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(54) **CONNECTOR SYSTEM AND AIR MAINTENANCE TIRE ASSEMBLY**

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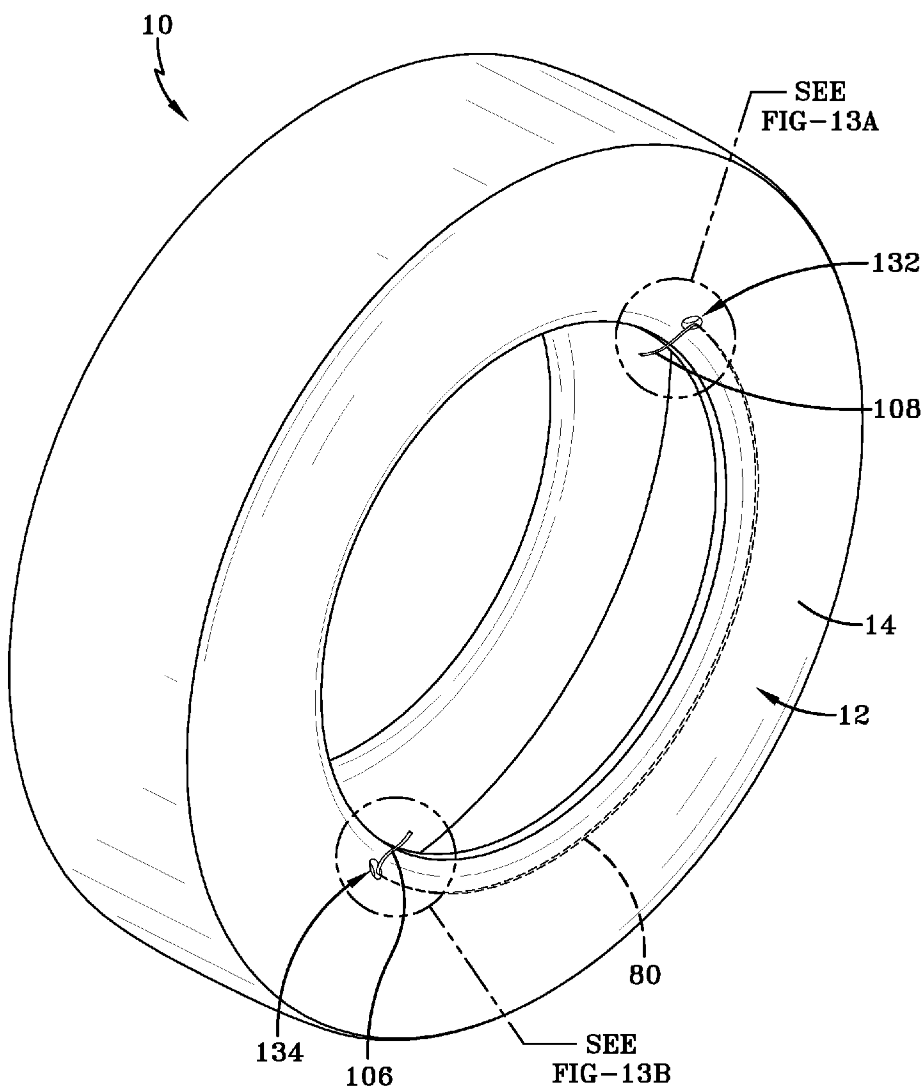
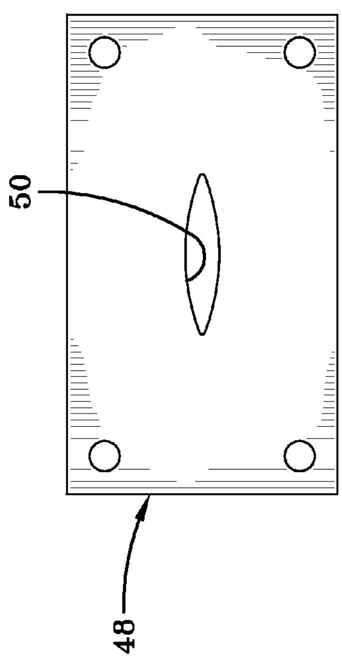
***B60C 9/02*** (2006.01)

(52) **U.S. Cl.**
USPC ........................................................ **152/548**

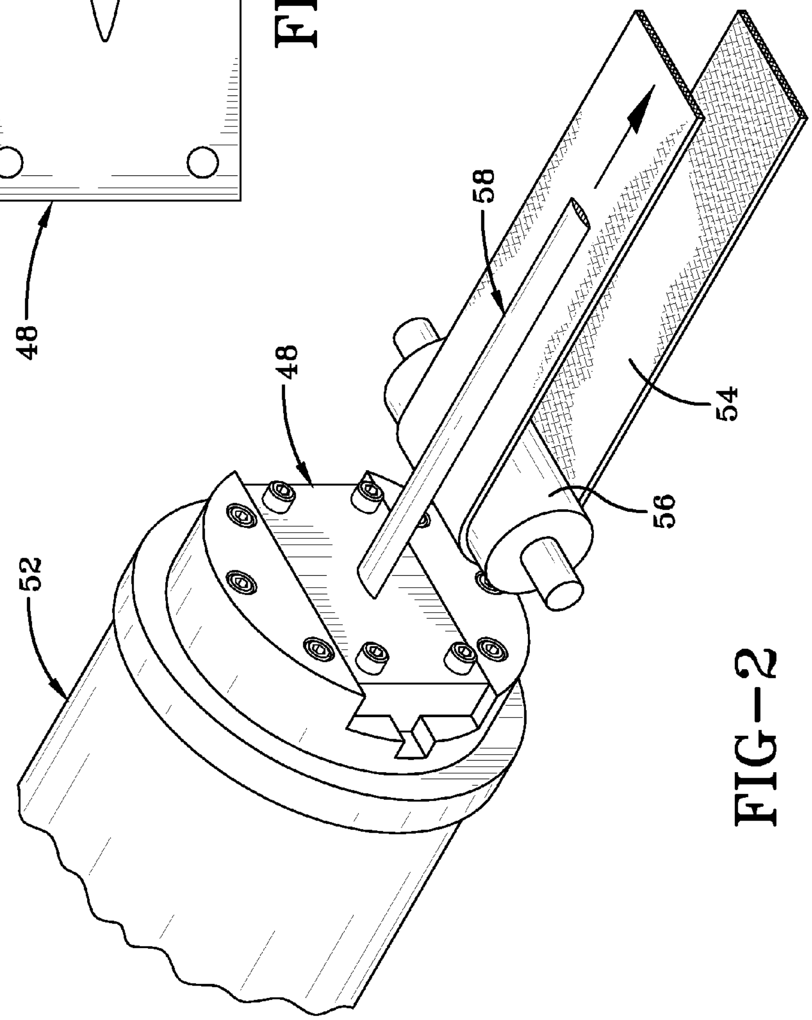
(57) **ABSTRACT**

A connector system and tire assembly includes an elongate integral air passageway contained within a flexible tire component of a tire carcass, the air passageway extending between an air inlet cavity and an air outlet cavity in the flexible tire component, and the air passageway extending at least a partial circumferential path around the tire carcass. A hollow dome-shaped inlet nut seats within the inlet cavity and a hollow dome-shaped outlet nut seats within the outlet cavity. The inlet nut couples to an air inlet device for conducting air external to the tire carcass into the inlet nut central chamber; and the outlet nut outward body side couples to a valve device positioned within the tire cavity.

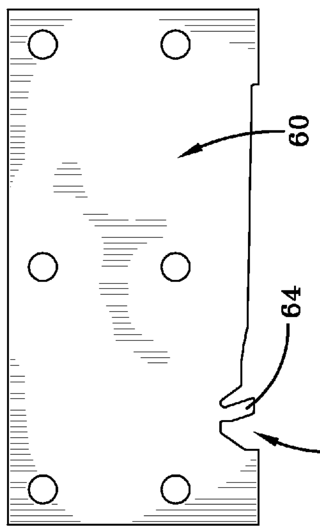




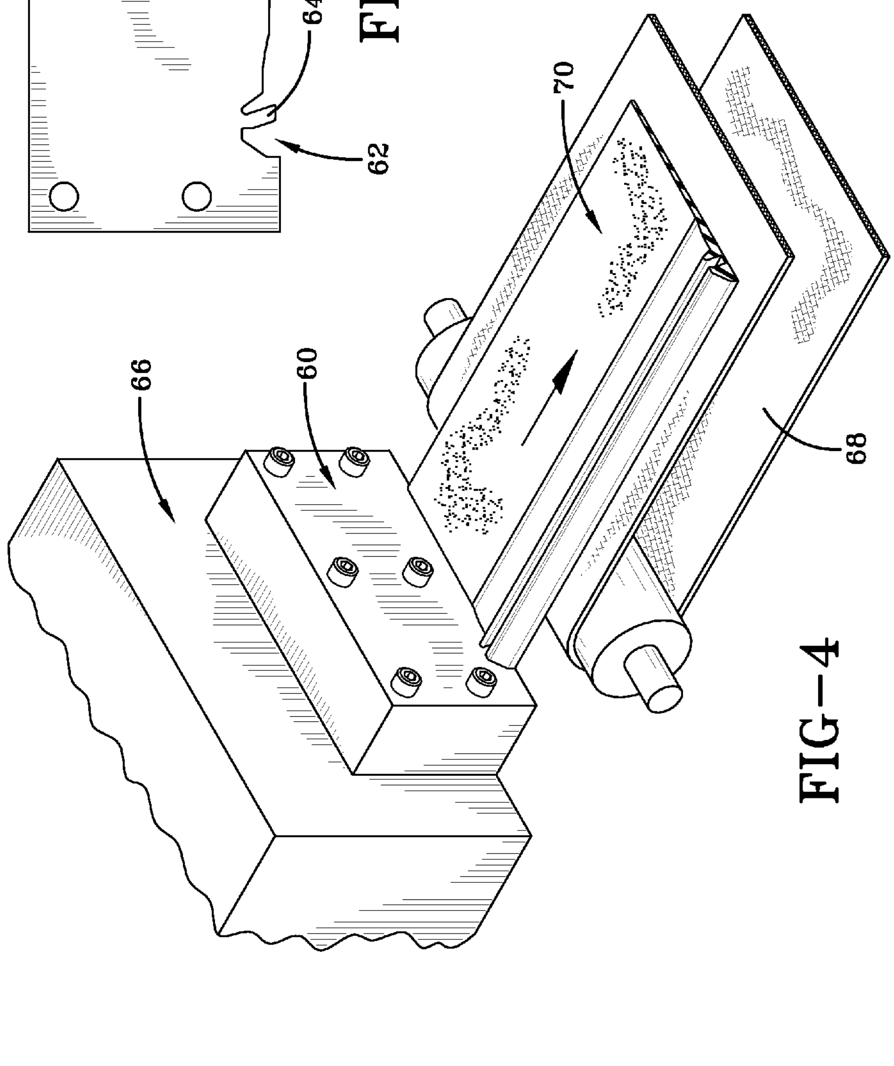

FIG—1



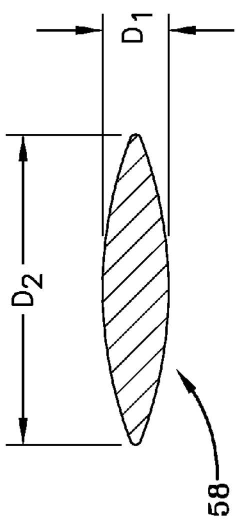

FIG—2



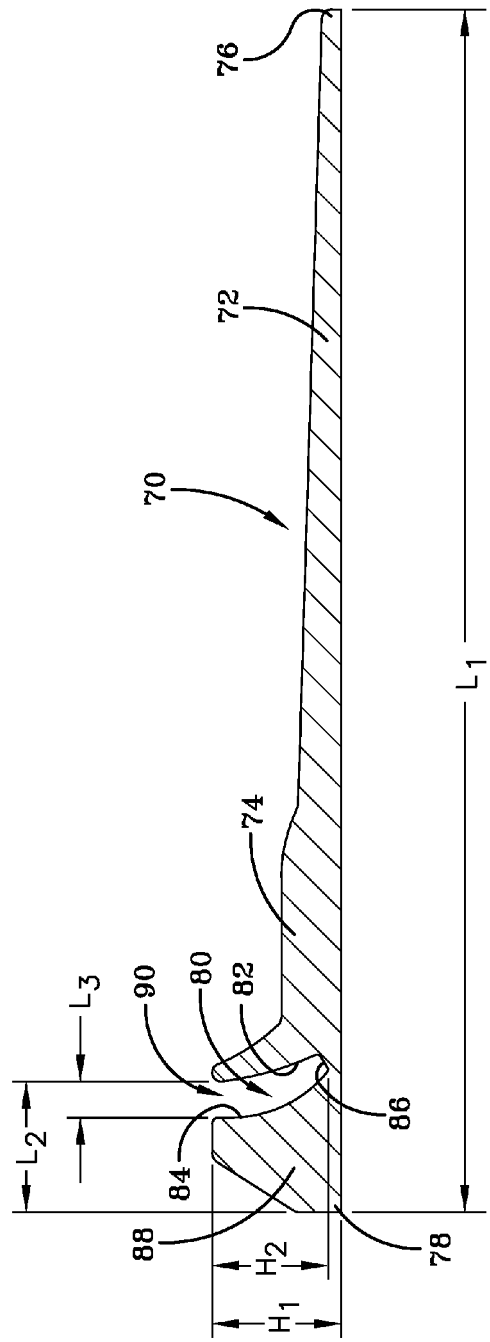

FIG—3




FIG—4




FIG—5




FIG—6

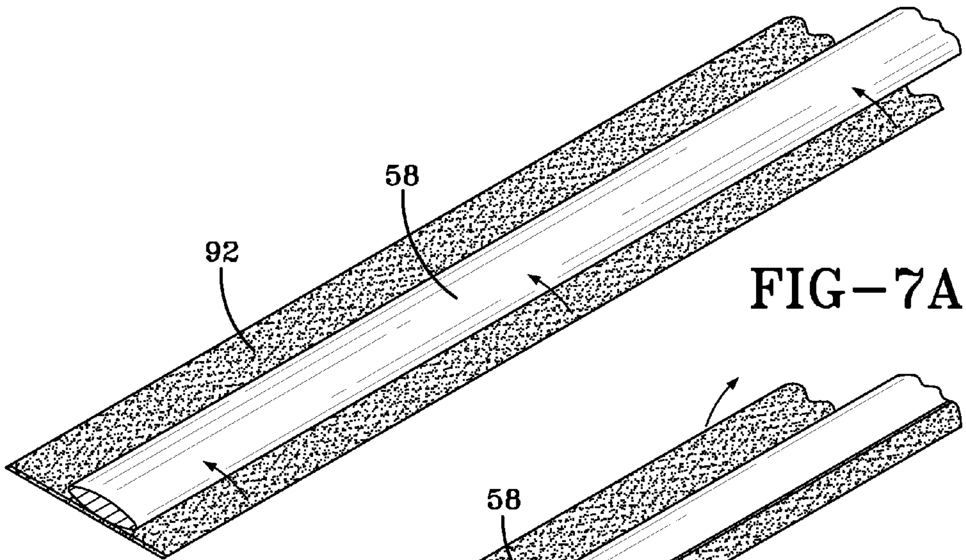



FIG-7A

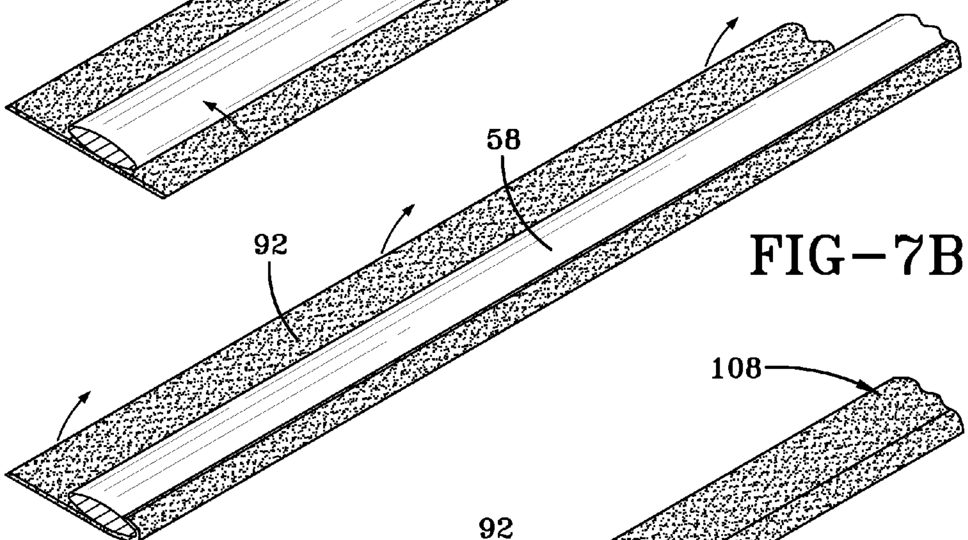



FIG-7B

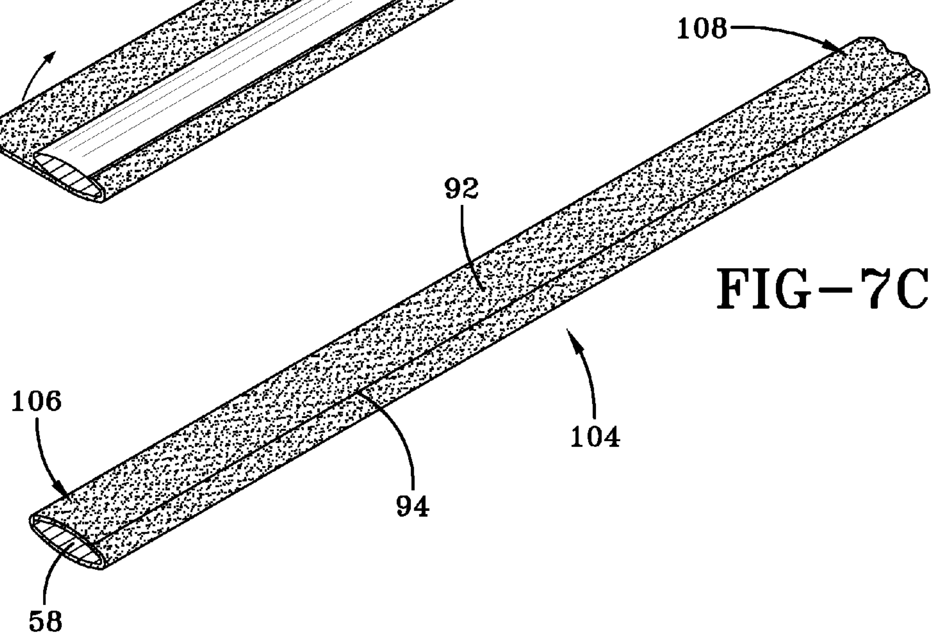



FIG-7C

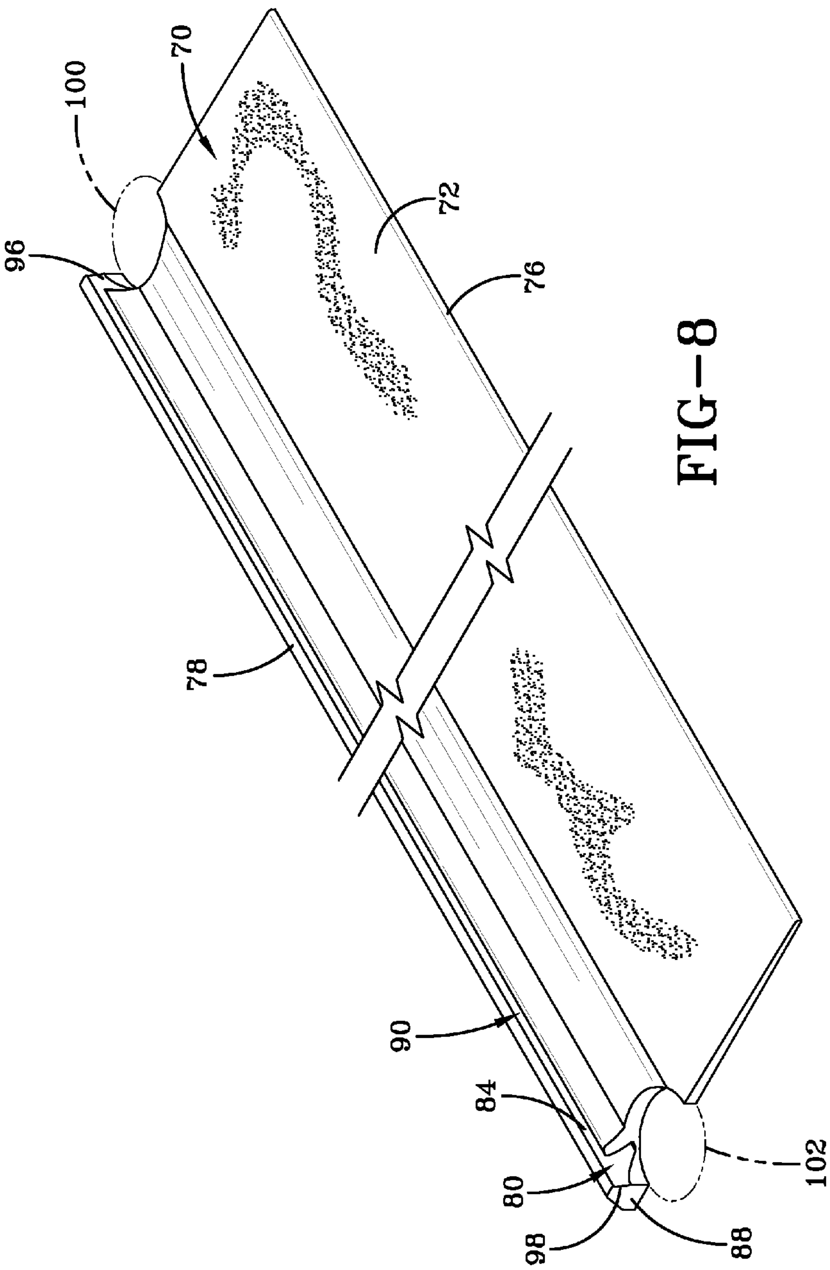
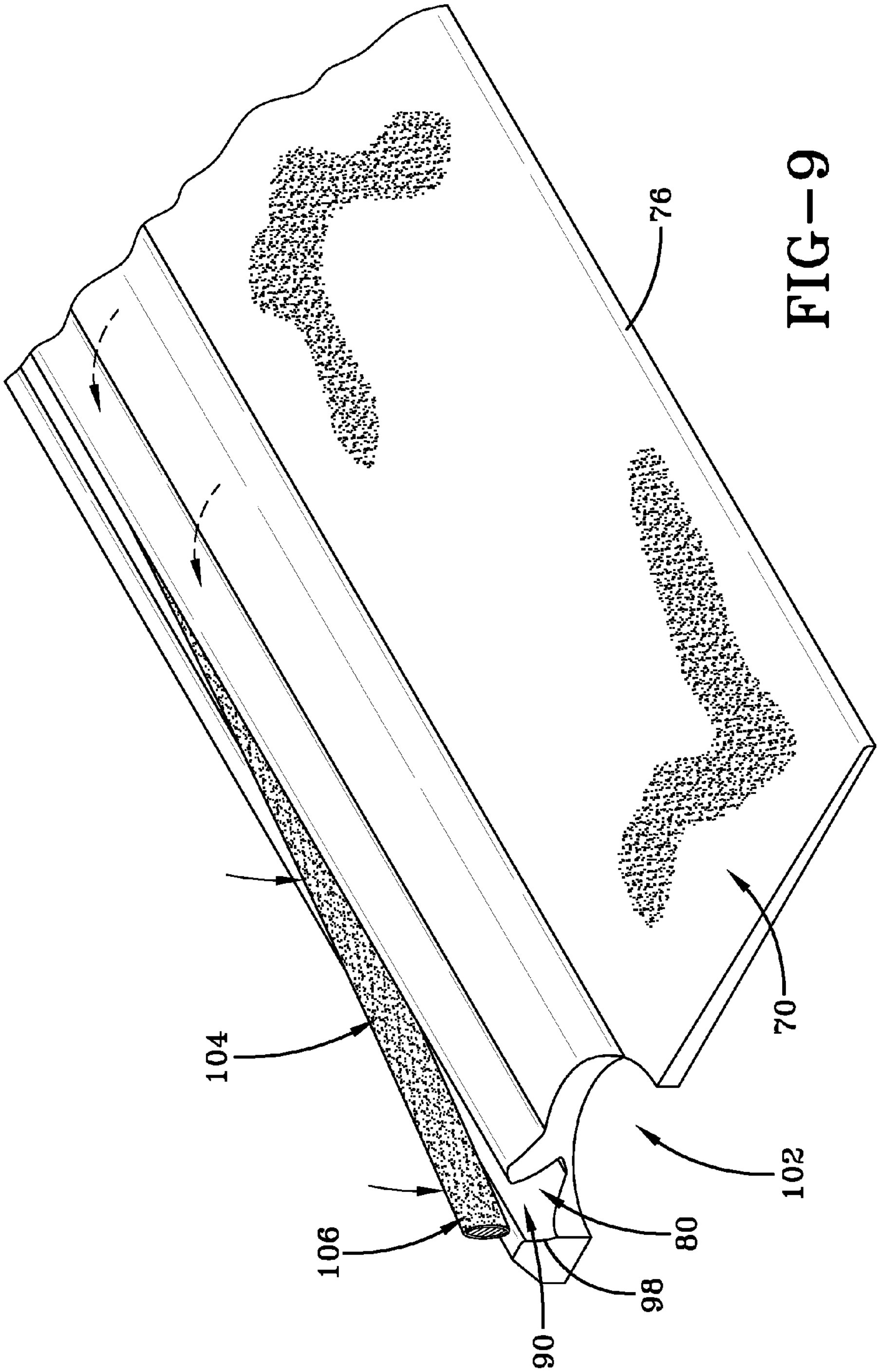



