920** and a front surface, or weatherproofing layer **3960** on printed circuit (PC) board **3930** to limit heat transfer to board **3930**. Weatherproofing layer of clear plastic, or polymer **3960** protects a front surface of PC board **3930**. LED light source **3932** is affixed to board **3930** and is located centrally of a round apertures **3927**, **3929**, and **3931** in layers **3984**, **3986**, and **3982** respectively, of plate **3920**.

FIG. **148** is yet a further simplified centerline-sectional view of a fourteenth exemplary heated LED light **4010** including a housing formed by a housing member **4018** and a light transmissible lens **4019** having a light transmissible portion and a first heat source **4012**. Heat source **4012** includes a PTC heater **4022** affixed with adhesive in thermally conductive relation with an inner, or rear surface of a thermally conductive body **4020** including a highly conductive thermal core plate **4084** in the form of a cylindrical aluminum central plate **4084**, or other thermally conductive material, having an outer, or first surface layer **4086** and an inner, or second surface layer **4082**. Optionally, the thermal conductivity of core or plate **4084** is greater than the thermal conductivity of the outer first surface **4086**. The absence of layer **4082** between the mating surfaces of core plate **4084** and PTC heater **4022** is provided to help maximize heat transfer between core plate **4084** and PTC heater **4022**, thus improving efficiency. An insulating air gap **4080** is provided between a back surface of plate **4020** and a weatherproofing layer **4060** on printed circuit (PC) board **4030** to limit heat transfer to board **4030**. Weatherproofing layer of clear plastic, or polymer **4060** protects a front surface of PC board **4030**. LED light source **4032** is affixed to board **4030** and is located centrally of a round aperture **4027**, **4029**, and **4031** in layers **4084**, **4086**, and **4082** respectively, of plate **4020**.

FIG. **149** is yet even a further simplified centerline-sectional view of a fifteenth exemplary heated LED light **4110** including a housing formed by a housing member **4118** and having a lens **4110** with a light transmissible portion and a first heat source **4012**. Heat source **4112** includes heat dissipating body **4120** having a radiative front concave surface **4191** configured to shape the distribution of radiant heat transfer from body **4120** to an inner surface of lens **4119**. An inner surface **4182** of body **4120** is a low emissivity radiant barrier coating. Optionally, surface **4182** is a shiny aluminum layer that reflects radiant heat. A weatherproofing layer of clear plastic, or polymer **4160** protects a front surface of PC board **4030**. An insulating air gap **4180** is provided between a back surface **4182** of plate **4120** and weatherproofing layer **4160** on printed circuit (PC) board **4130** to limit heat transfer to board **4030**. LED light source **4132** is affixed to PC board **4130** and is located centrally of a round aperture **4127** and **4129** in plate **4120** and surface **4182**, respectively.

FIG. **150** is even another simplified centerline-sectional view of a sixteenth exemplary heated LED light **4210** including a housing formed by a housing member **4218** and having a lens **4210** with a light transmissible portion and a first heat source **4212**. Heat source **4212** includes heat dissipating body **4220** having a radiative front convex surface **4292** configured to shape the distribution of radiant heat transfer from body **4220** to an inner surface of lens **4219**. An inner surface **4282** of body **4220** is a low emissivity radiant barrier coating. Optionally, surface **4282** is a shiny aluminum layer that reflects radiant heat. A weatherproofing layer of clear plastic, or polymer **4260** protects a front surface of PC board **4230**. An insulating air gap **4280** is provided between a back surface **4282** of plate **4220** and weatherproofing layer **4260** on printed circuit (PC) board **4230** to limit heat transfer to board **4230**. LED light source **4232** is affixed to PC board **4230** and is located centrally of a round aperture **4227** and **4229** in plate **4220** and surface **4282**, respectively.

As shown in the heat dissipating bodies of FIGS. **149** and **150**, it is understood that a combination of concave, convex, and flat configurations can be provided on a heat dissipating surface having emissivity characteristics such as an emissivity of at least 0.8 and preferably at least 0.9 in order to generate radiant heat transfer that is generally perpendicular to a heat dissipating surface so that radiant heat transfer can be shaped to best deliver heat to complex three-dimensional internal lens structures so as to more evenly dissipate condensate buildup within such lenses.

As shown herein in FIGS. **85-150**, condensate mitigation is also understood to apply to mitigating condensate buildup on housed sensor arrangements having light or optical transmission portions of lenses. For example, sensors are being housed in light house assemblies for use in implementing intelligent driverless vehicles. Sensors in such lens housings are at risk from condensate buildup and the teachings of the present disclosure are also intended to mitigate condensate buildup on housings with lenses that include such sensors and also for those housings solely designed to house such sensors and devoid of any light source.

Furthermore, the subject matter of this application shown in FIGS. **85-150** is intended to apply to other forms of housings, encasements, dividers, and casings having either an optically transmissible portion or a light transmissible portion, such as weatherproof/waterproof housings for cameras, video cameras, masks and goggles, such as scuba masks and industrial masks, and other encasements having a need to clear condensate from an optical/light transmissible portion (inside or outside surface), such as housings and cover plates for sensors, such as sensors used to provide input for artificial intelligence systems used on autonomous and self-driving vehicles, or cars/trucks/buses or other vehicles and conveyors of animate and/or inanimate objects.