FIG-8




FIG—9

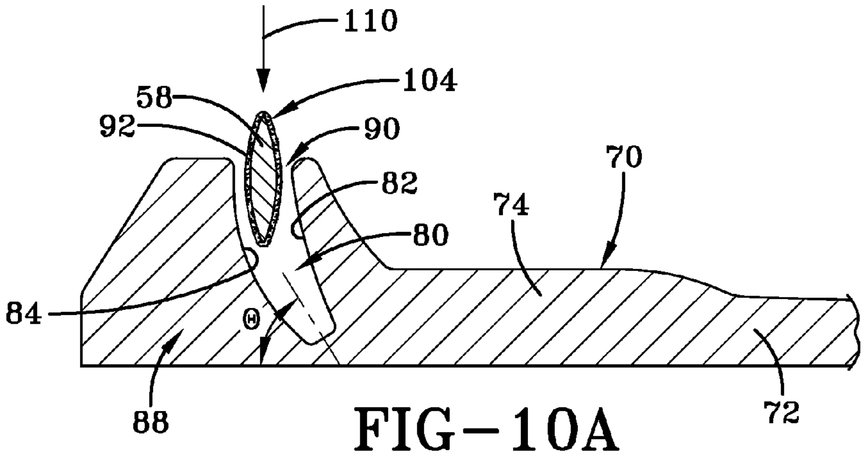



FIG-10A

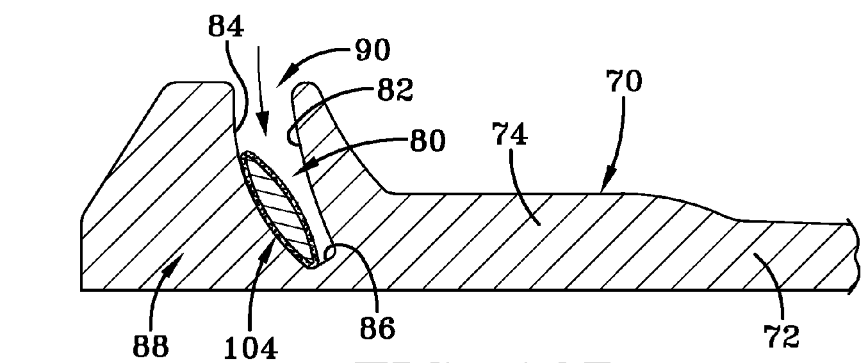



FIG-10B

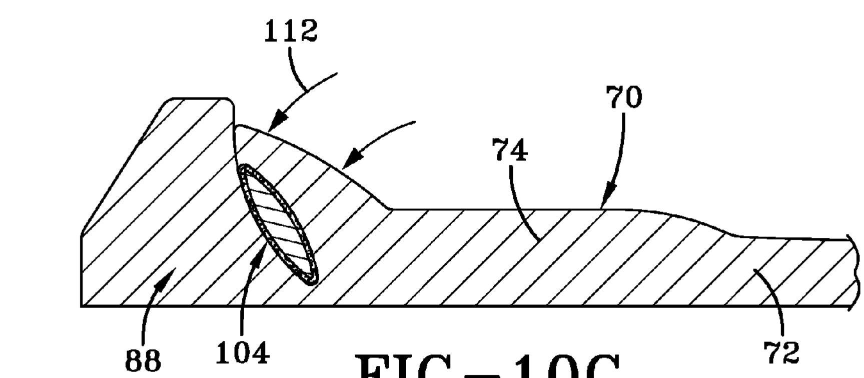
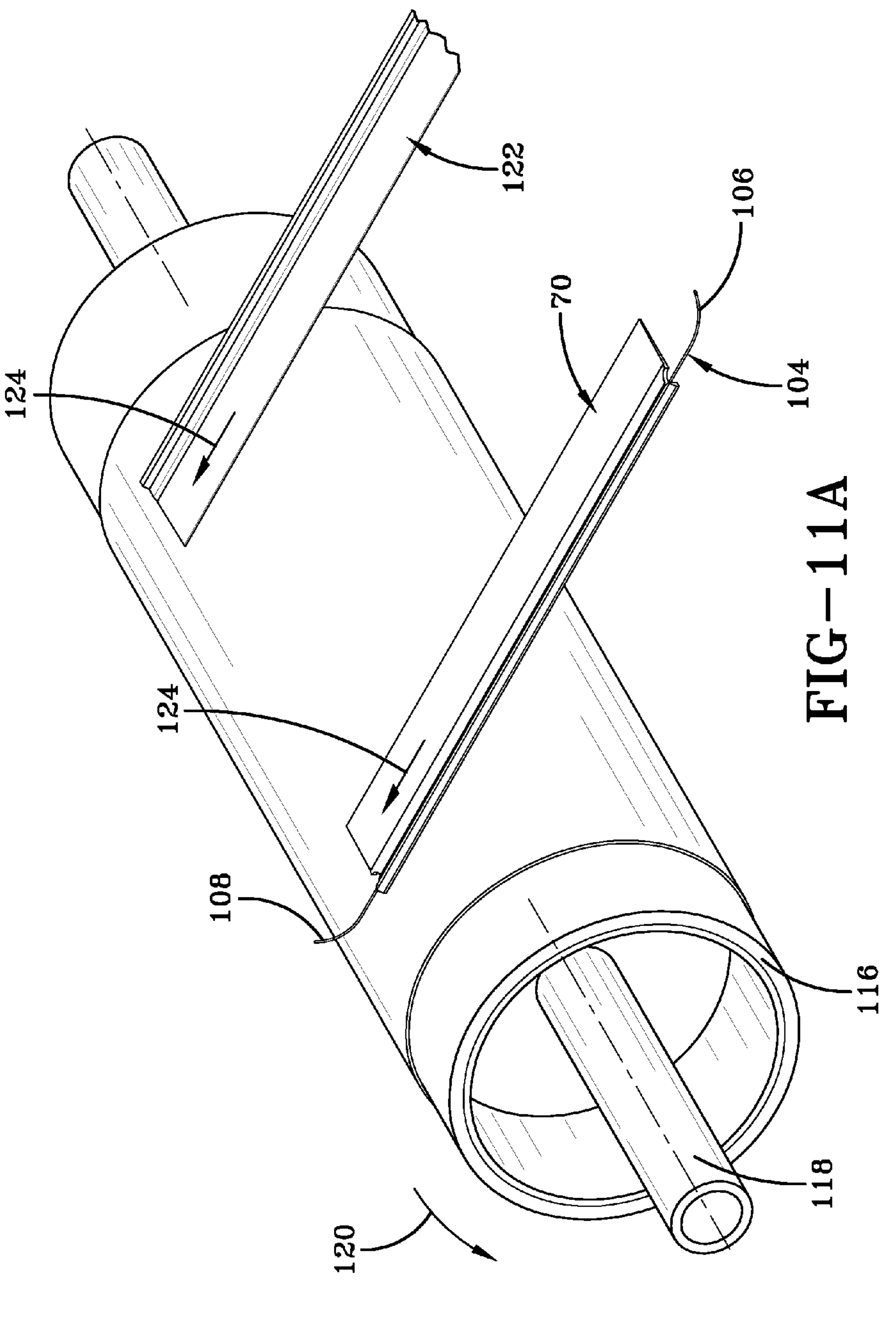
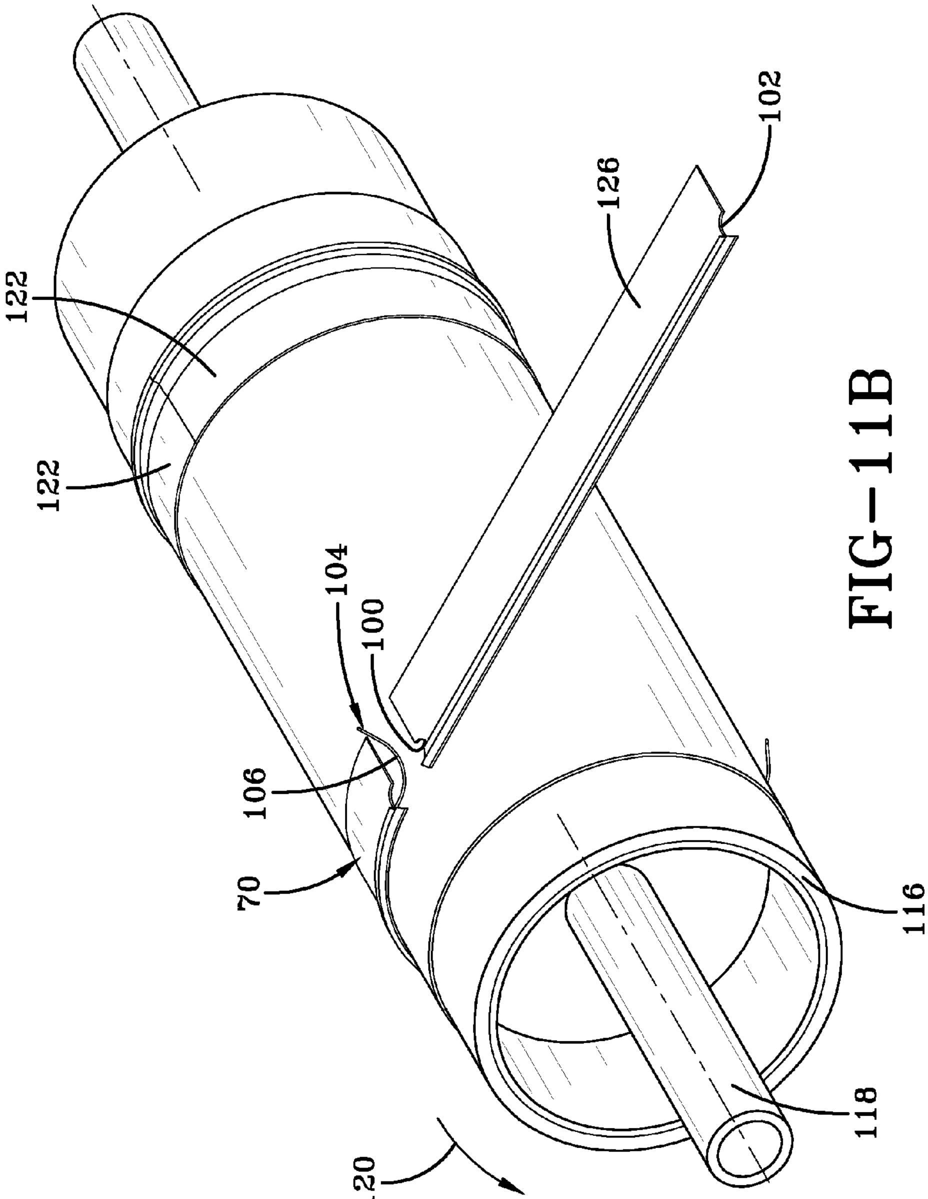



FIG-10C




FIG—11A




FIG—11B

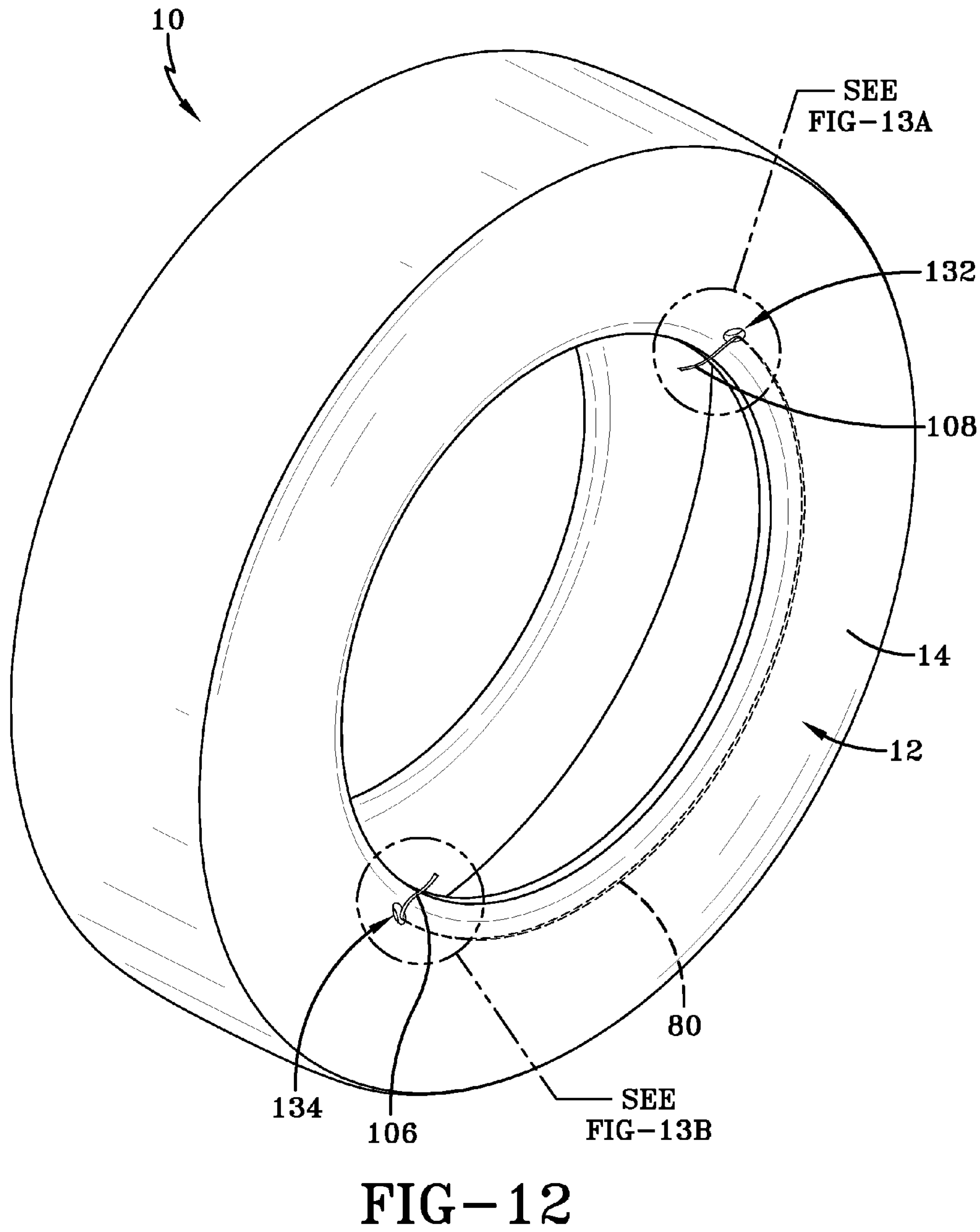



FIG-12

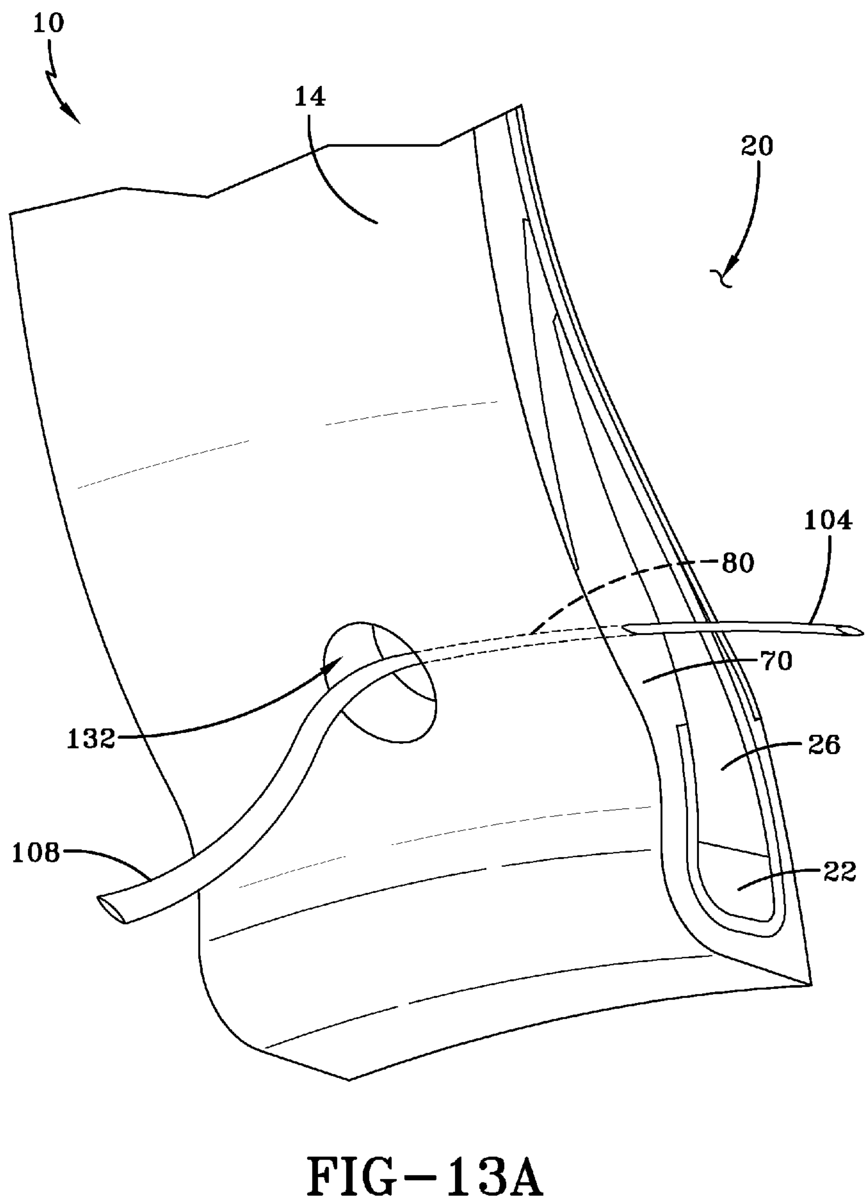
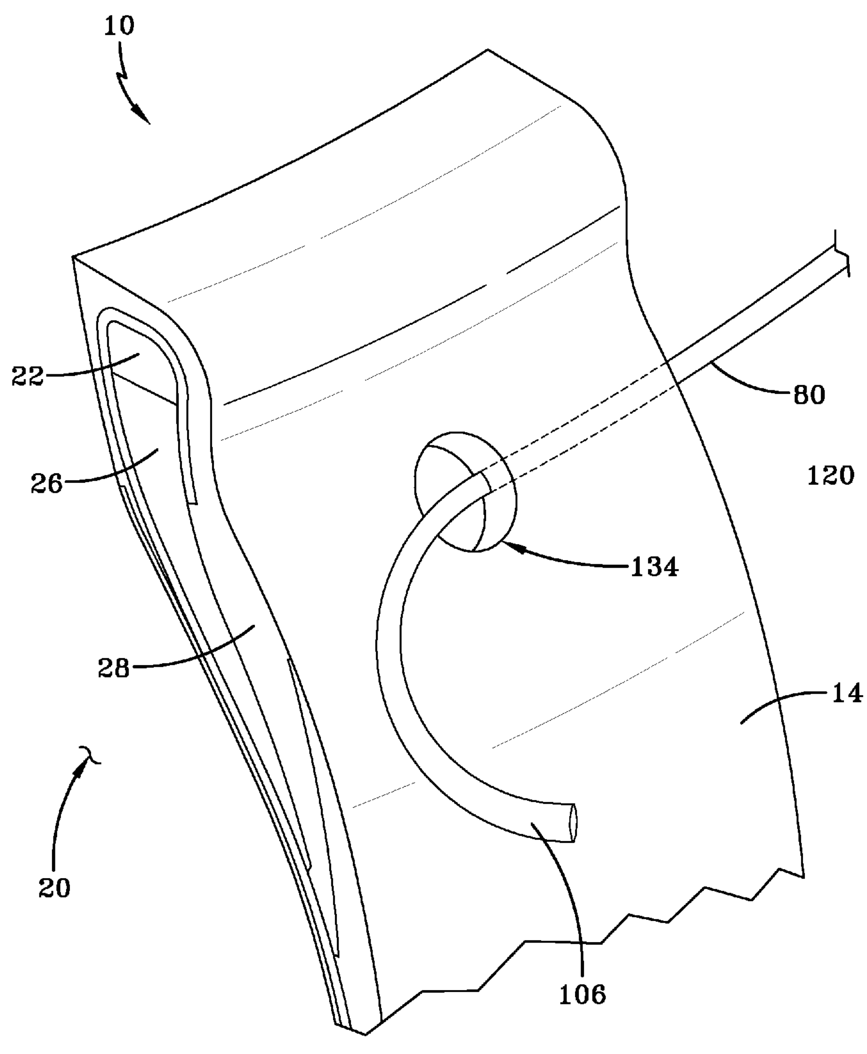



FIG-13A




FIG–13B

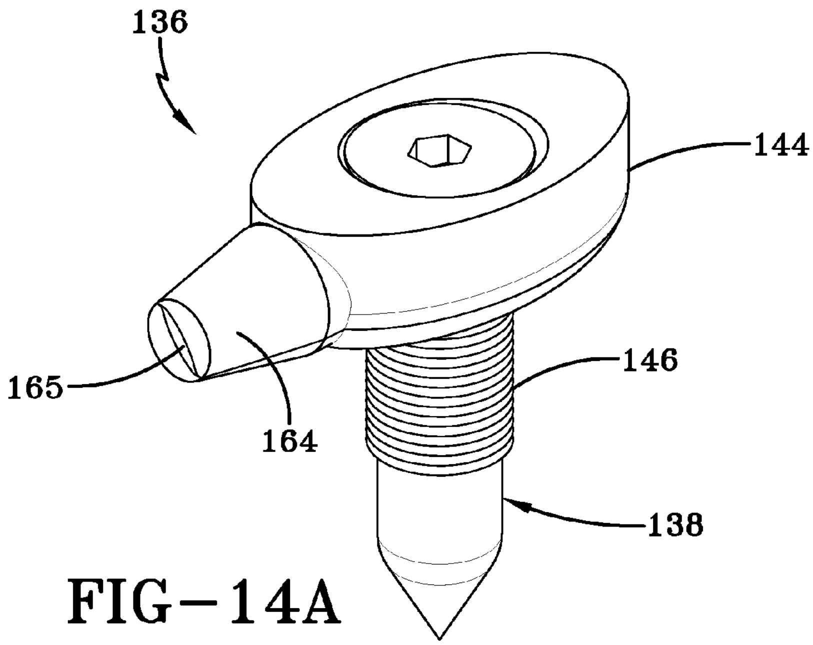



FIG-14A

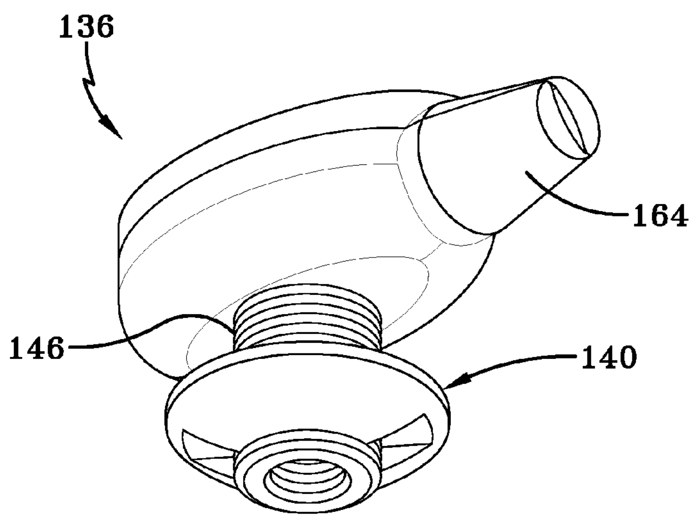



FIG-14B

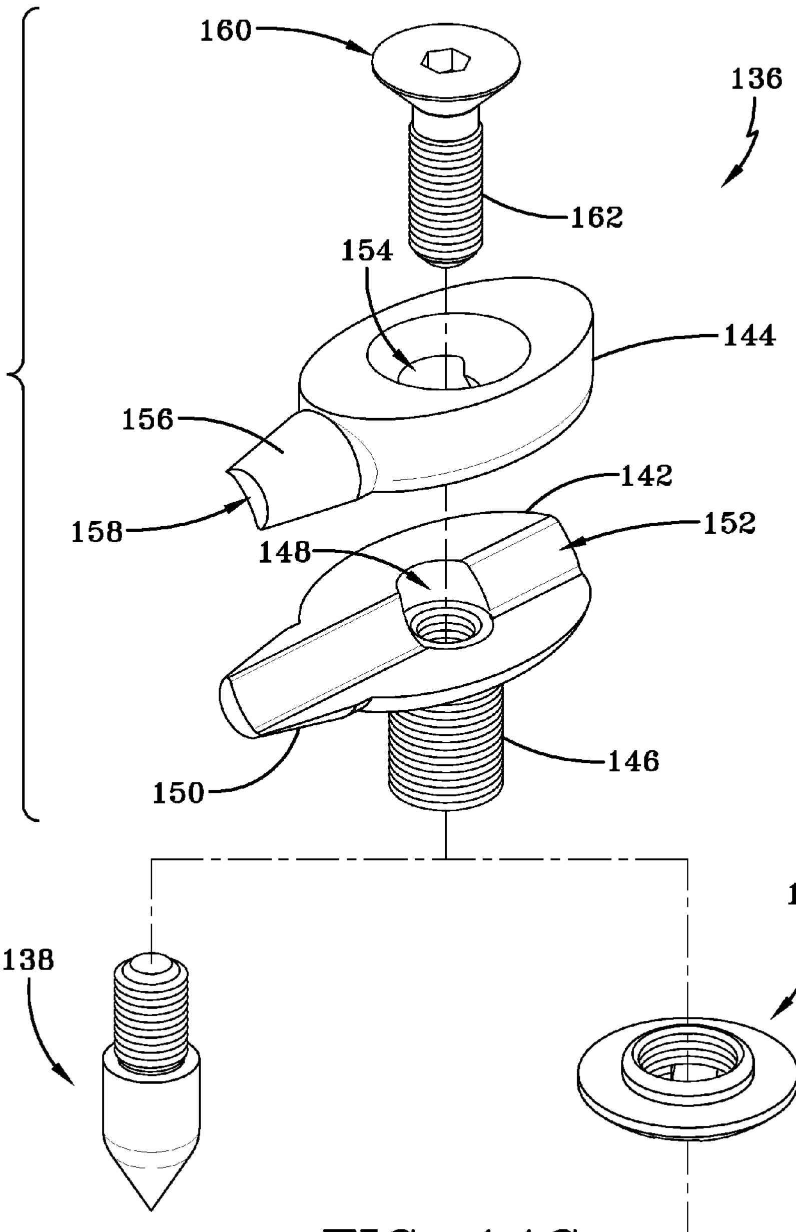



FIG-14C

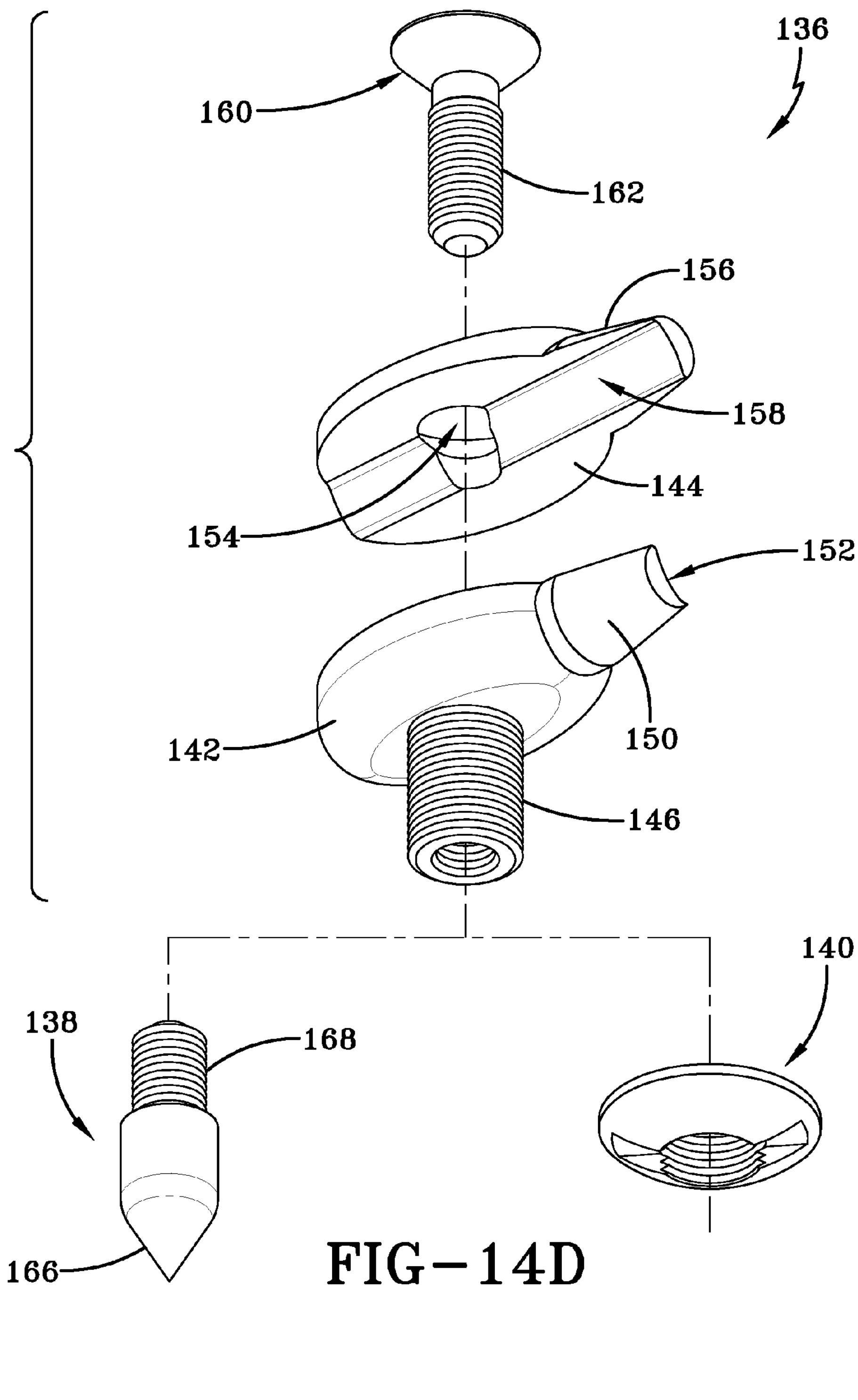
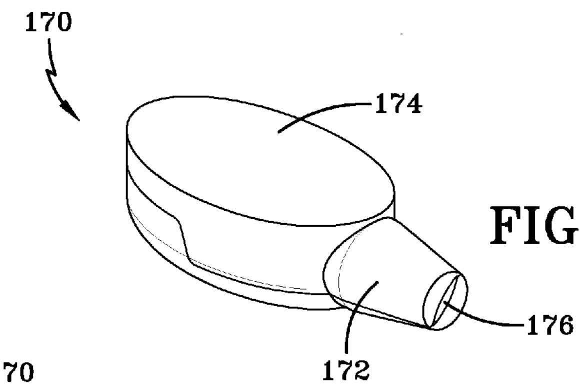
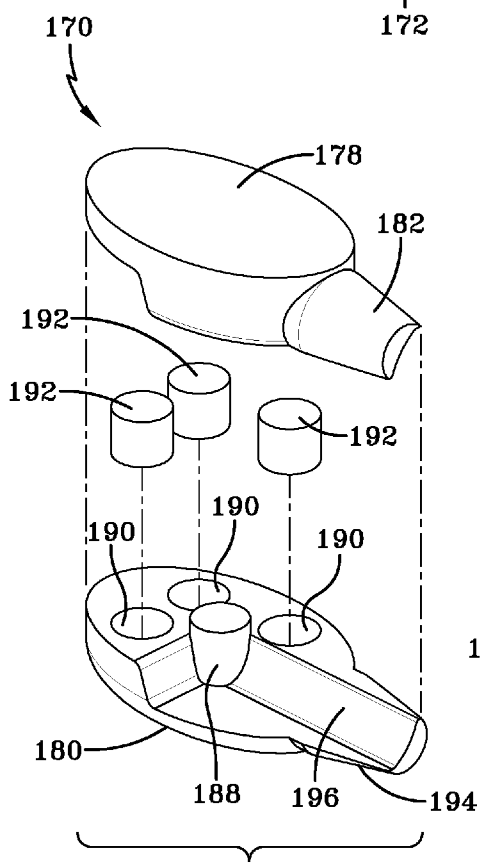


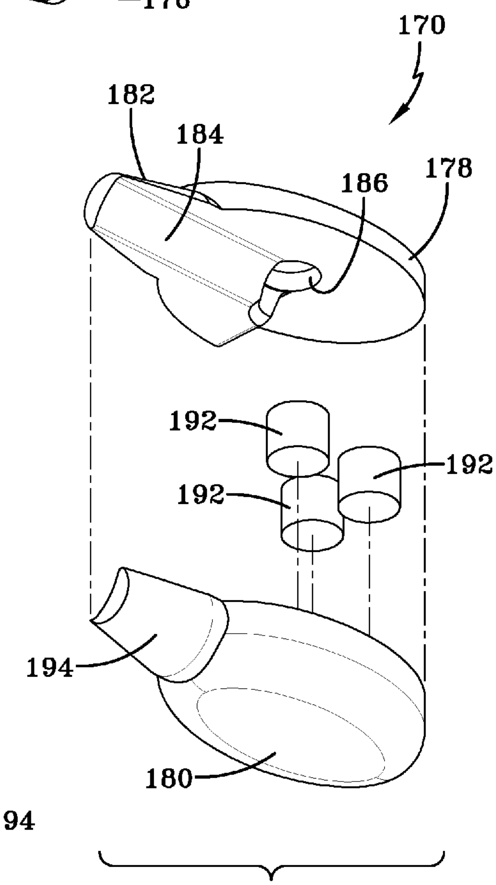

FIG-14D




FIG–15A




FIG–15B

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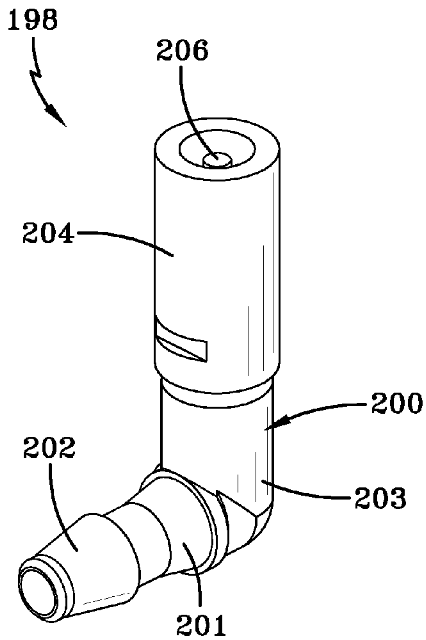



FIG-16A

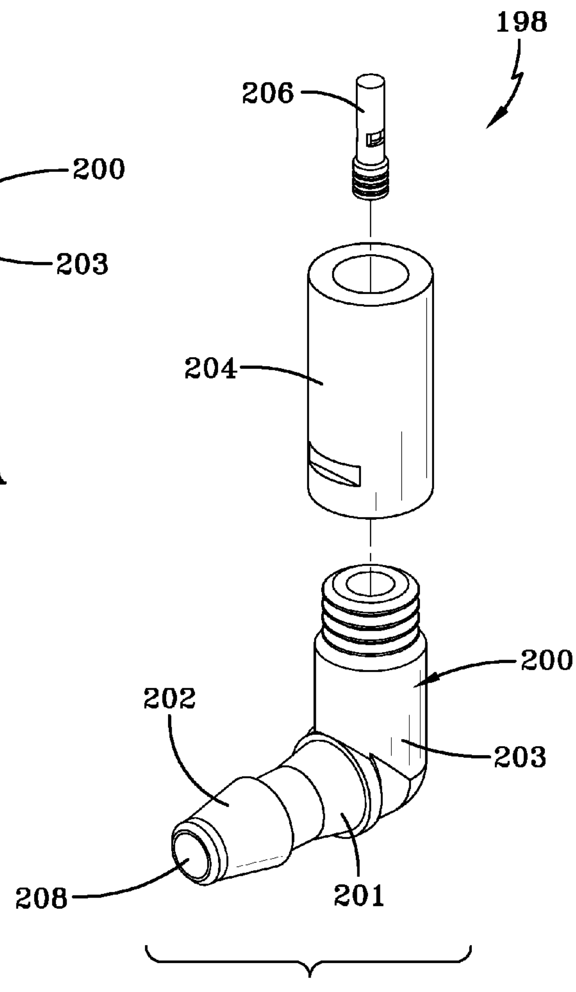



FIG-16B

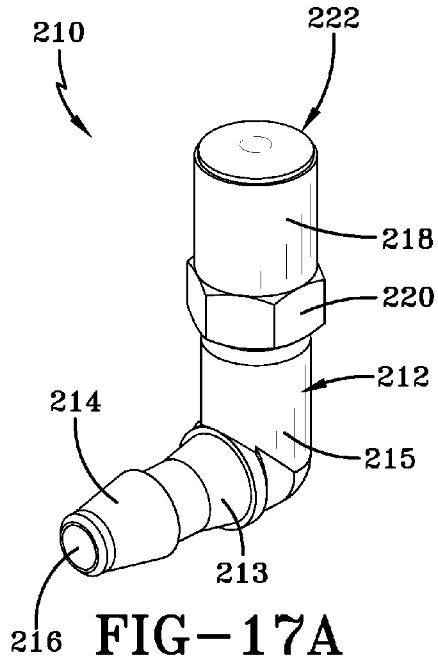



FIG-17A

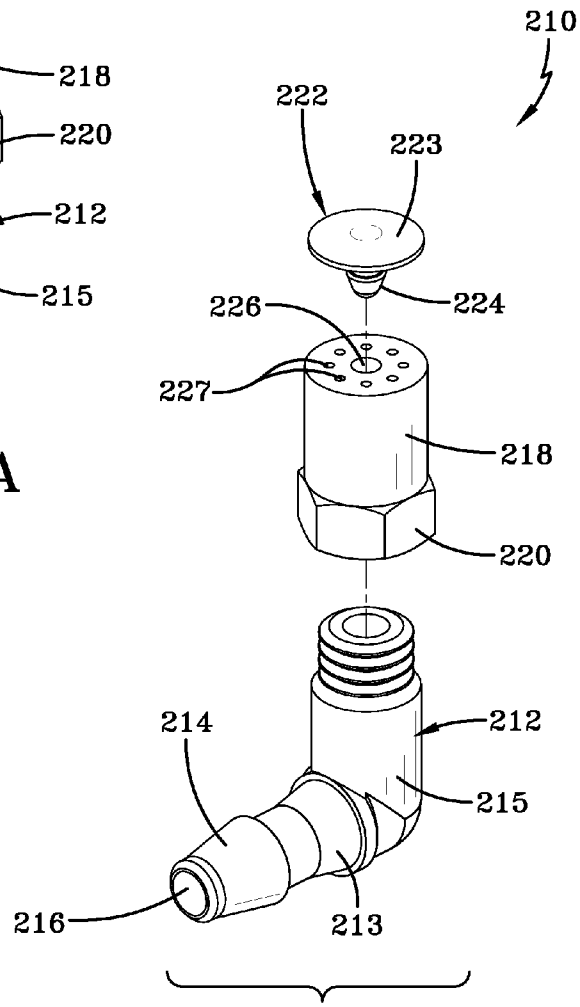



FIG-17B

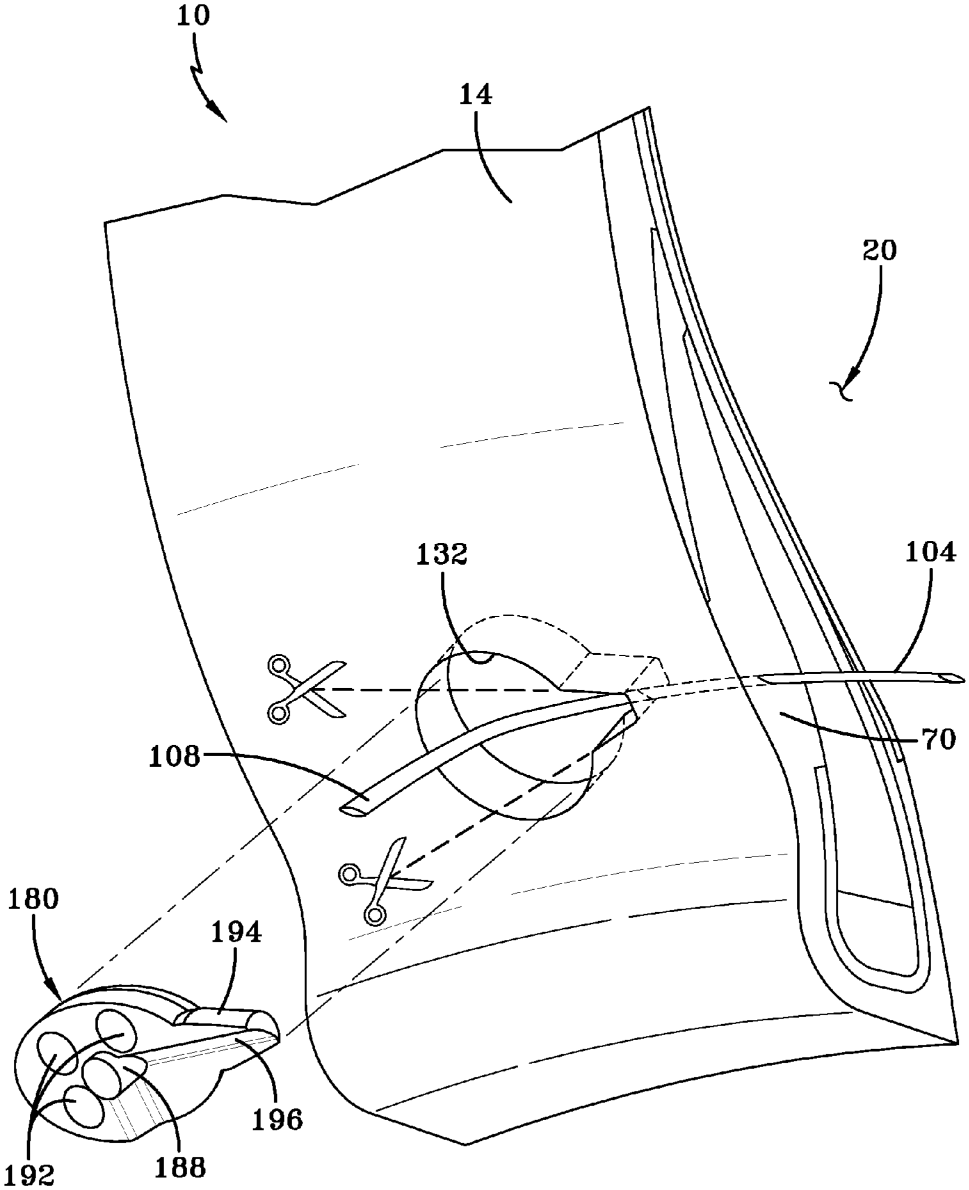



FIG-18A

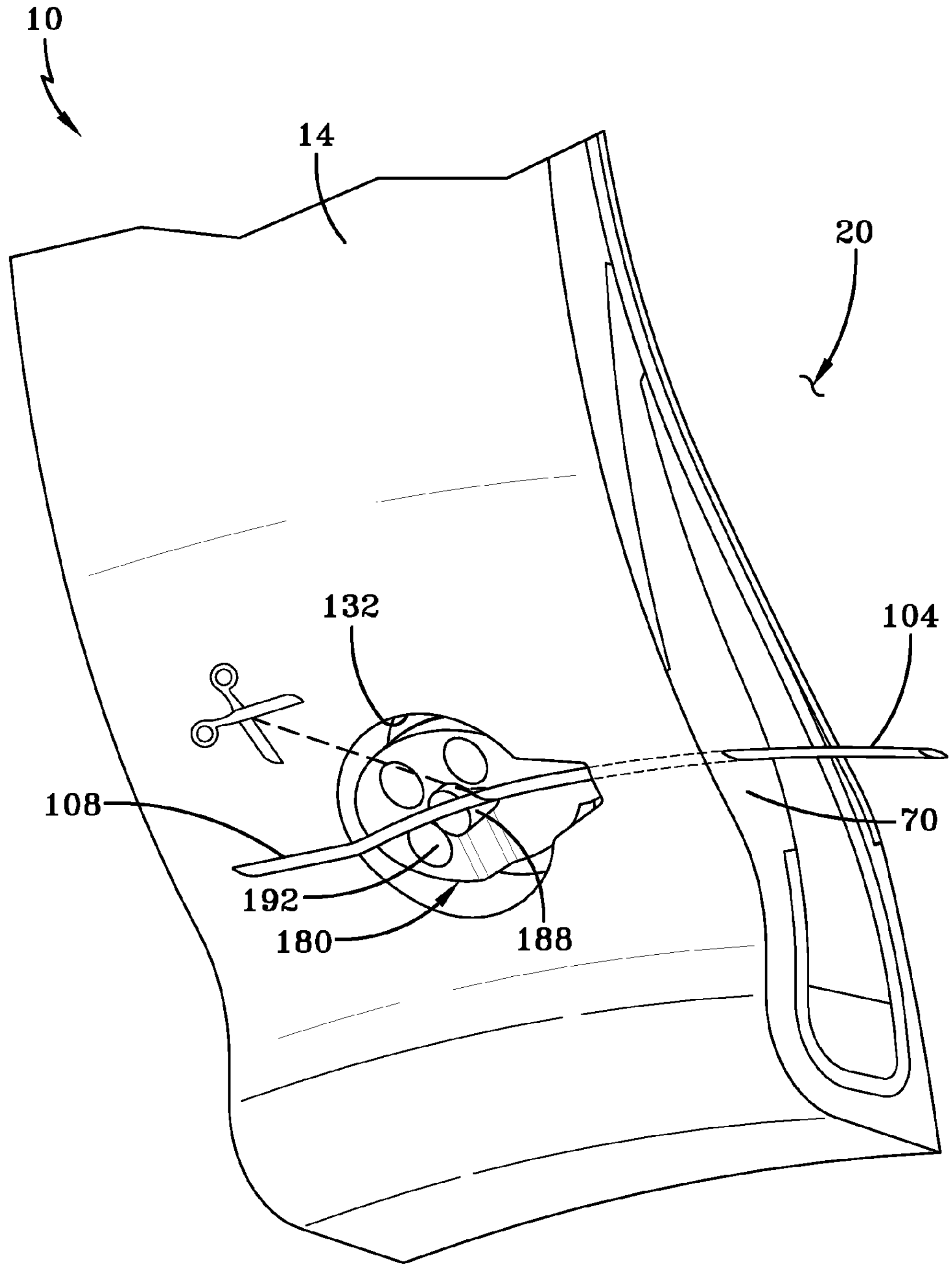
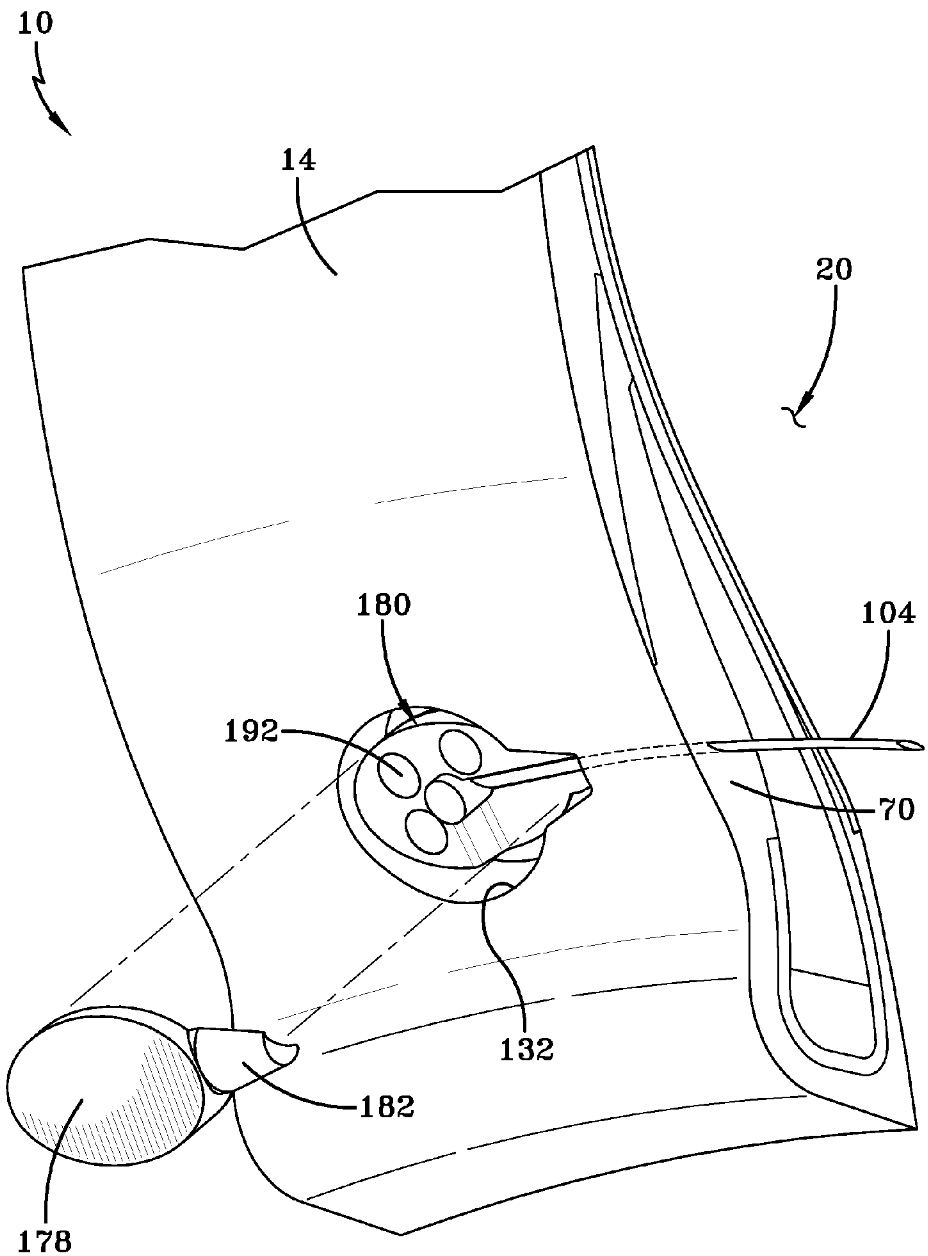