Even furthermore, it is understood that each of the housings, or light housings shown in FIGS. **85-150** can be implemented with the addition of an atmospheric vent, including atmospheric vents that include moisture permeable and water impermeable membranes and fabrics, such as TEMISH® vent waterproof and dustproof filters contained in light vent housings available form Nitto, Inc., 300 Frank W. Burr Blvd., Suite 66, Teaneck, N.J. USA. The addition of the present heat sources disclosure with reference to FIGS. **85-150** provides a thermal driving gradient to facilitate moisture migration from within a light or sensor housing in order to remove moisture therein that might otherwise build up from cyclical barometric pressure changes resulting from weather pattern changes and/or elevational changes during operation that pump, or pressure feed moisture-laden air in an out of the housing through seams and/or a light housing vent.

Yet even furthermore, it is understood that each of the housings, or light housings shown in FIGS. **85-150** can be implemented with the addition of a heat source electrically connected with a thermal detector and a switch that only operates the heat source at or below a threshold temperature, for example, at or below 38 degrees Fahrenheit (3.3 degrees C.). Optionally, a sensor configuration can turn power off at or above such a threshold temperature. One suitable sensor is a thermistor.

While the subject matter of this application was motivated in addressing condensate (ice, snow, frost, vapor and water) mitigation within lenses on light generating structures, it is in no way so limited. The disclosure is only limited by the accompanying claims as literally worded, without interpretative or other limiting reference to the specification, and in accordance with the doctrine of equivalents.

The terms “a”, “an”, and “the” as used in the claims herein are used in conformance with long-standing claim drafting practice and not in a limiting way. Unless specifically set forth herein, the terms “a”, “an”, and “the” are not limited to one of such elements, but instead mean “at least one”.

In compliance with the statute, the various embodiments have been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the various embodiments are not limited to the specific features shown and described, since the means herein disclosed comprise disclosures of putting the various embodiments into effect. The various embodiments are, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

What is claimed is:

1. An environmentally controlled vehicle electronics package, comprising:

a container having a wall forming an enclosure configured to encase an electronic component and an electromagnetic wave transmissible portion comprising an outer electromagnetic lens and an inner electromagnetic lens proximate and spaced from the outer electromagnetic lens; and

a heater including an elongate tube heat transfer body and a heat source communicating with an inner surface of the elongate tube heat transfer body, the heater provided in the package between the outer electromagnetic lens and the inner electromagnetic lens, the heat source in heat transfer communication with the elongate heat transfer body and configured to mitigate condensate occlusion of the electromagnetic wave transmissible portion.

2. The electronics package of claim **1**, wherein the elongate tube heat transfer body comprises a hollow elongate tube.

3. The electronics package of claim **2**, wherein the hollow elongate tube comprises an aperture comprising a routing path for power supply lines for the heat source within the hollow elongate tube.

4. The electronics package of claim **2**, wherein the hollow elongate tube comprises a heat pipe.

5. The electronics package of claim **4**, wherein the heat pipe further comprises an air intake aperture and a plurality of holes spaced along the heat pipe configured to release heated air from the heat pipe.

6. The electronics package of claim **2**, wherein the hollow elongate tube is supported along a peripheral edge of the electromagnetic wave transmissible portion.

7. The electronics package of claim **6**, wherein the electromagnetic wave transmissible portion is a lens portion of the container.

8. The electronics package of claim **2**, wherein the heat source comprises a positive temperature coefficient (PTC) heater.

9. The electronics package of claim **2**, wherein the heat source is a temperature regulated source of heat.

10. An environmentally controlled vehicle electronics package, comprising:

a container having a wall forming an enclosure configured to encase an electronic component and a light transmissible portion comprising an outer optical lens and an inner optical lens proximate and spaced from the outer optical lens; and

a heat transfer body comprising a hollow elongate tube provided between the inner optical lens and the outer optical lens and having an aperture providing a path configured to receive at least one power supply line to the heat source within the hollow elongate tube and a heat source provided in the package, the heat source communicating with the body and configured to mitigate condensate occlusion from the light transmissible portion.

11. The environmentally controlled vehicle electronics package of claim **10**, wherein the hollow elongate tube comprises a heat pipe.

12. The environmentally controlled vehicle electronics package of claim **10**, wherein the heat pipe further comprises an air intake aperture and a plurality of holes spaced along the heat pipe configured to release heated air from the heat pipe.

13. The environmentally controlled vehicle electronics package of claim **10**, wherein the hollow elongate tube is supported along a peripheral edge of the electromagnetic wave transmissible portion.

14. The environmentally controlled vehicle electronics package of claim **10**, wherein the electromagnetic wave transmissible portion is a lens portion of the container.

15. The environmentally controlled vehicle electronics package of claim **10**, wherein an electrically powered heat source is provided within the heat transfer body configured to transfer heat along the hollow elongate tube.

16. The environmentally controlled vehicle electronics package of claim **10**, wherein the electrically powered heat source is a temperature regulated source of heat.

17. The environmentally controlled vehicle electronics package of claim **10**, wherein the hollow elongate tube comprises an aperture comprising a routing path for power supply lines for the heat source within the hollow elongate tube.

18. The environmentally controlled vehicle electronics package of claim **10**, wherein the vehicle electronics package is a vehicle lens assembly and the container is a light housing.

19. The environmentally controlled electronics package of claim **10**, further comprising an electronic component encased in the container, the electronic component provided by an LED light source.

20. The environmentally controlled electronics package of claim **1**, wherein the vehicle electronics package is a vehicle lens assembly, the container is a light housing, and the electromagnetic wave transmissible portion is a double lens for a light source.

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