FIG-18B

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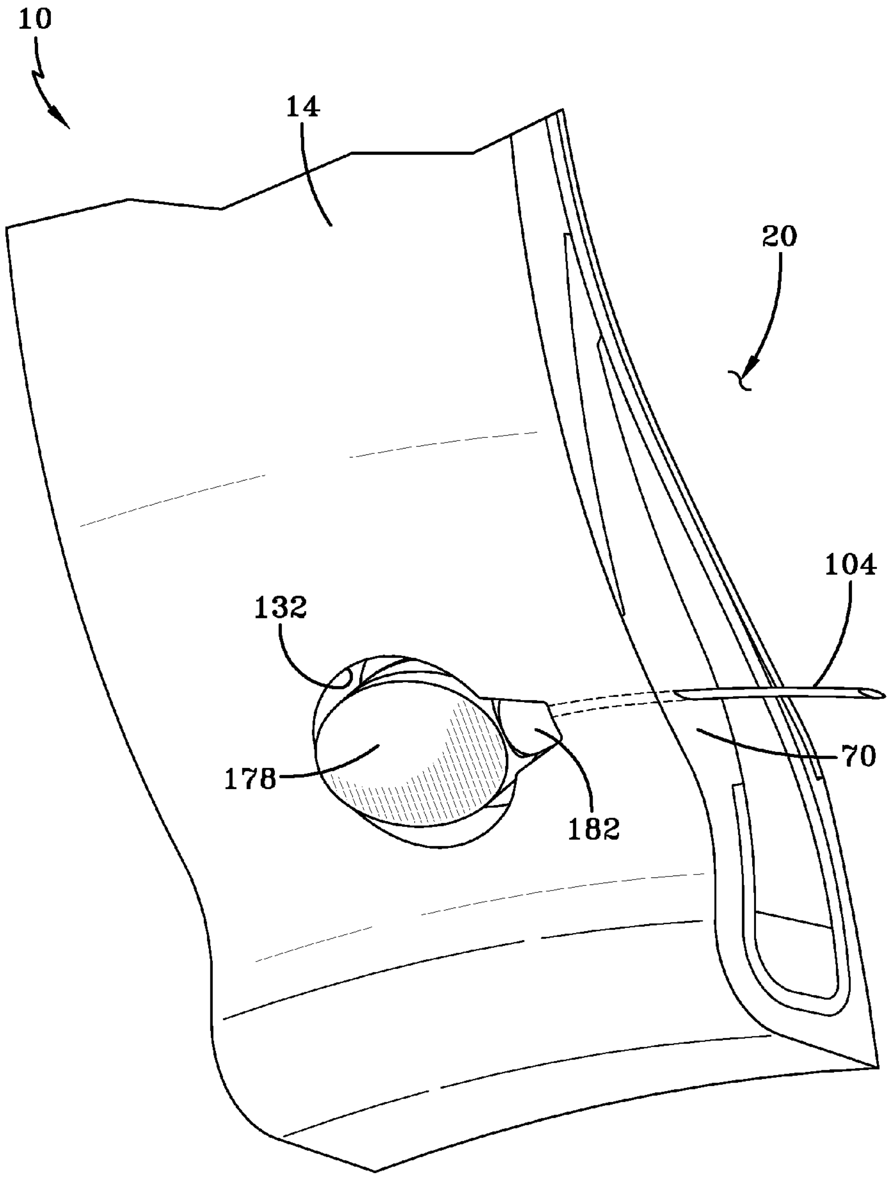
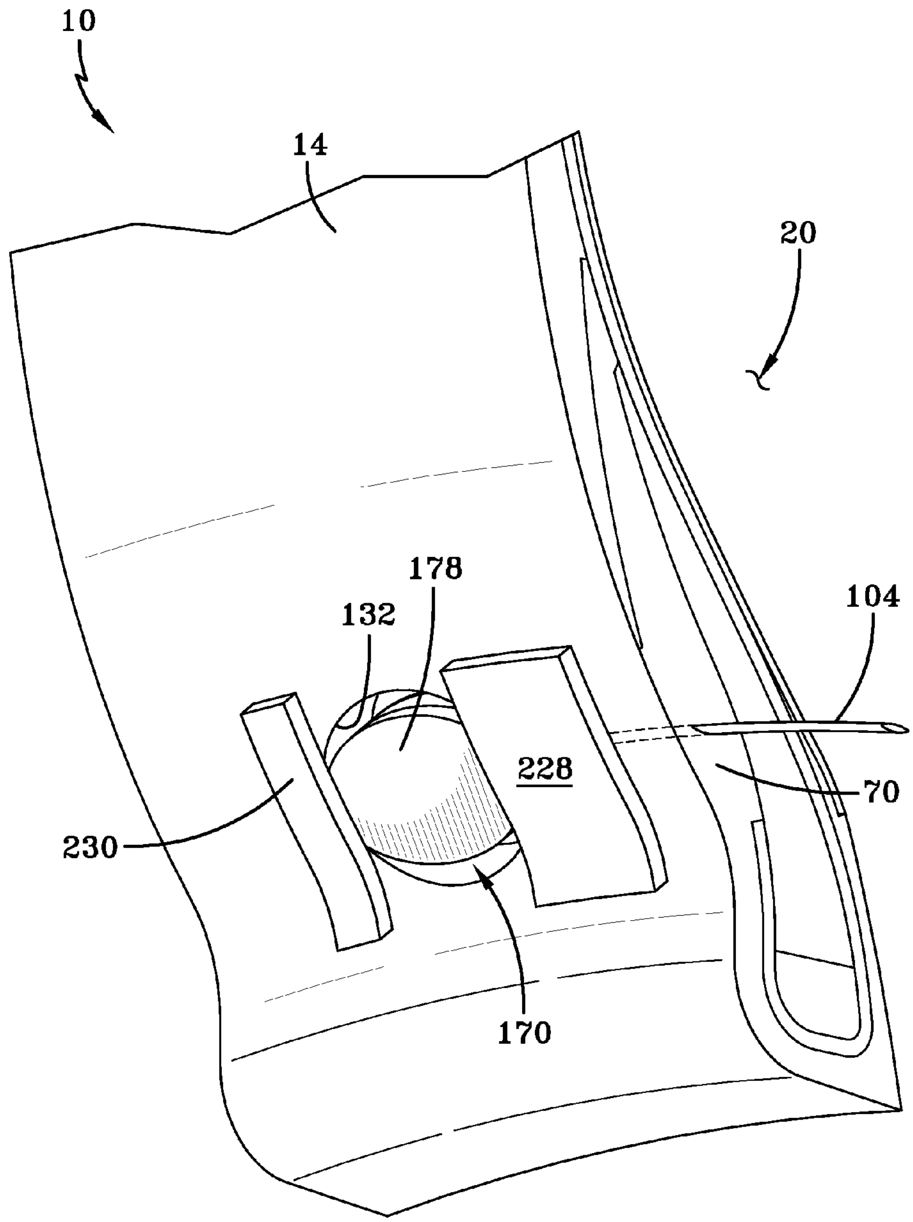



FIG-18D




FIG–18E

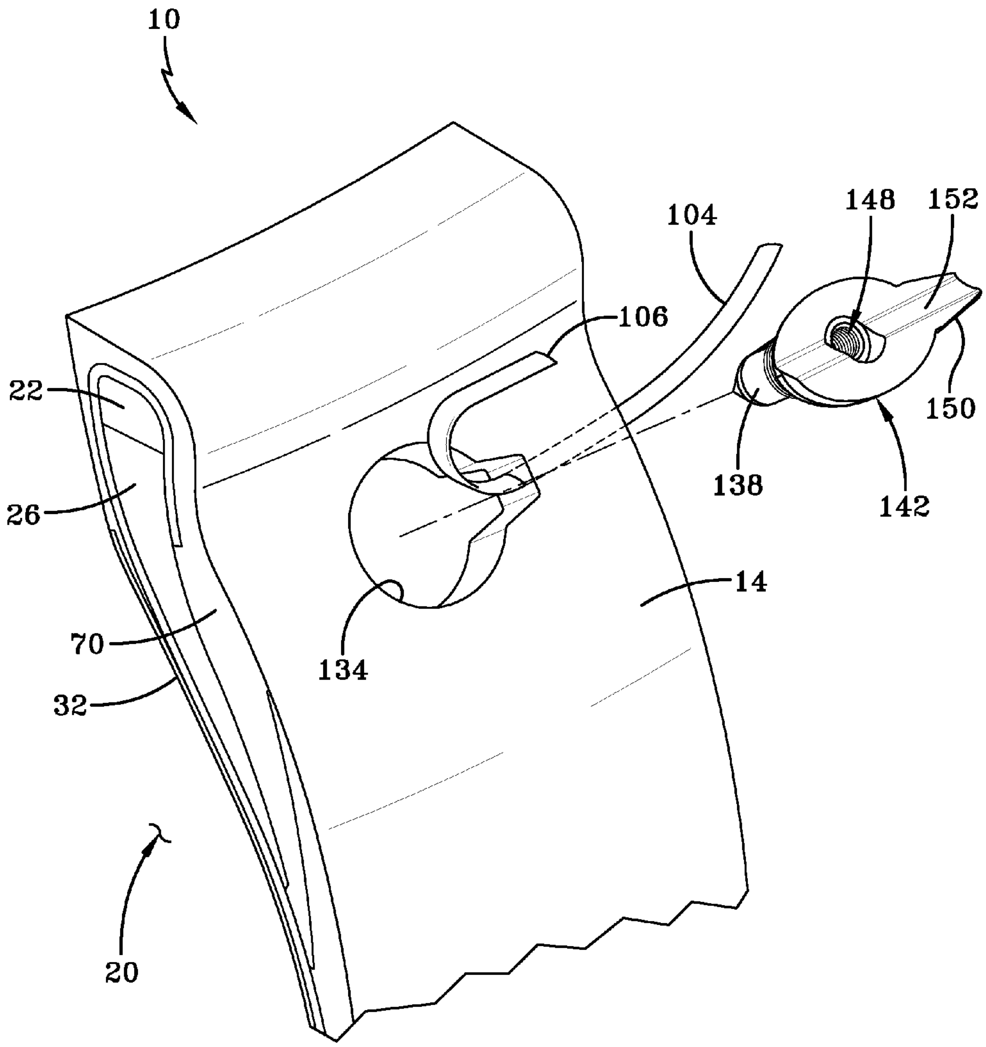



FIG-19A

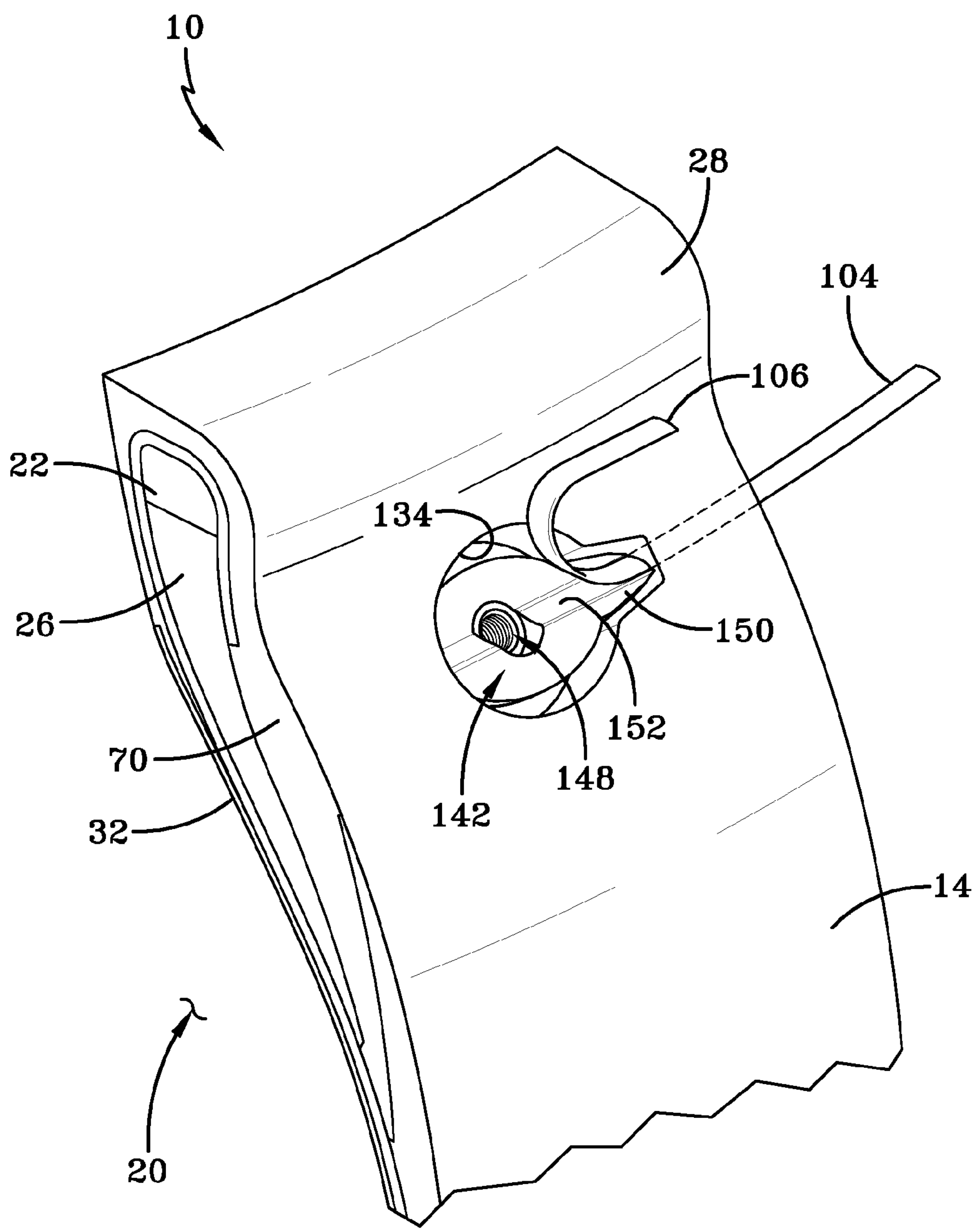



FIG-19B

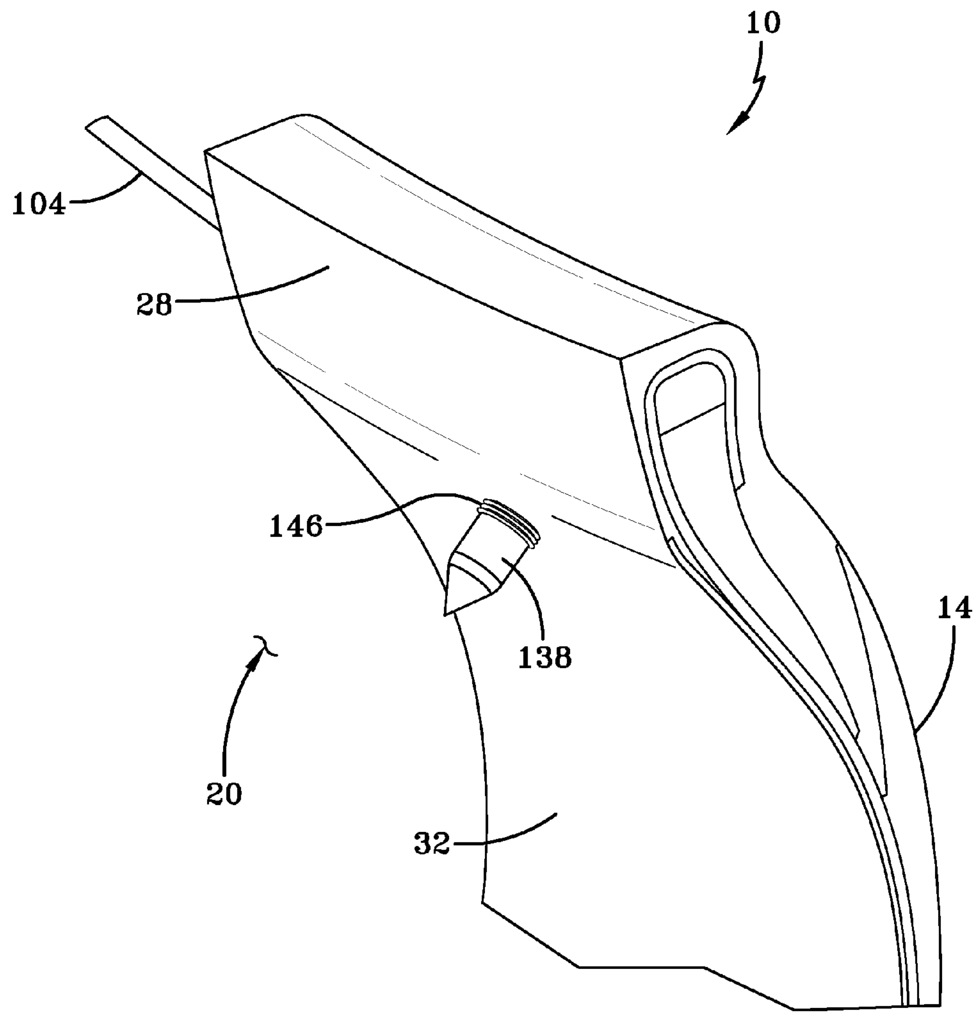



FIG-19C

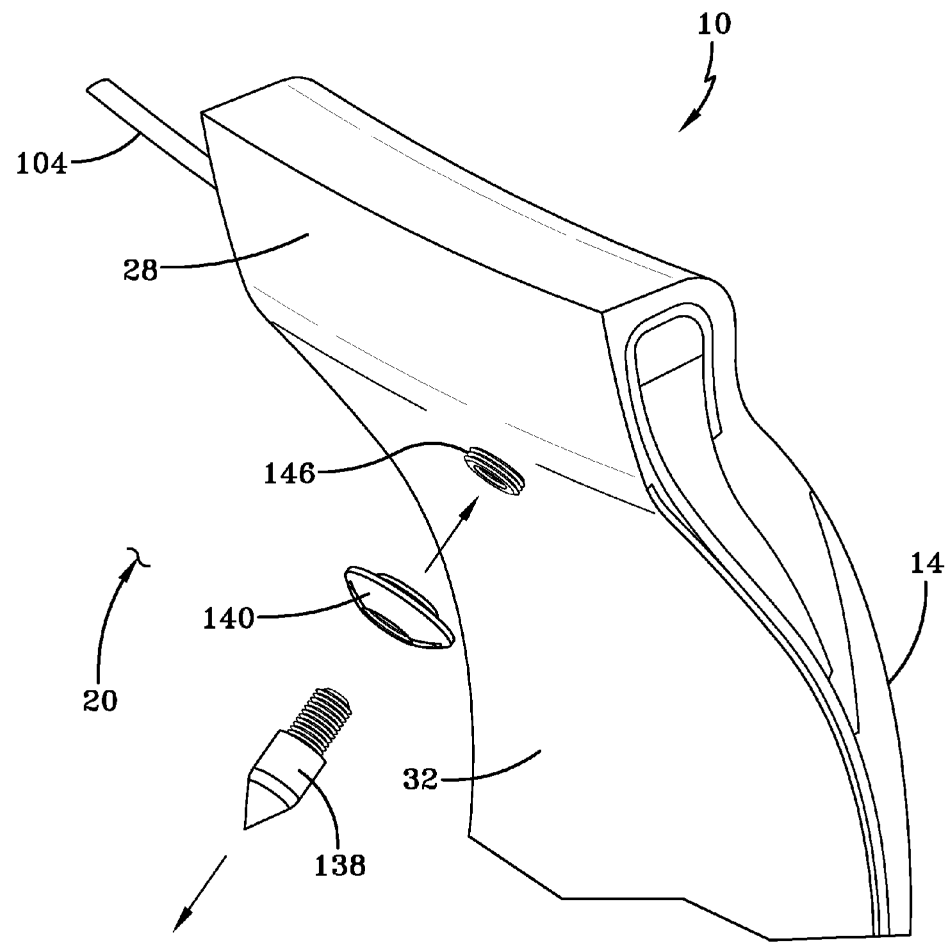



FIG-19D

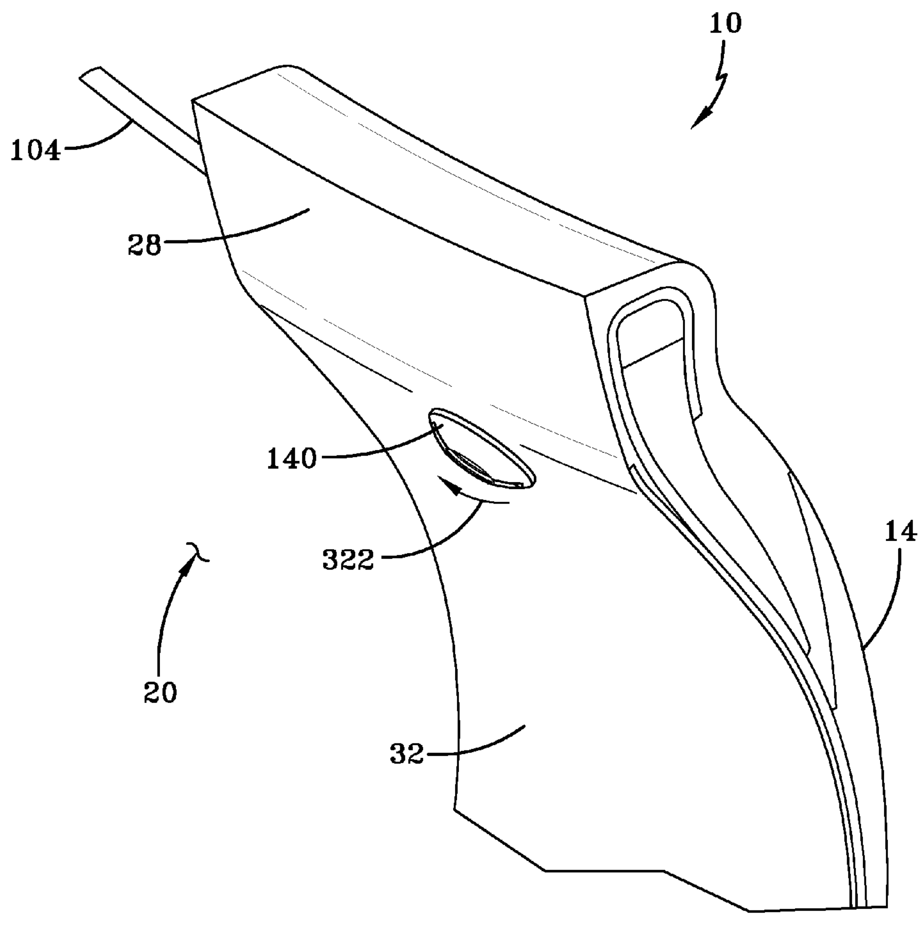



FIG-19E

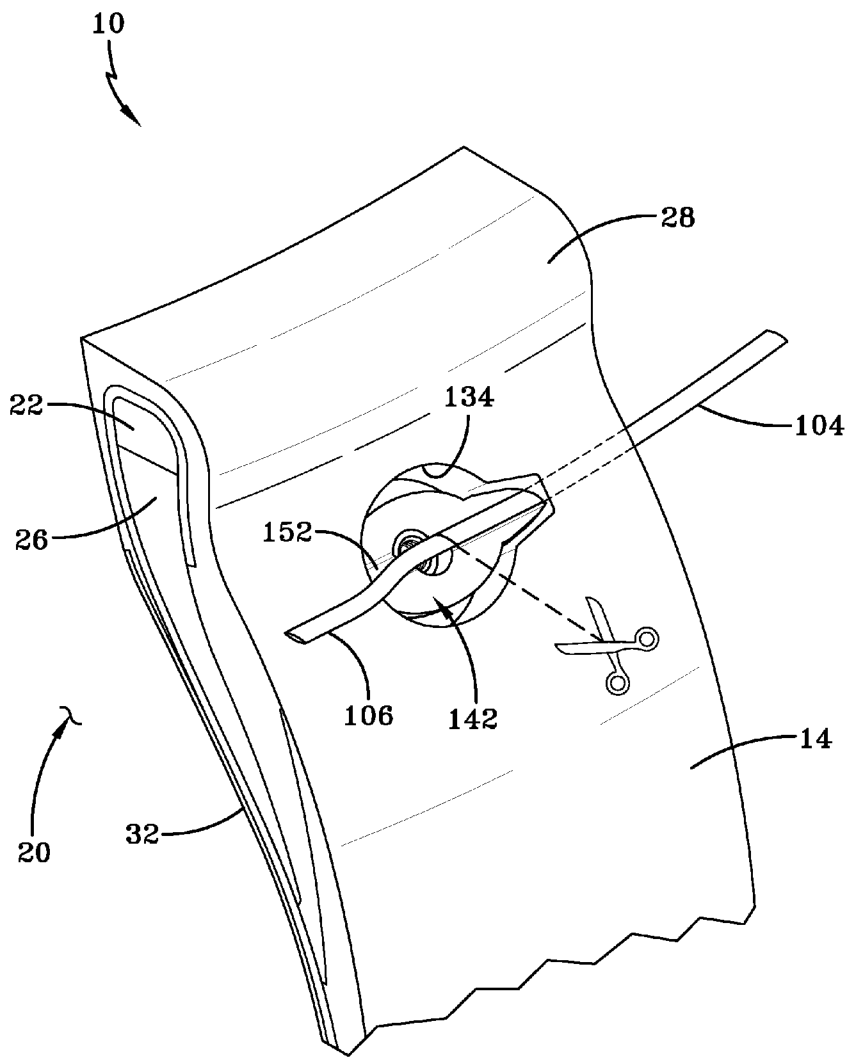



FIG-19F

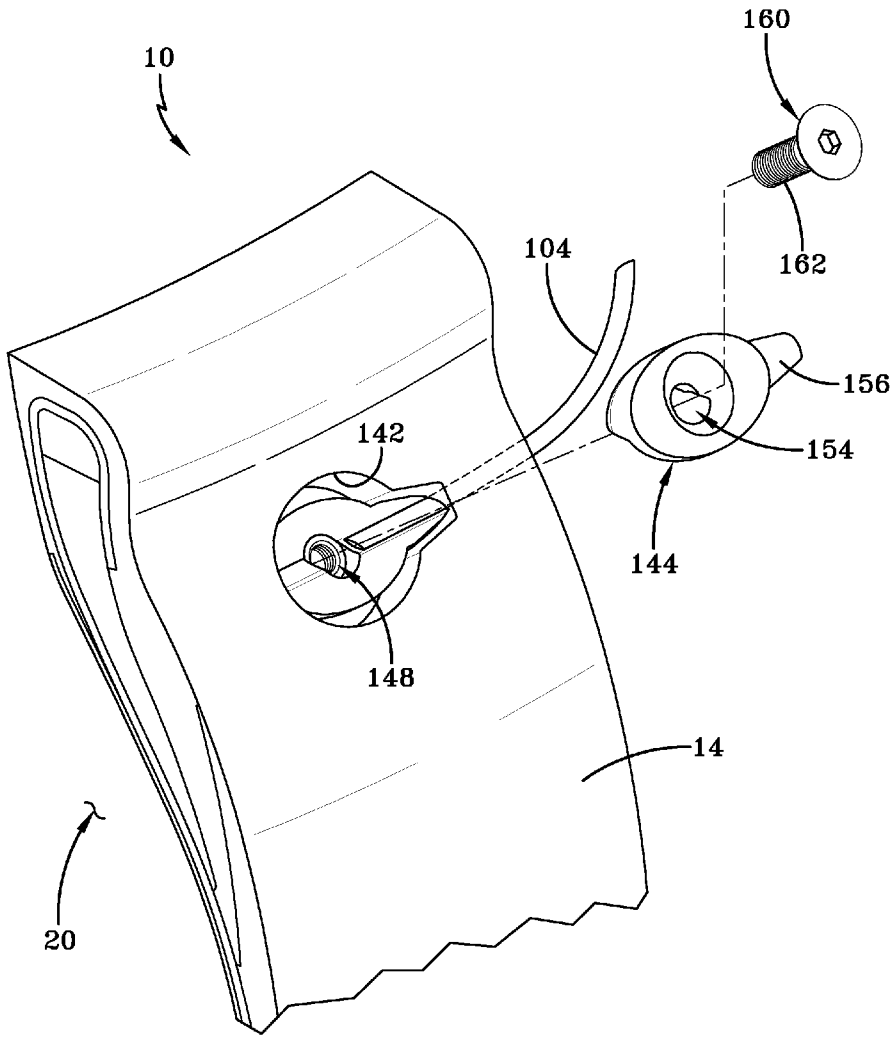
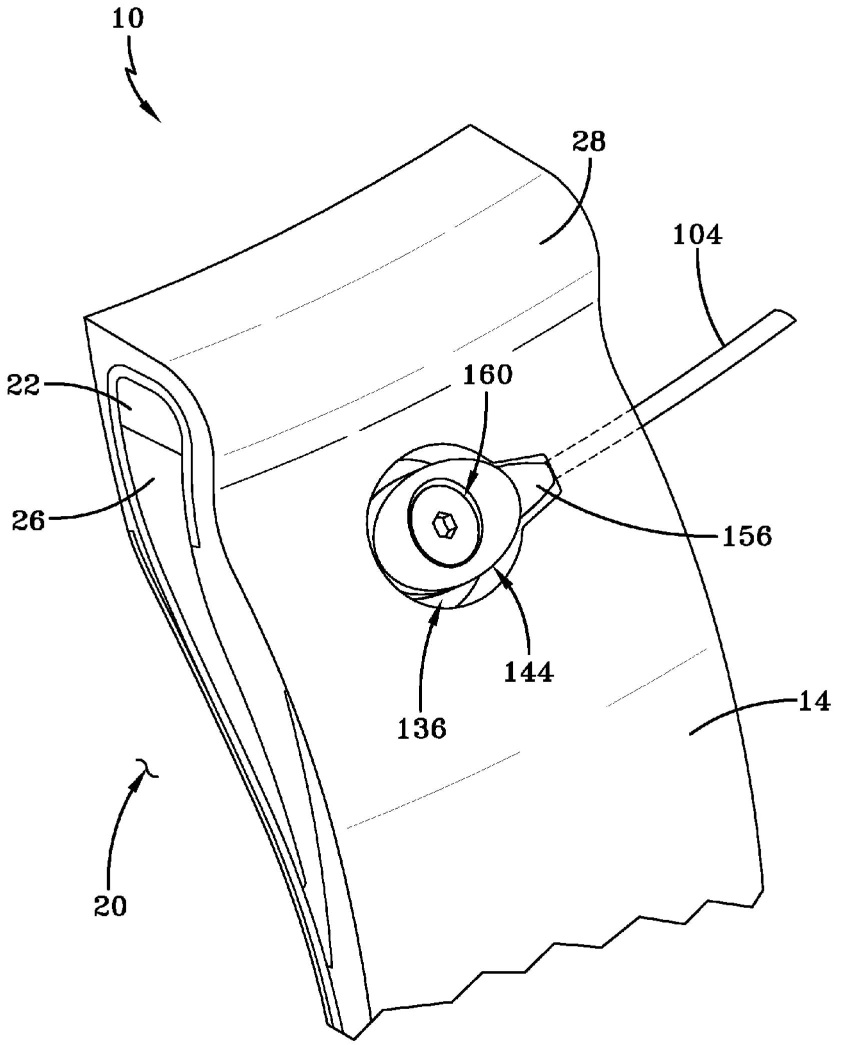
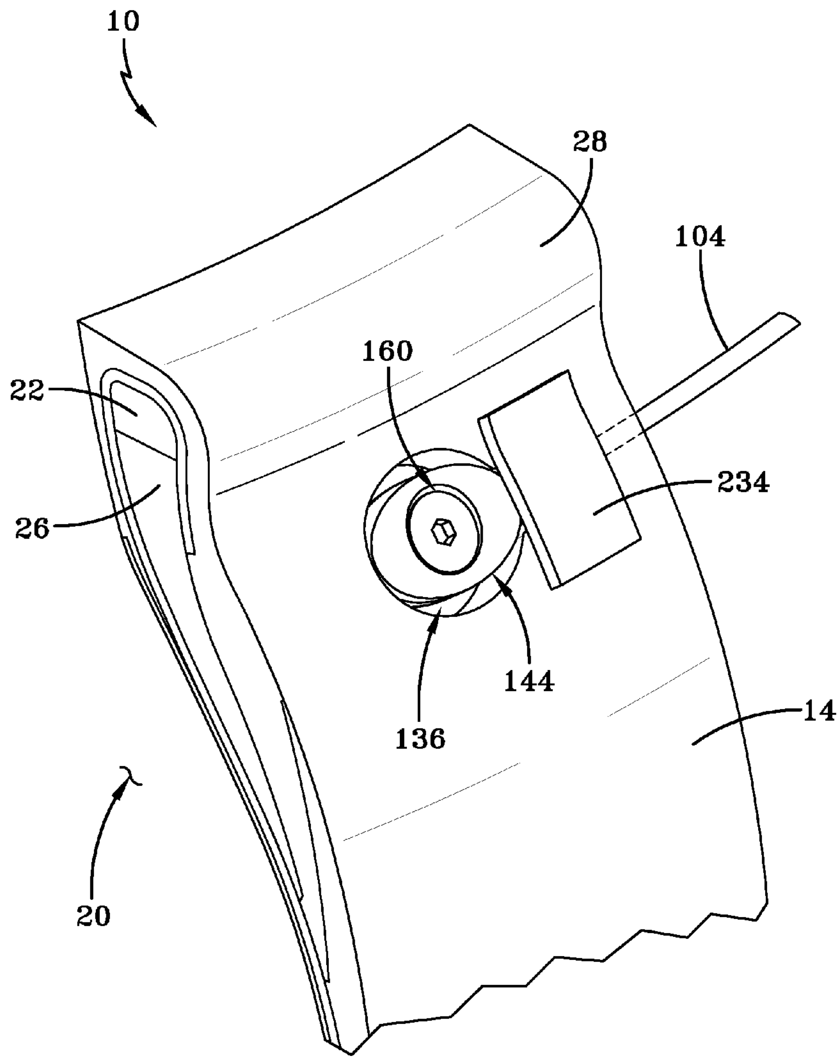



FIG-19G




FIG–19H




FIG–19I

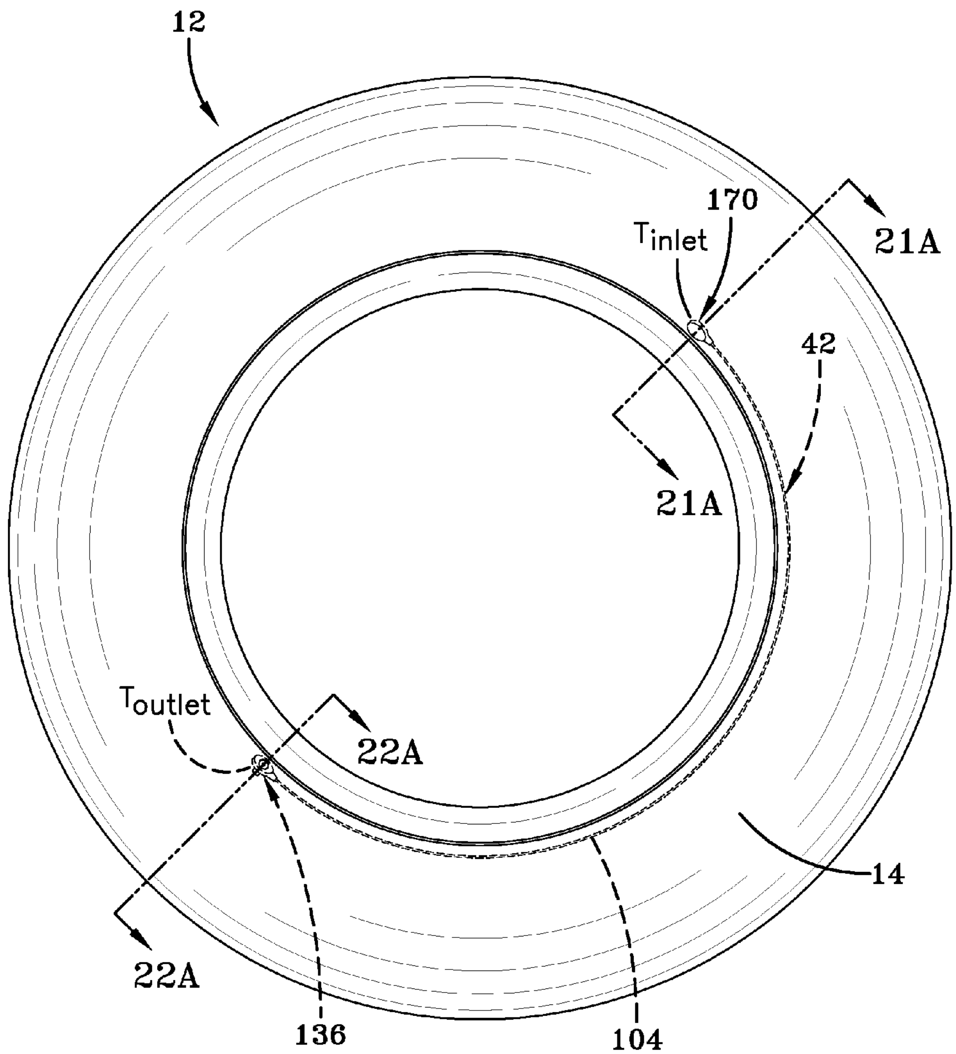



FIG-20

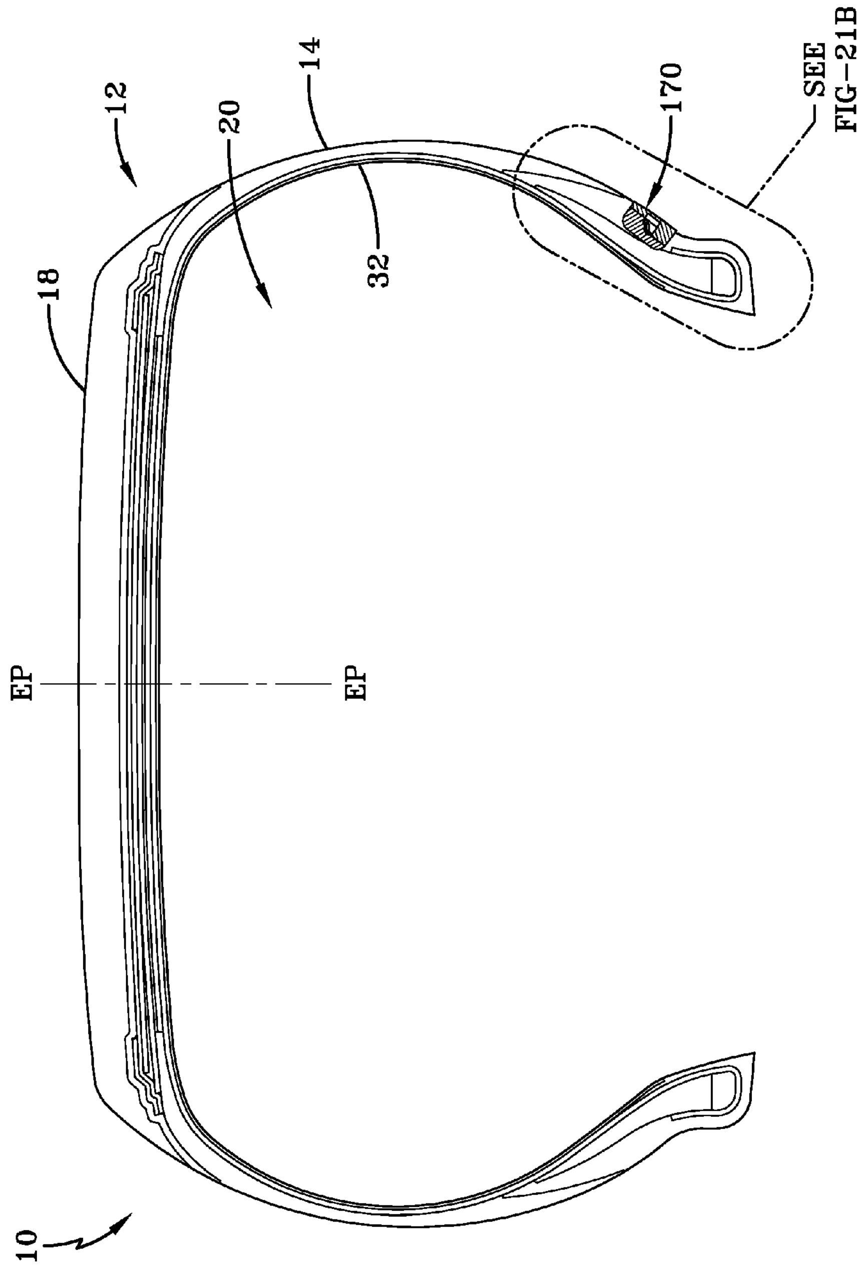
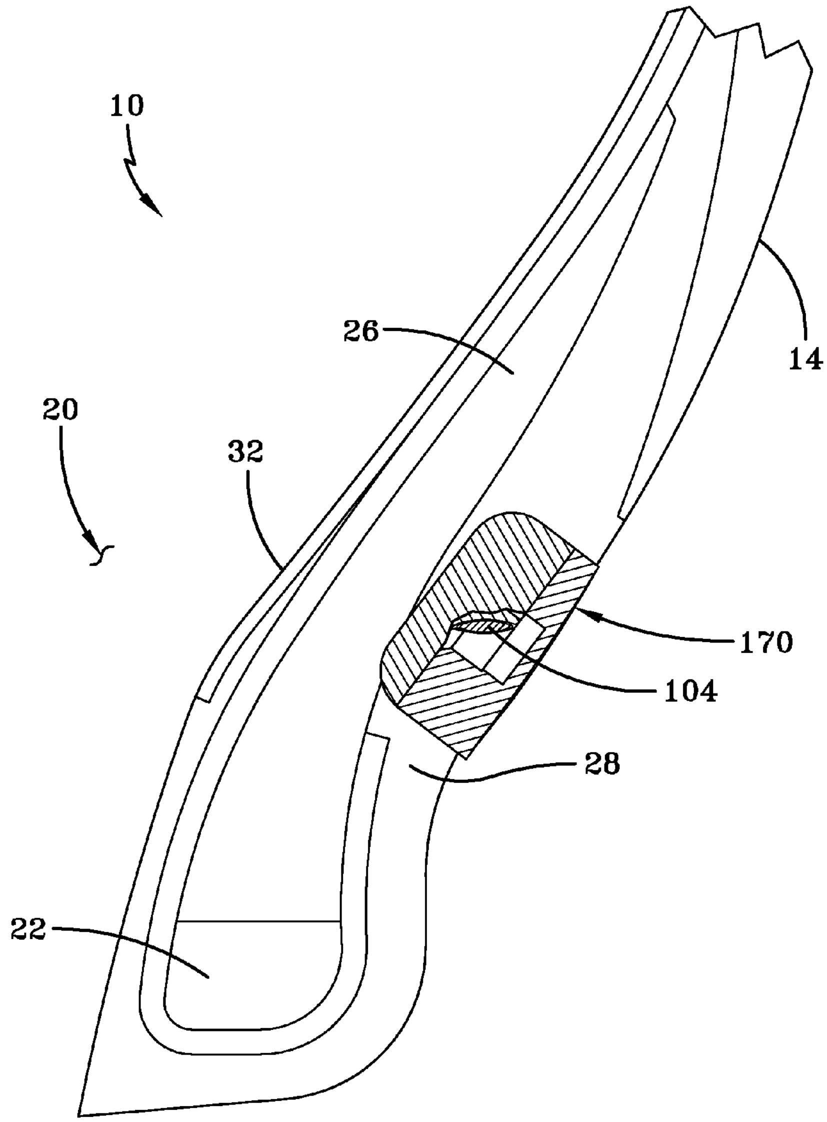



FIG-21A




FIG–21B

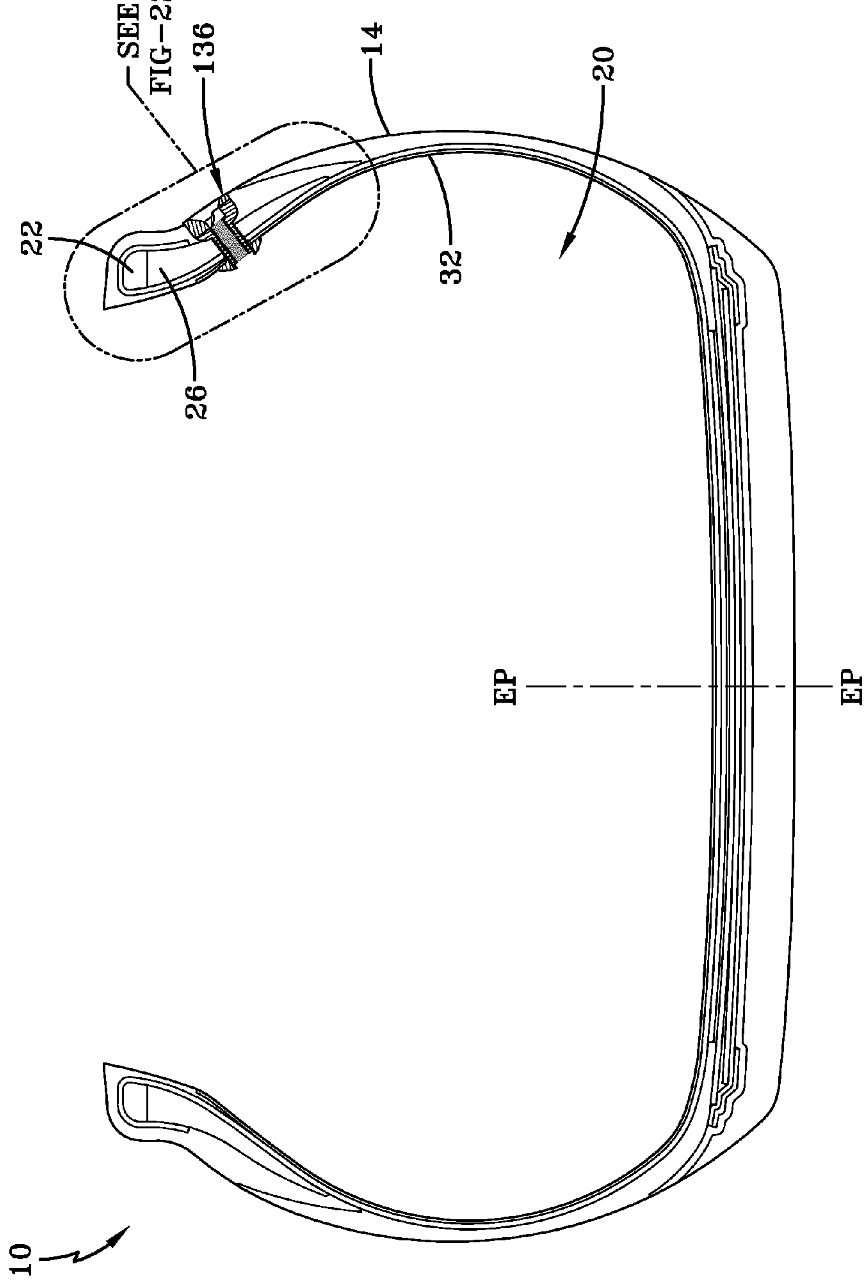



FIG-22A

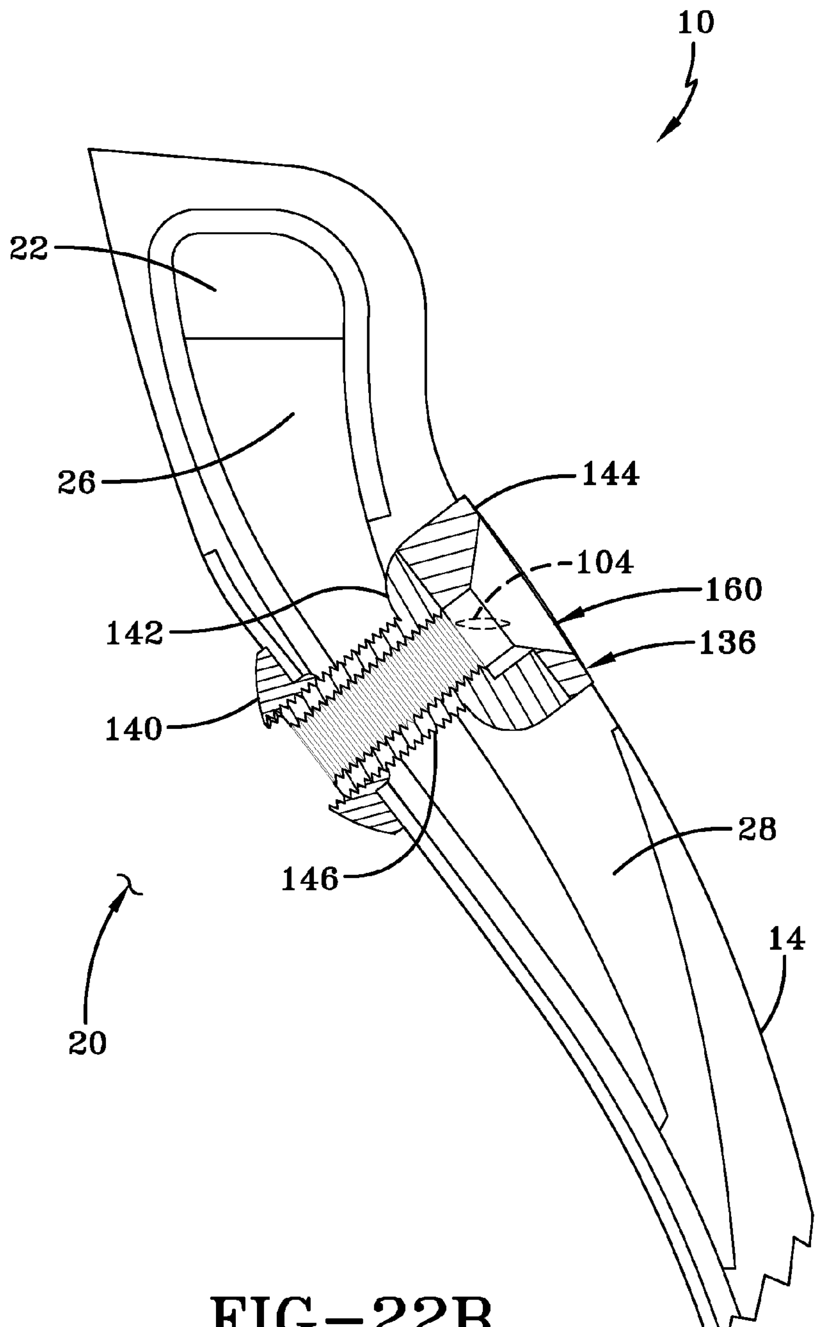



FIG-22B

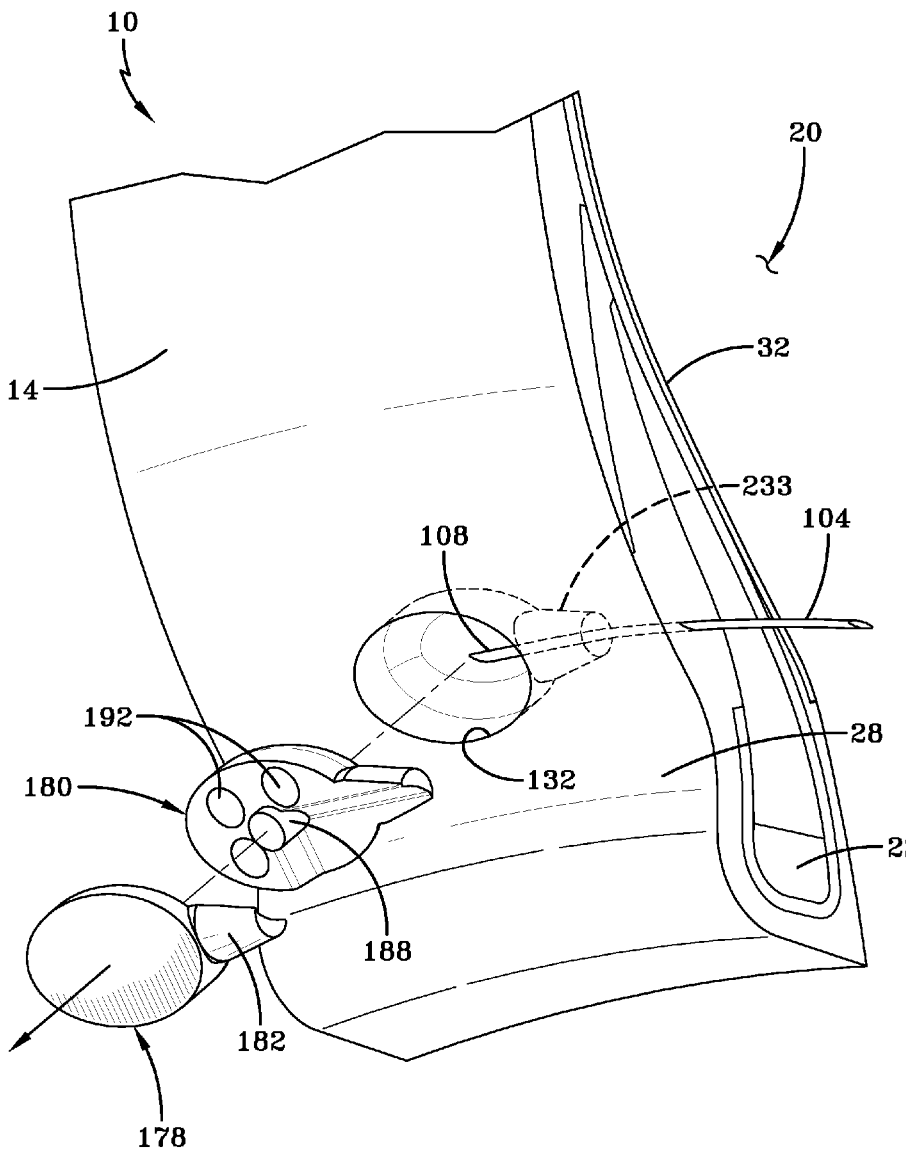



FIG-23

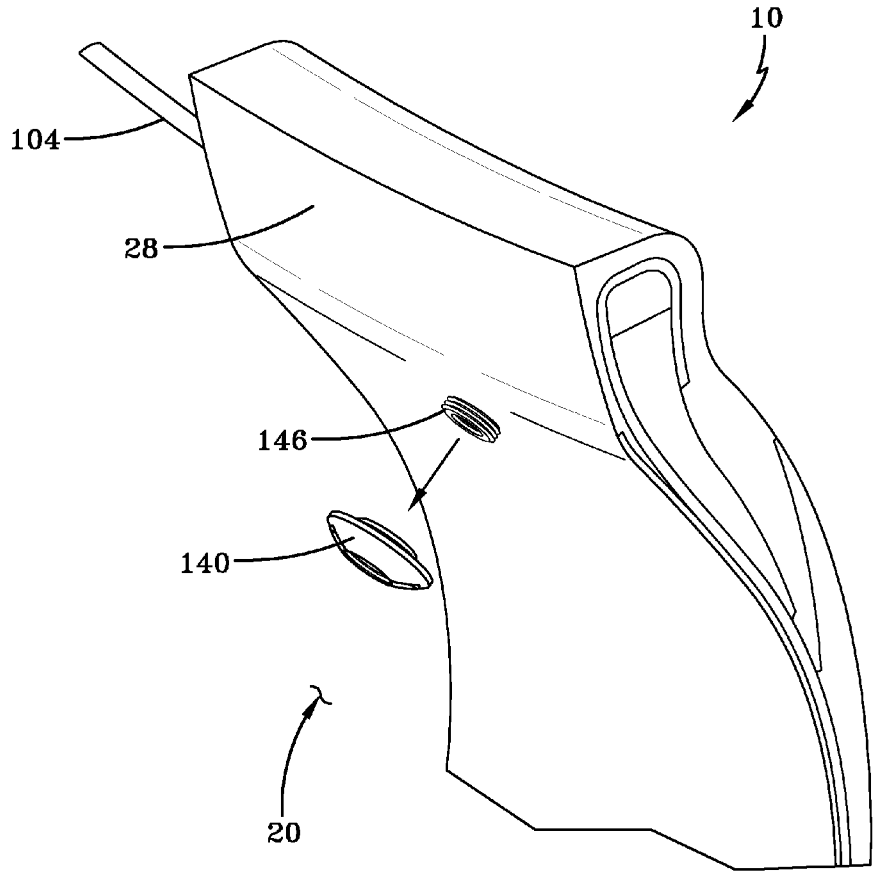
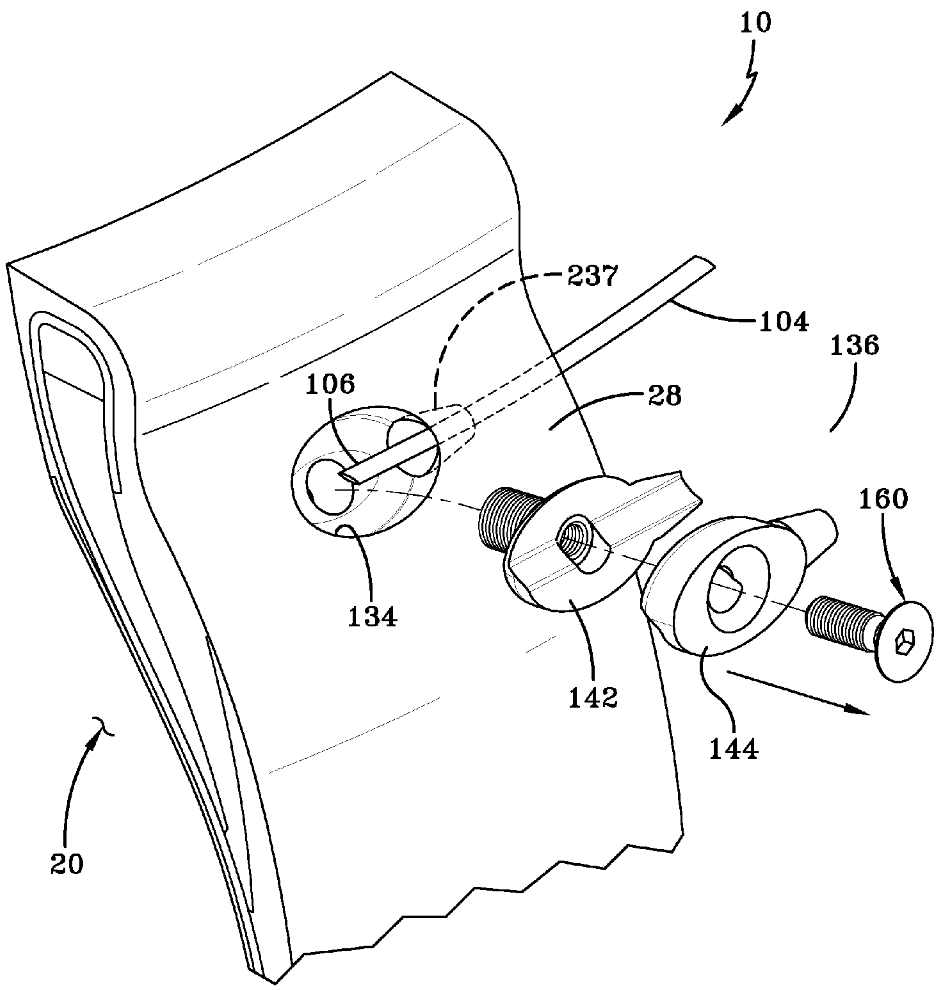
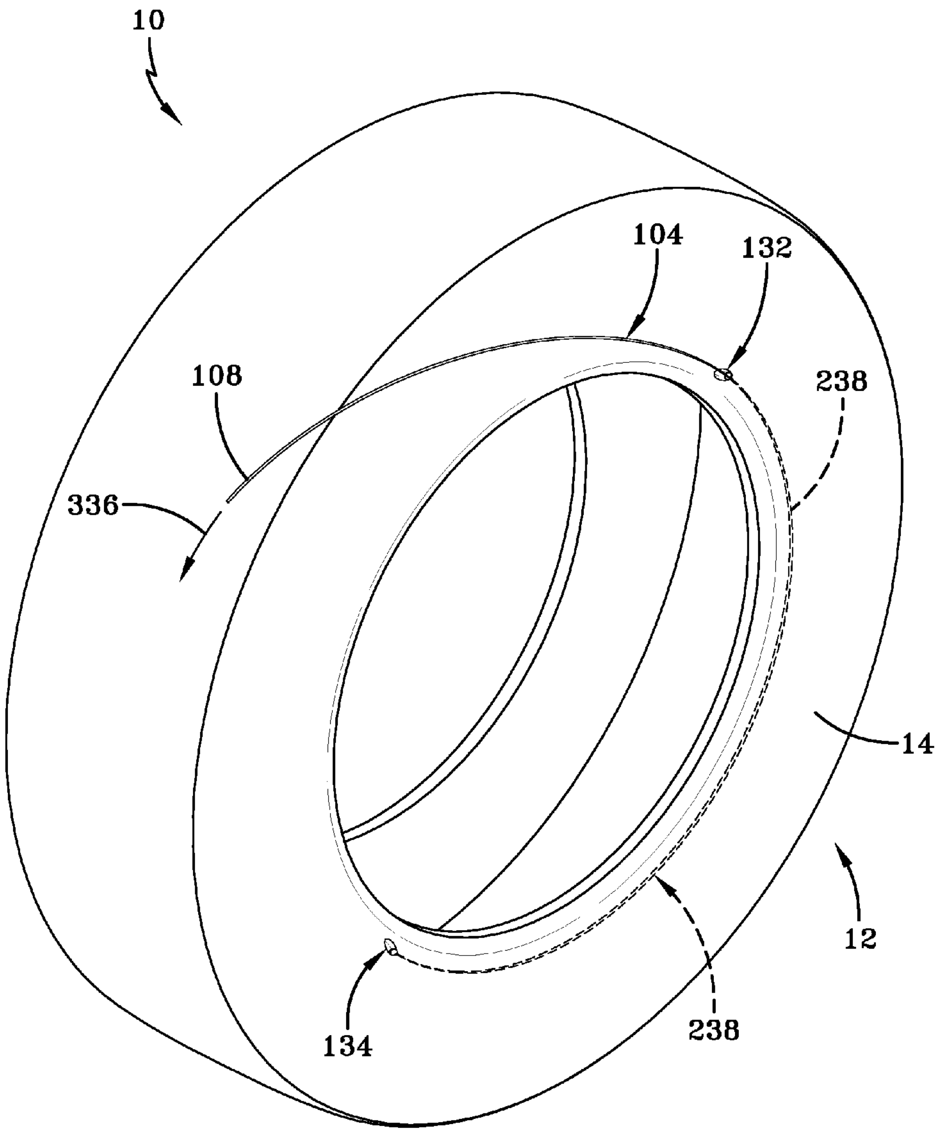



FIG-24




FIG–25




FIG–26

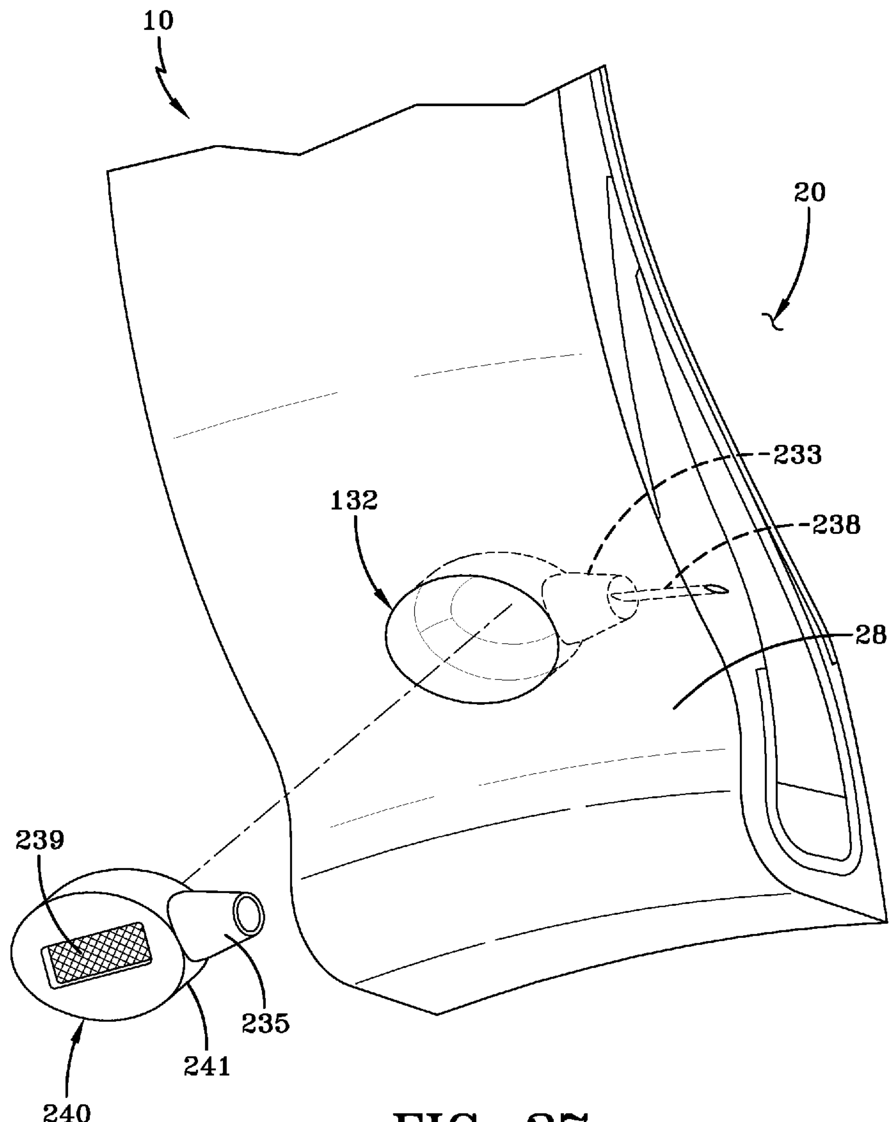



FIG-27

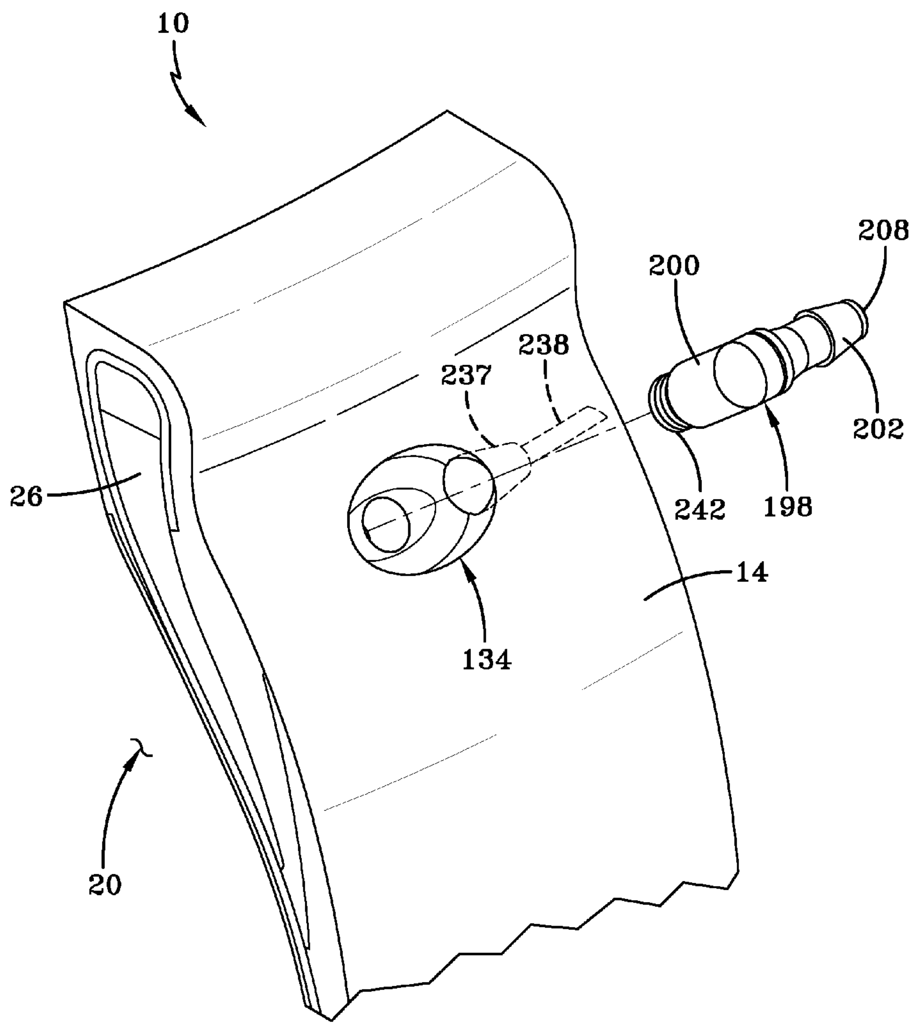



FIG-28A

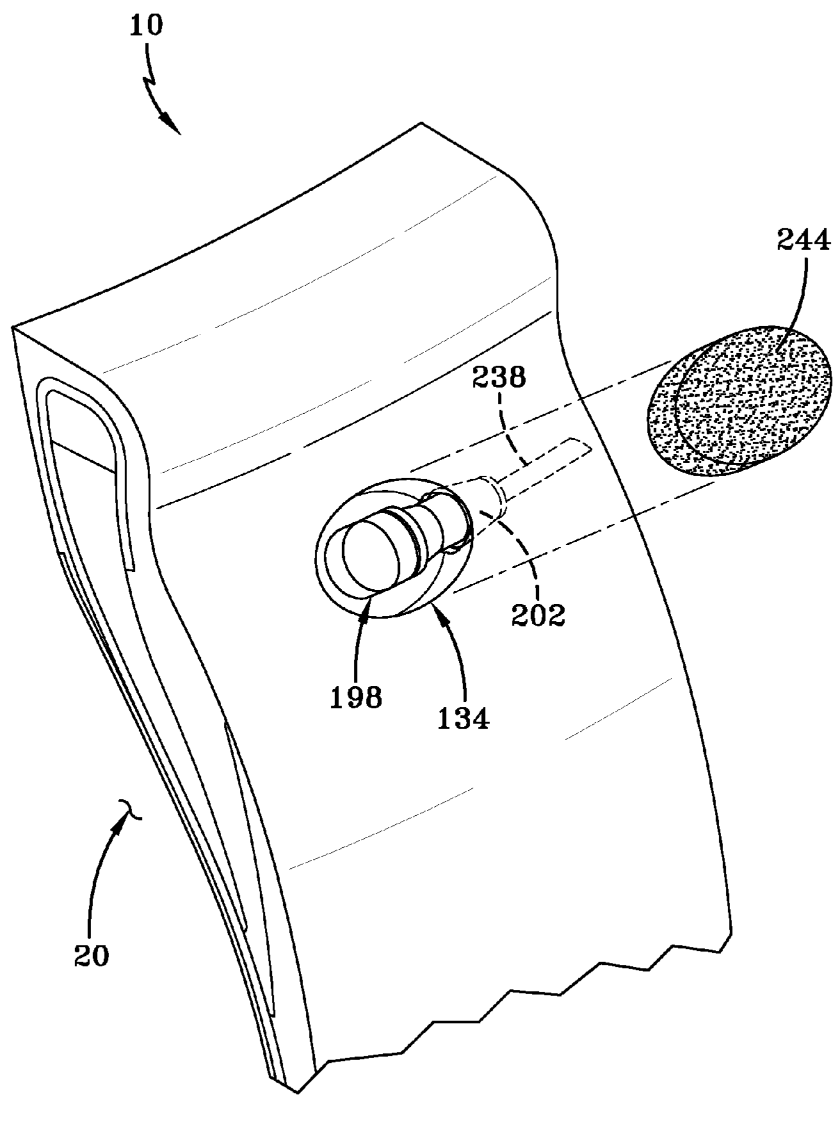



FIG-28B

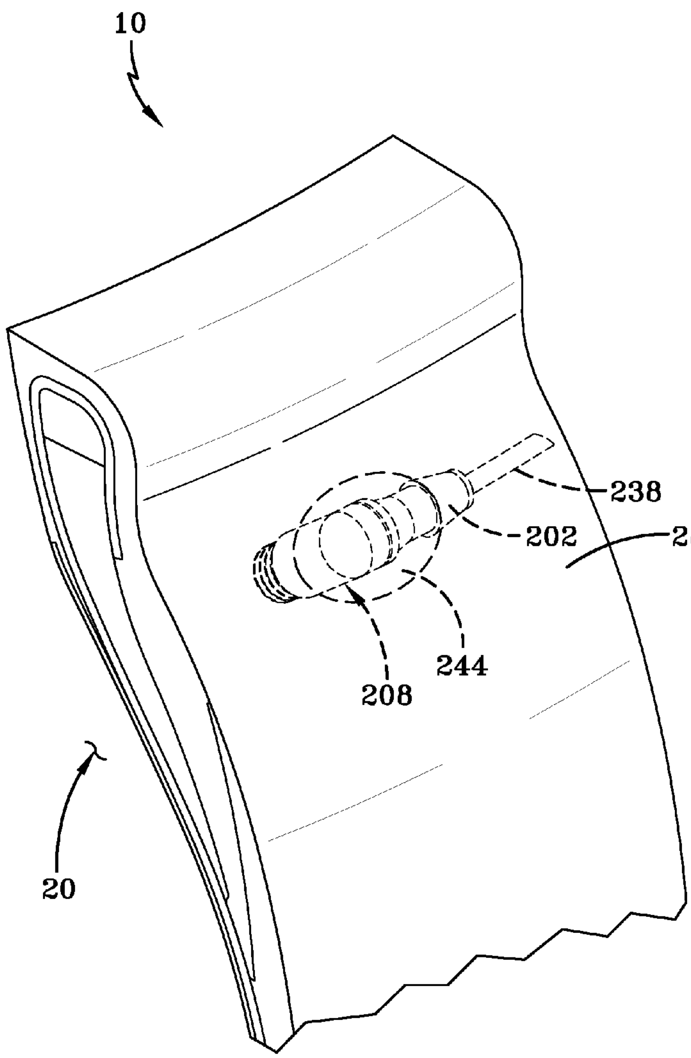
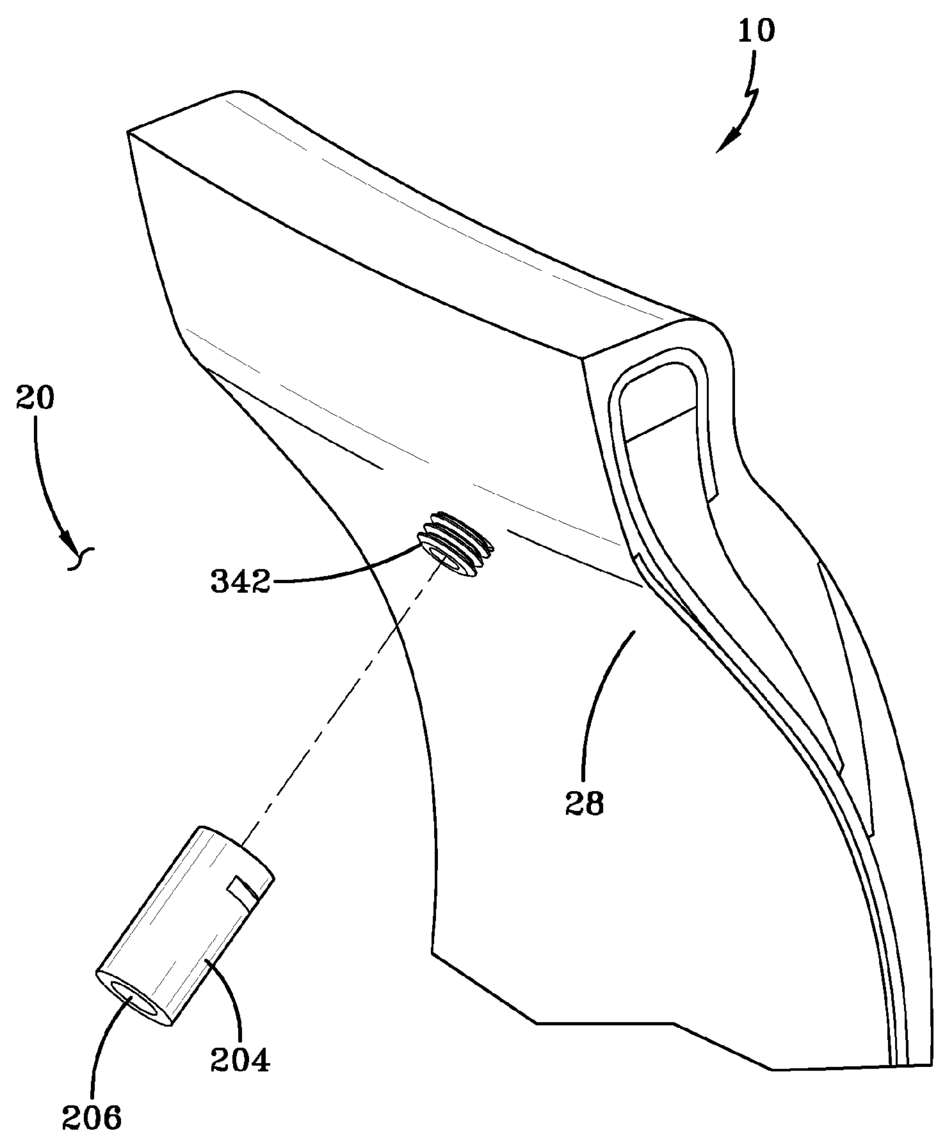



FIG-28C




FIG—29A

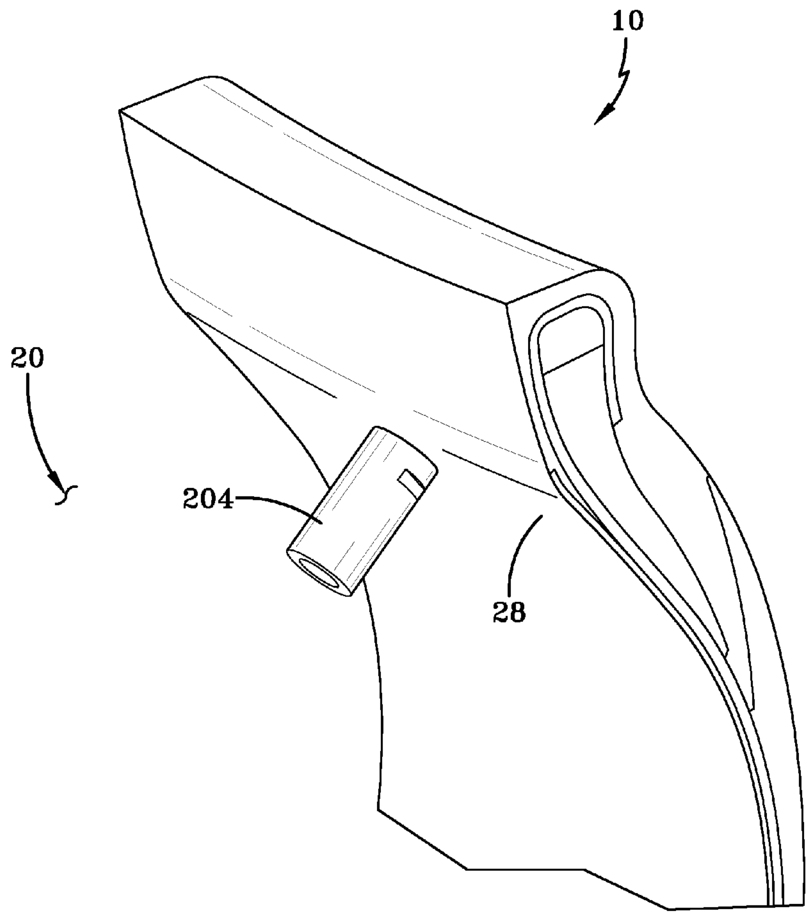



FIG-29B

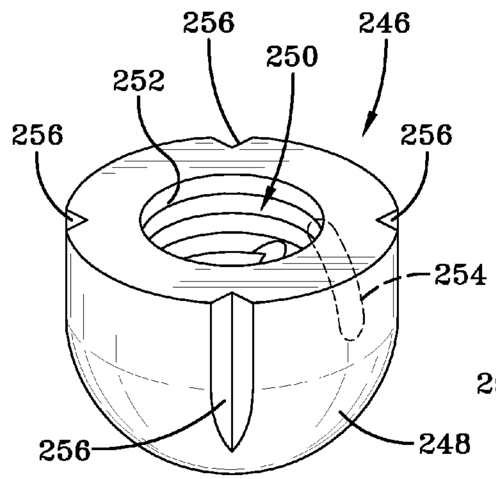



FIG-30A

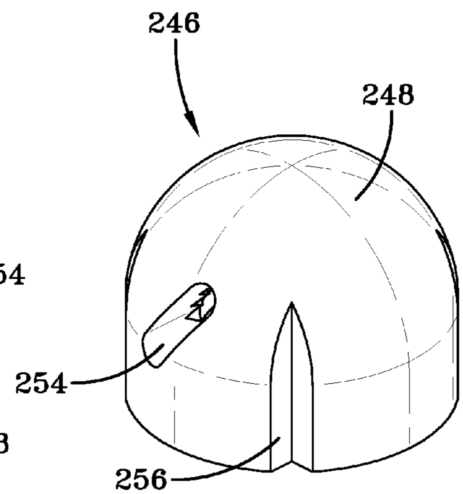



FIG-30B

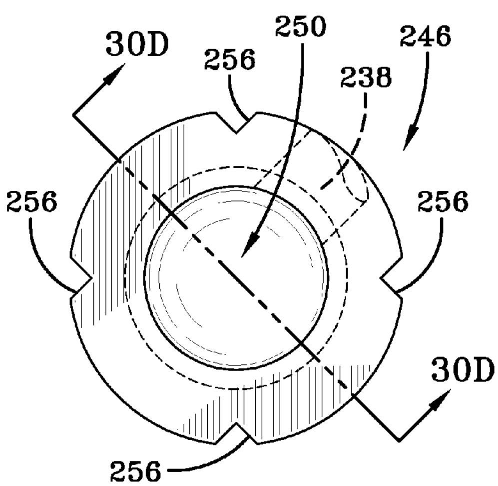



FIG-30C

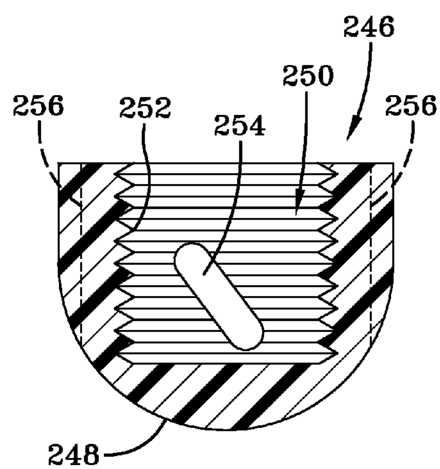



FIG-30D

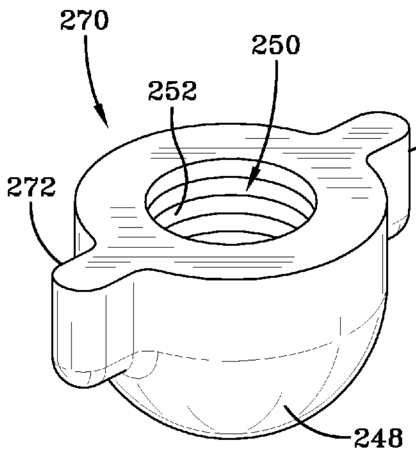



FIG-30E

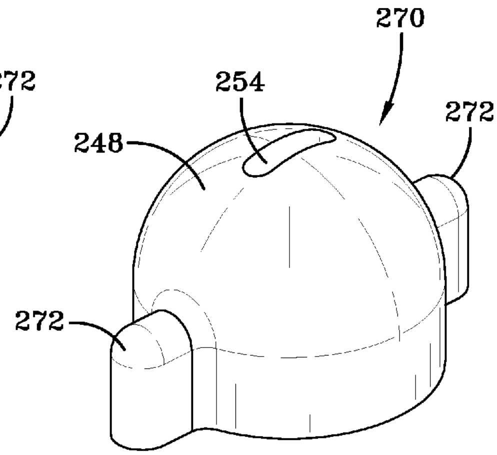



FIG-30F

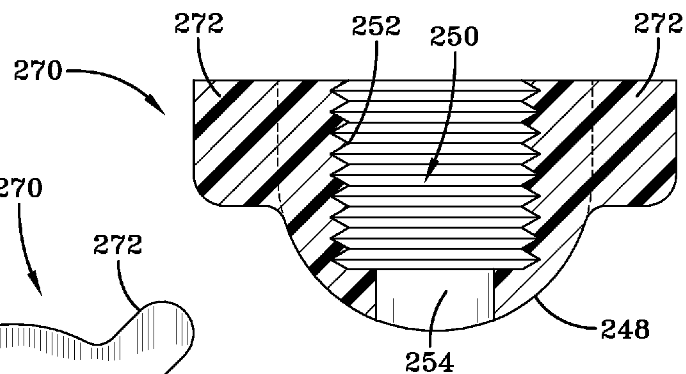



FIG-30H

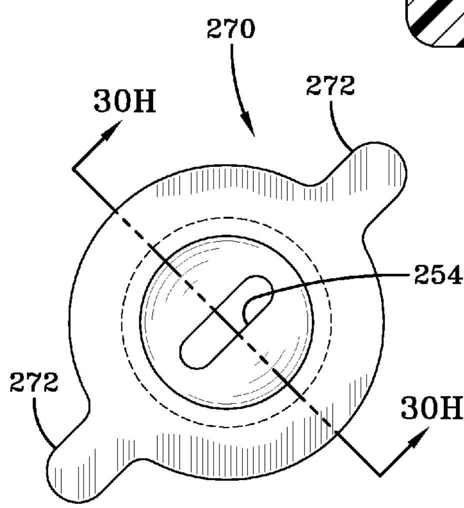
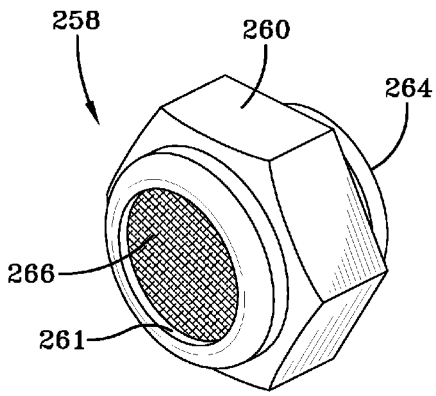
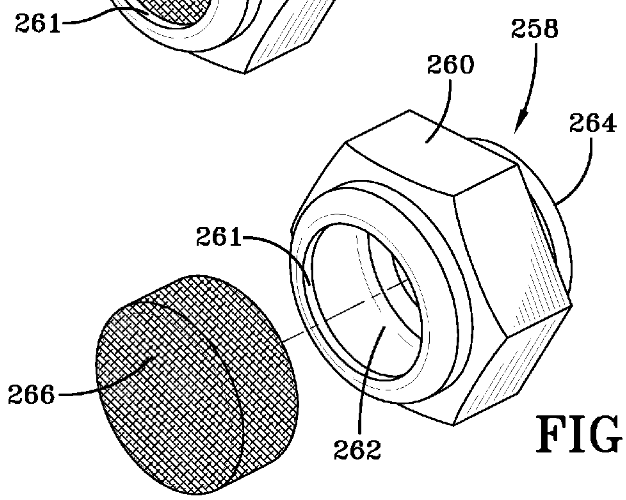


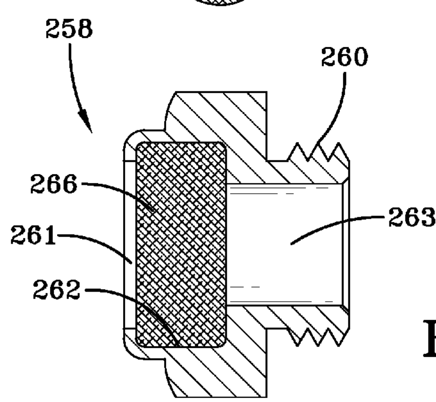

FIG-30G




FIG–31A




FIG–31B




FIG–31C

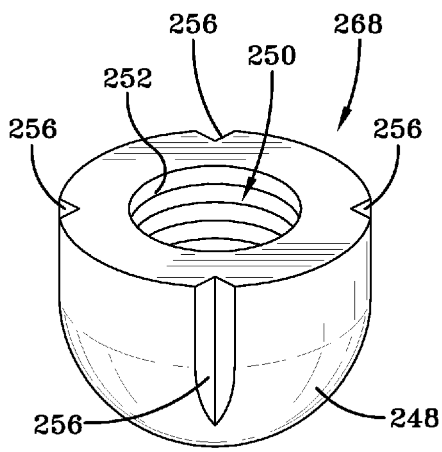



FIG-32A

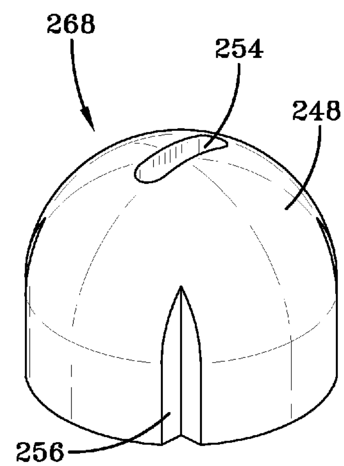



FIG-32B

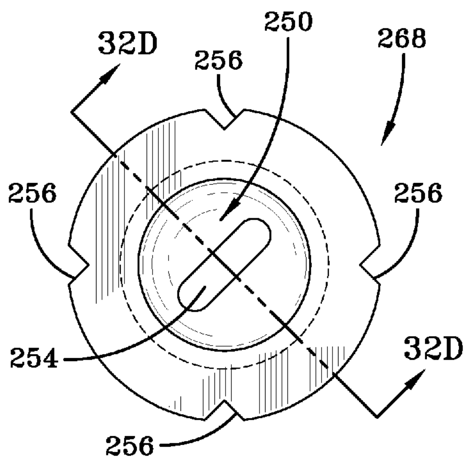



FIG-32C

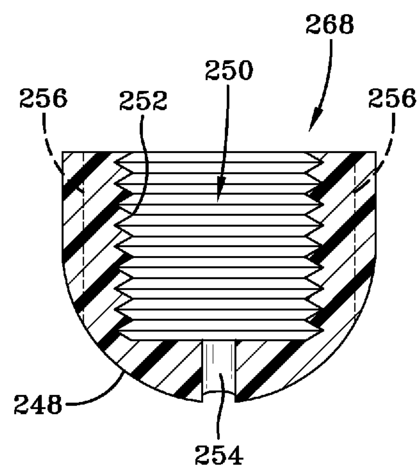
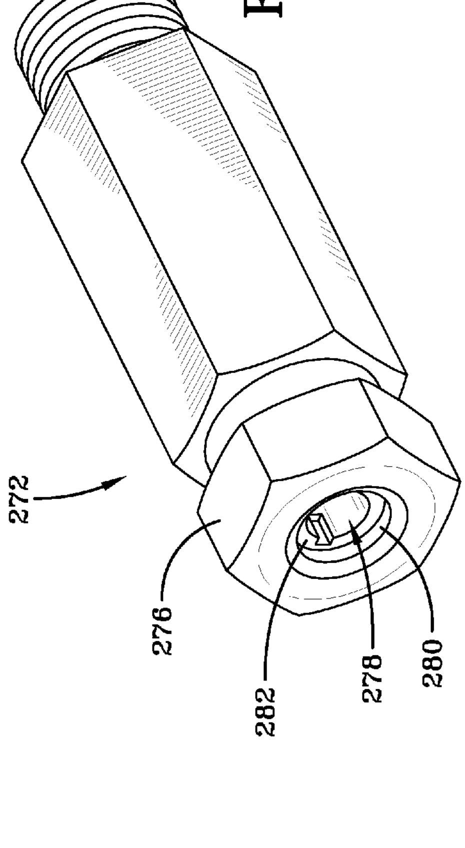
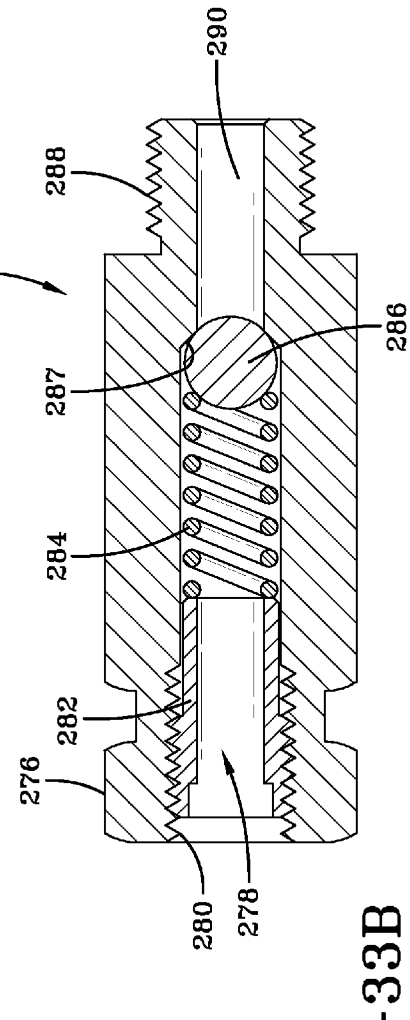


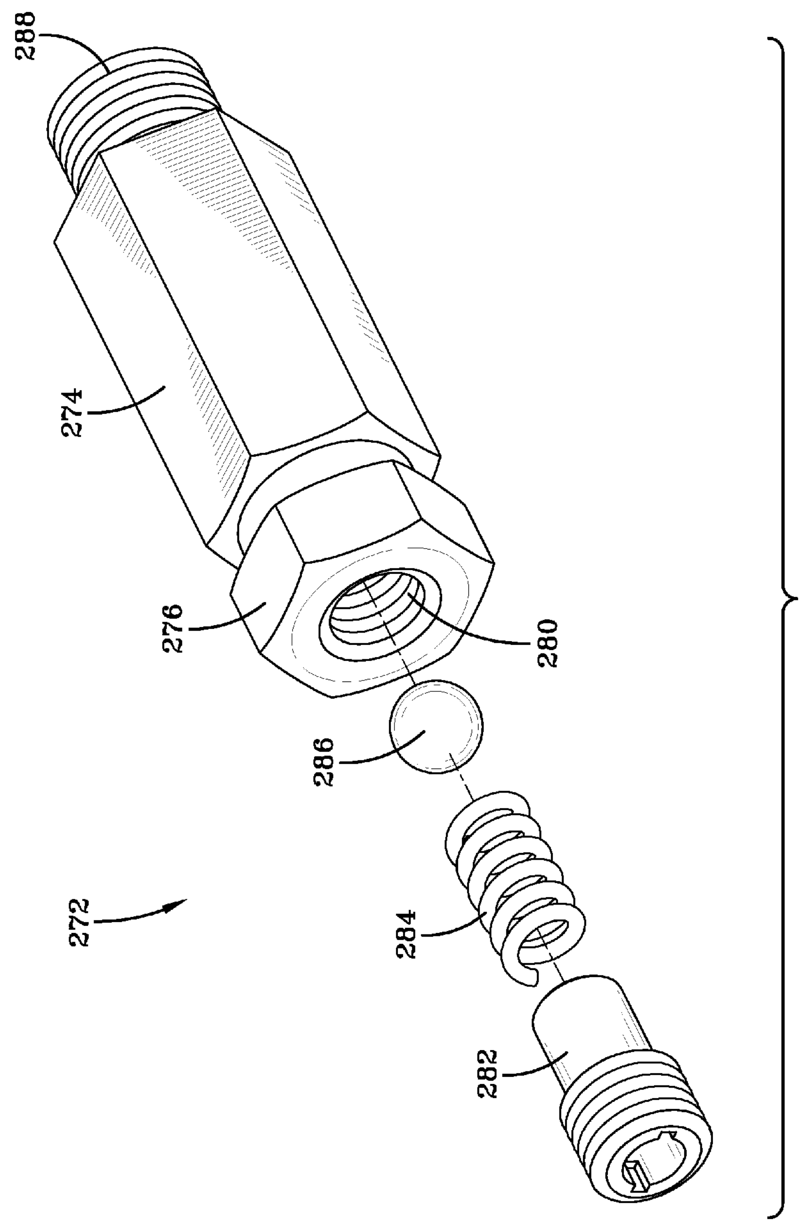

FIG-32D

FIG—33A

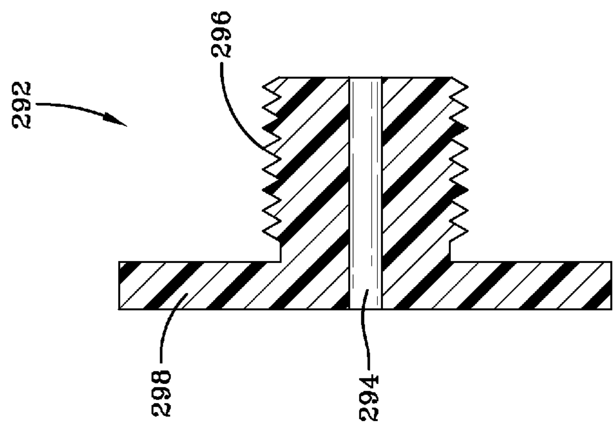


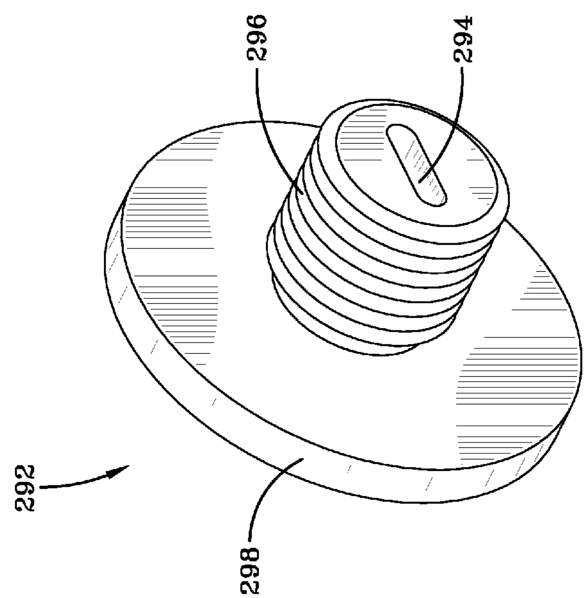

FIG—33B



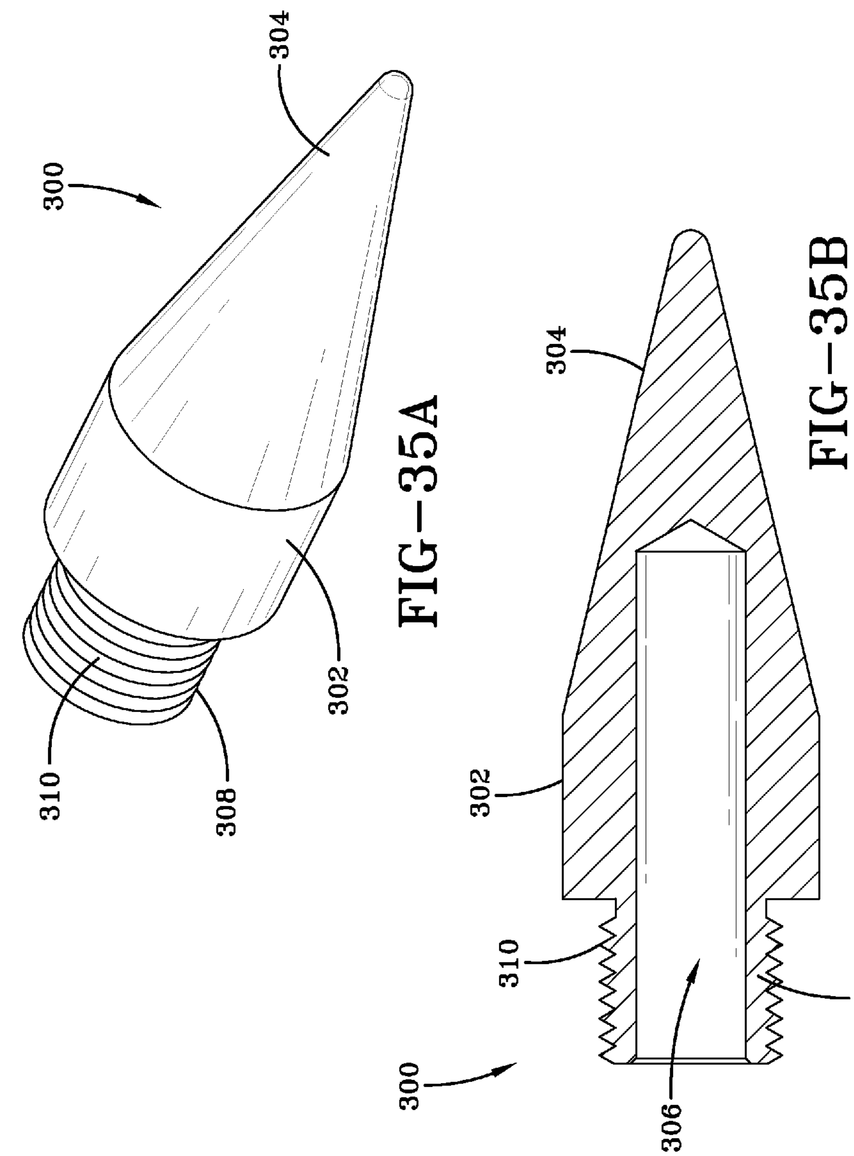

FIG—33C




FIG—34B




FIG—34A




FIG—35A

FIG—35B

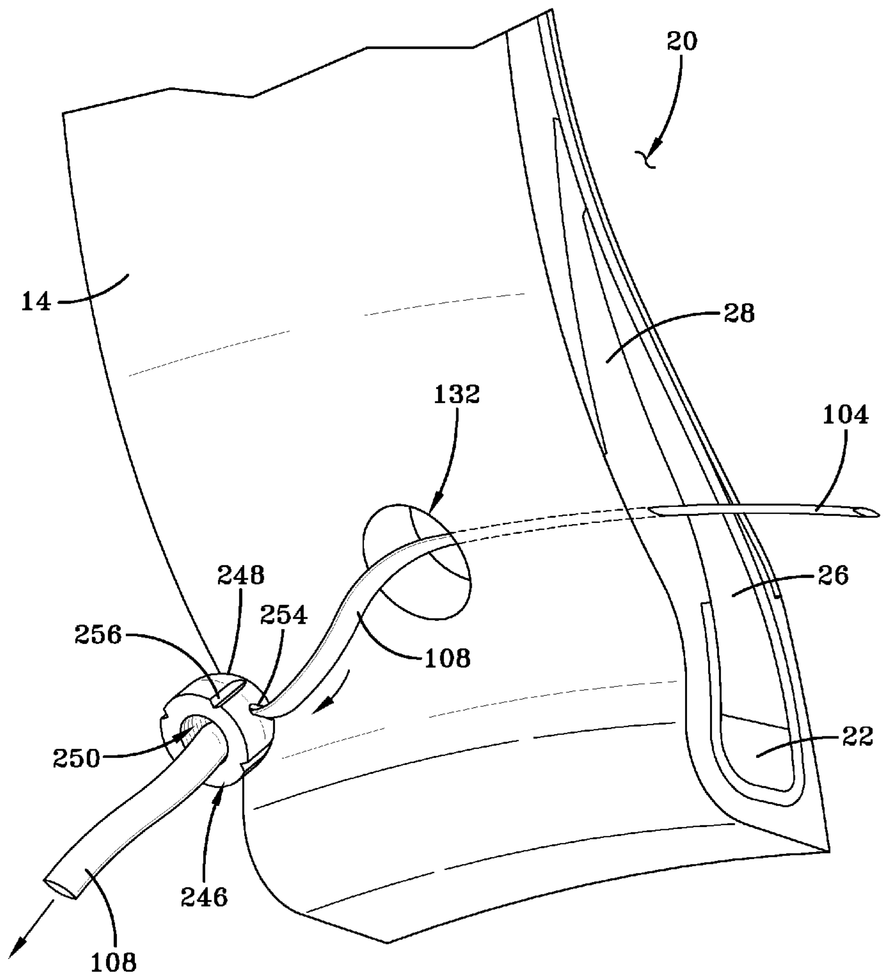



FIG-36A

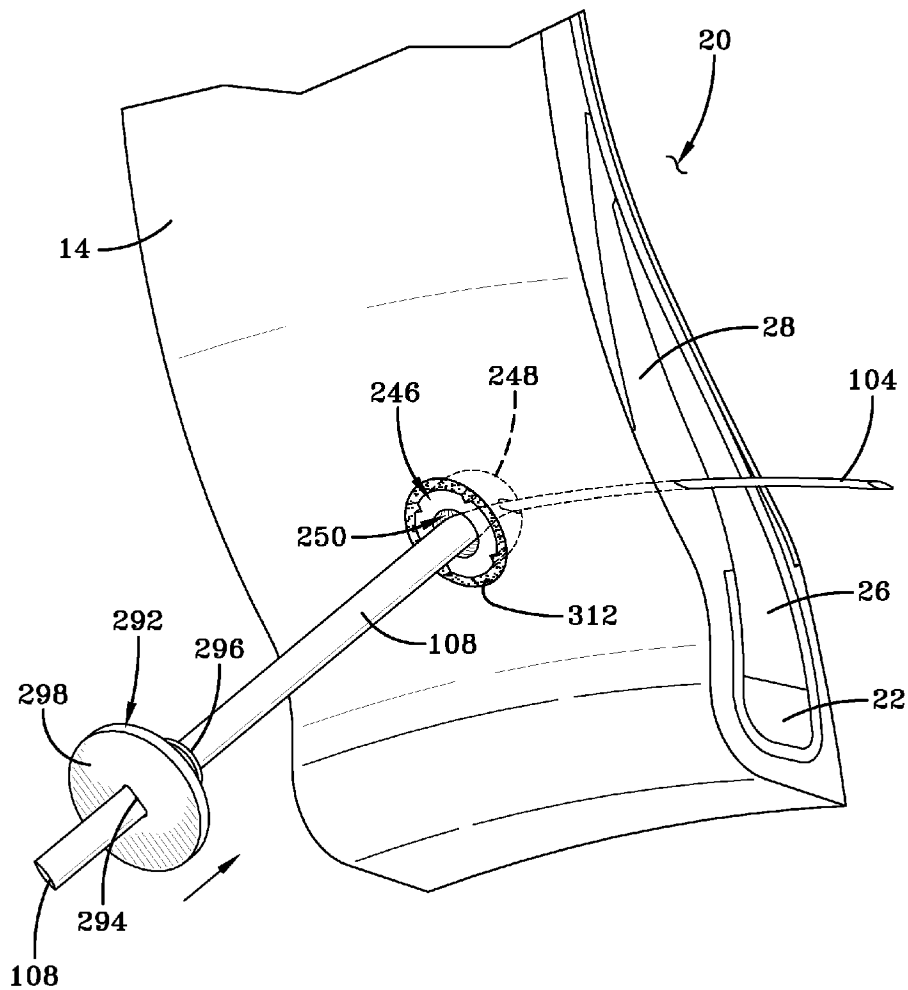
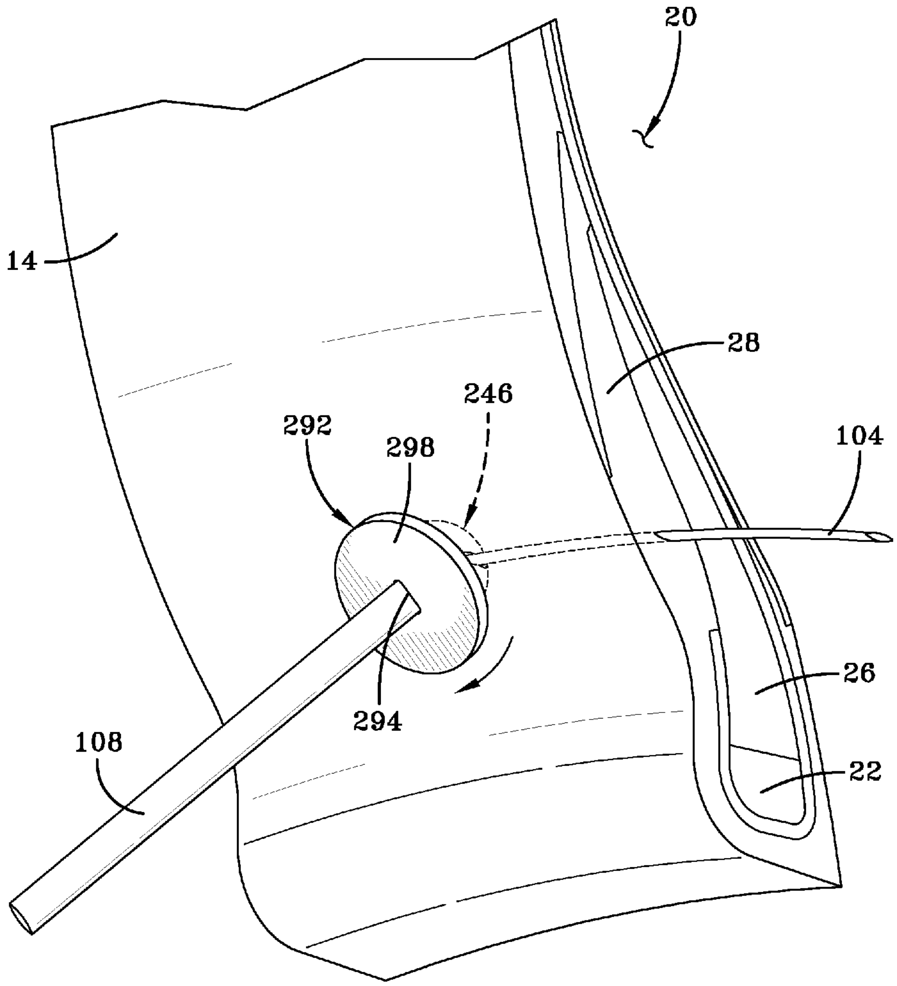
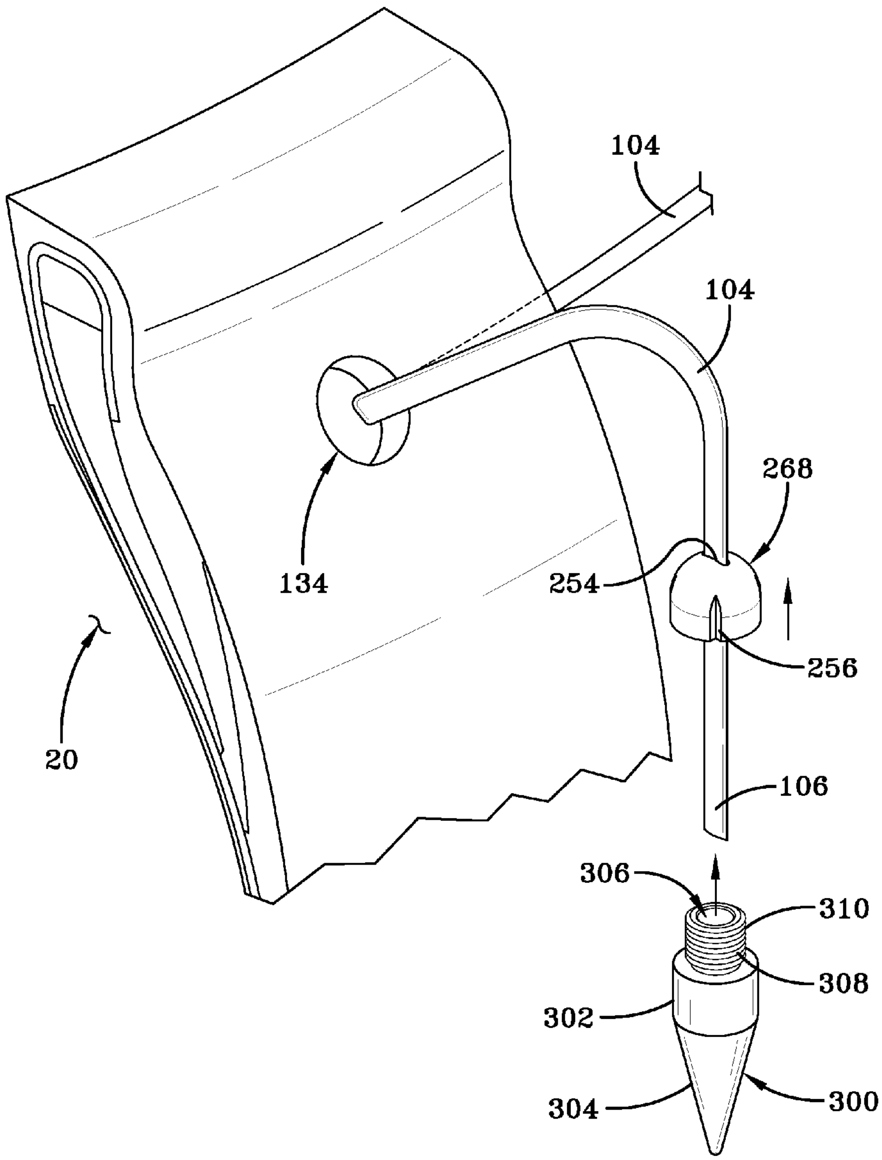



FIG-36B




FIG–36C




FIG–37A

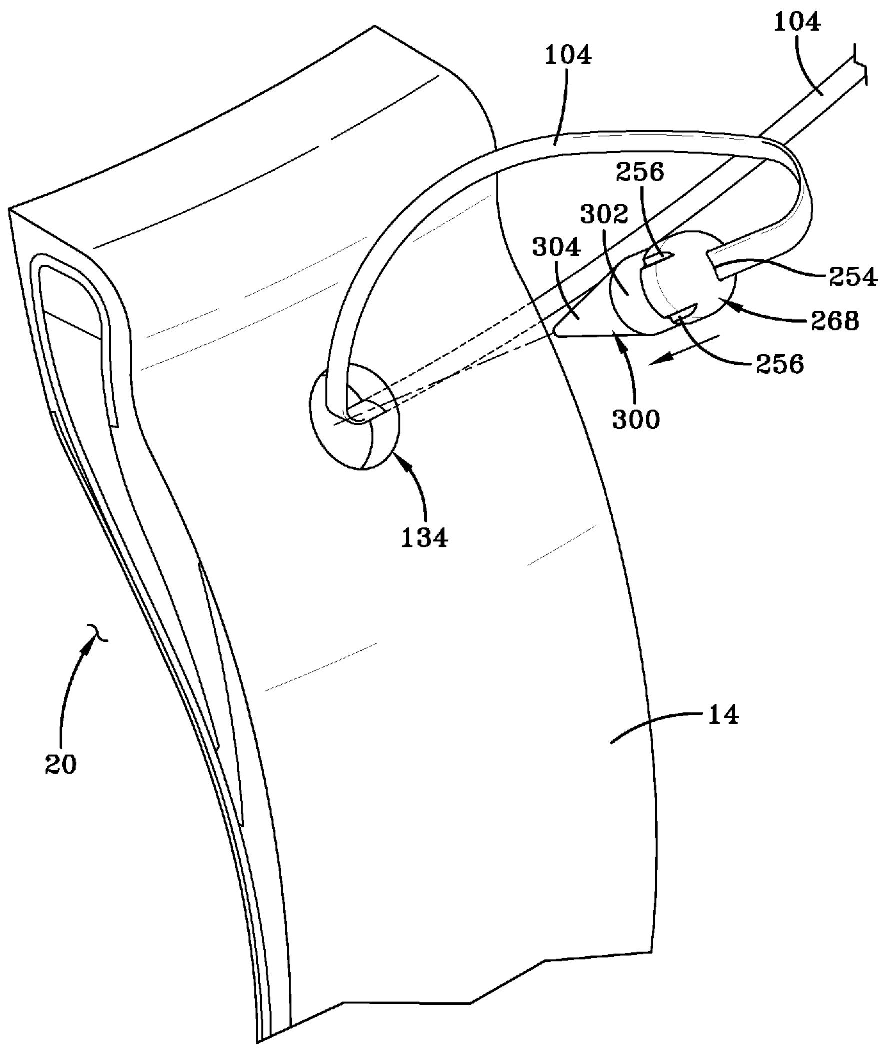



FIG-37B

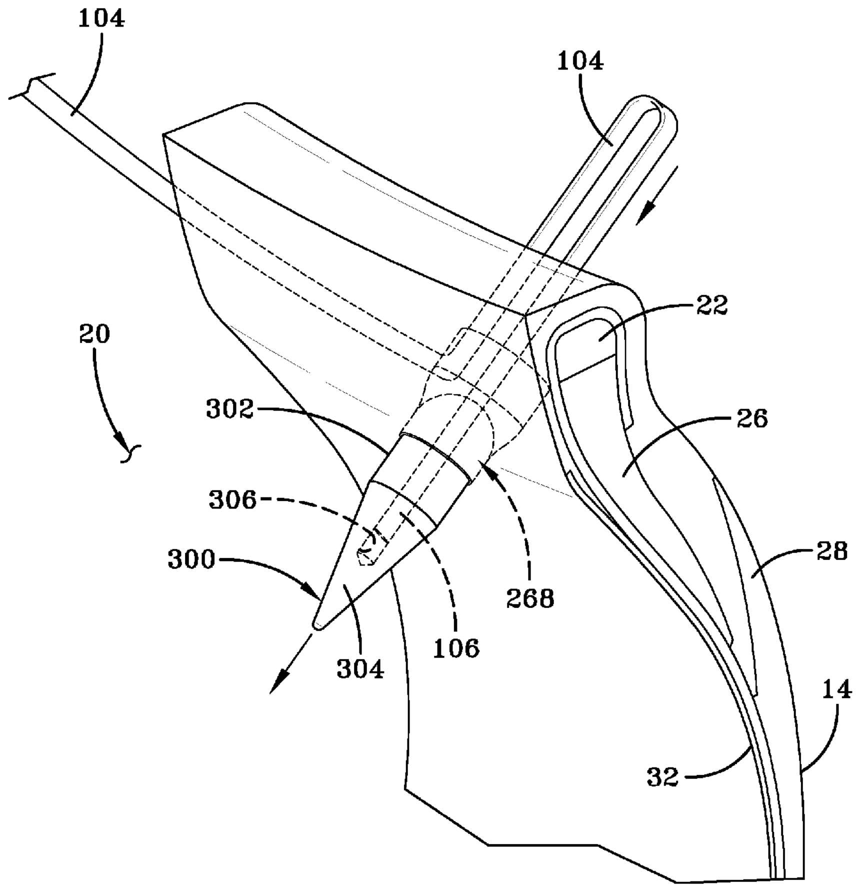



FIG-37C

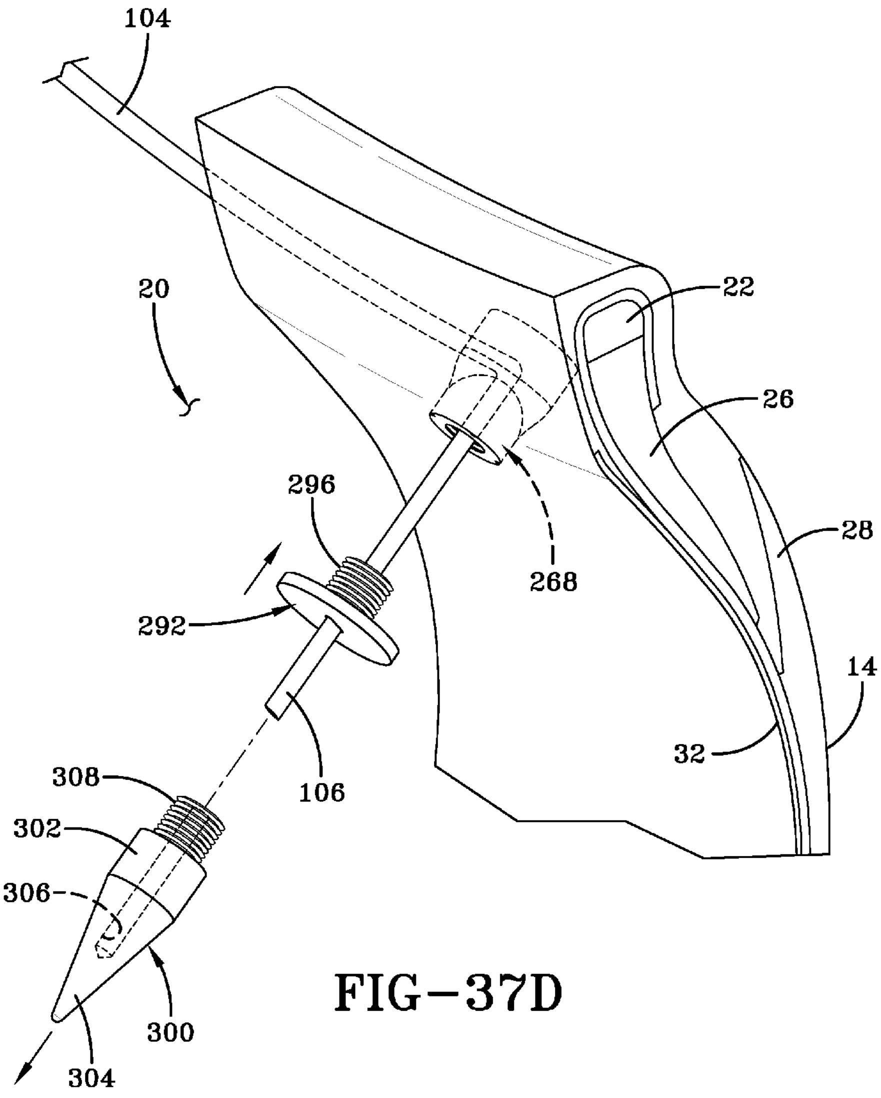



FIG-37D

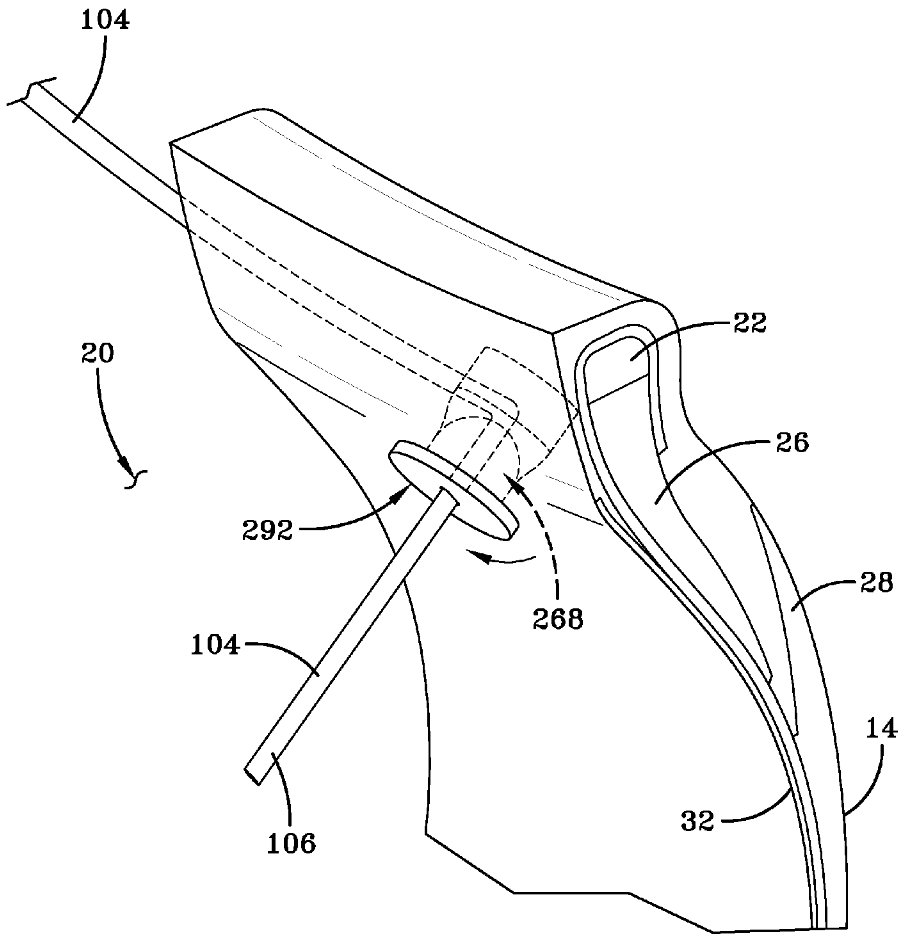



FIG-37E

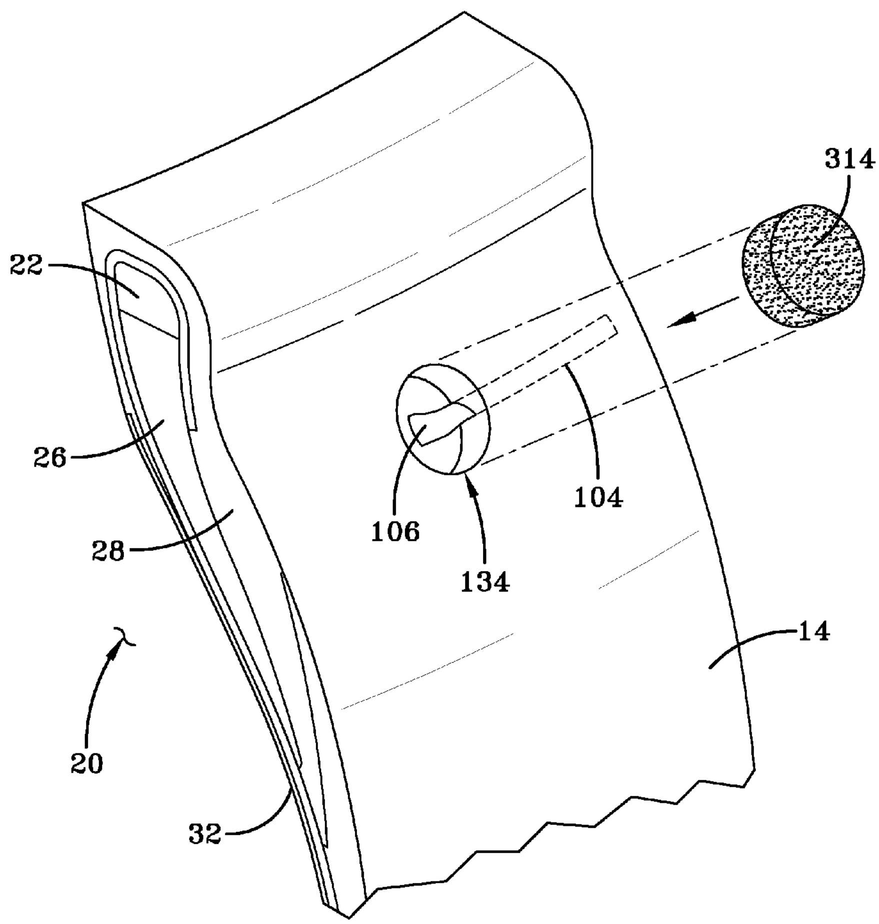



FIG-37F

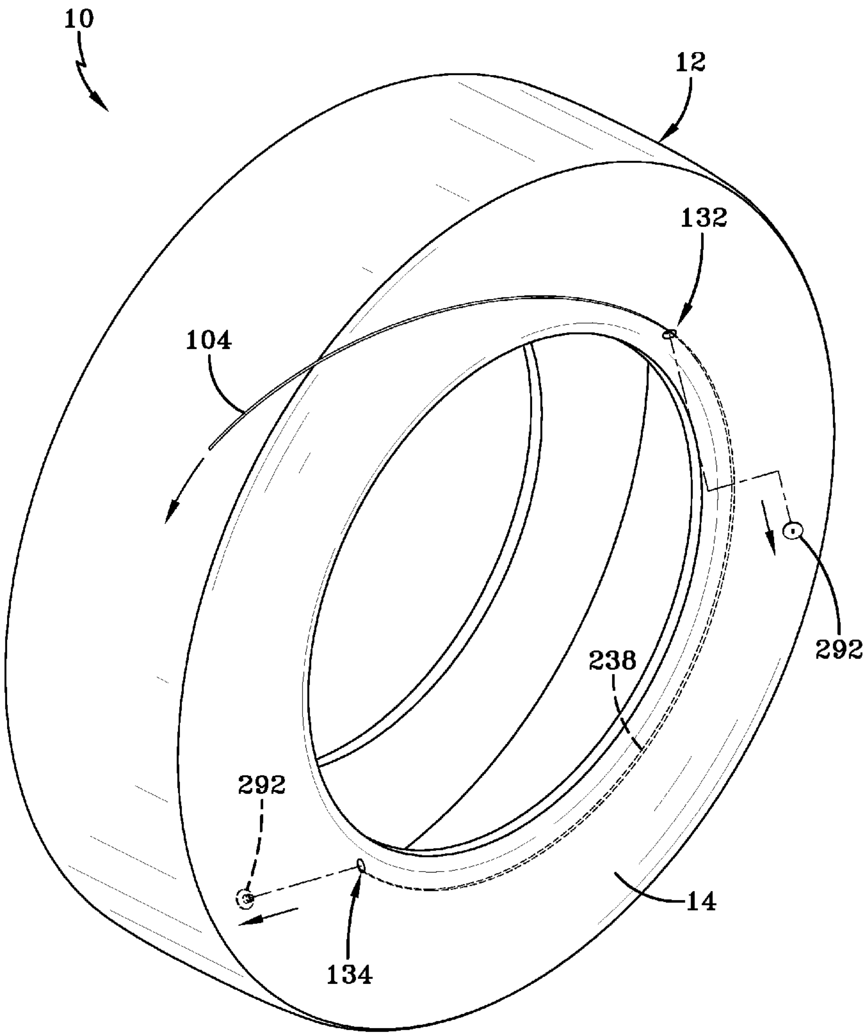



FIG-38

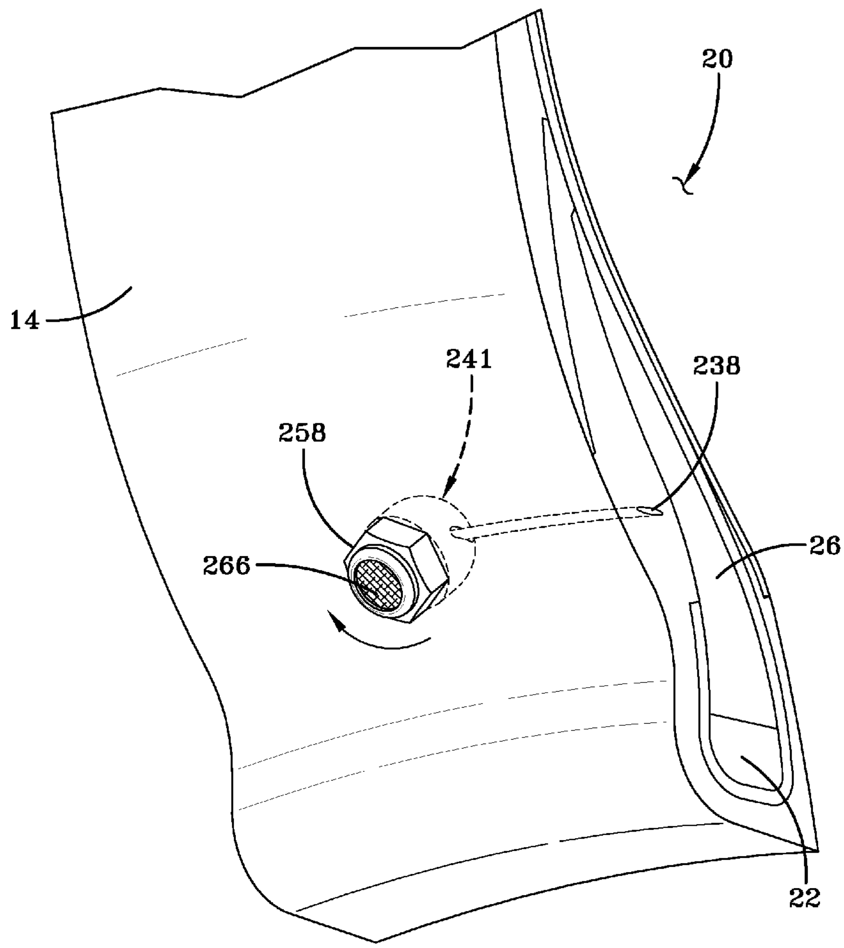



FIG-39

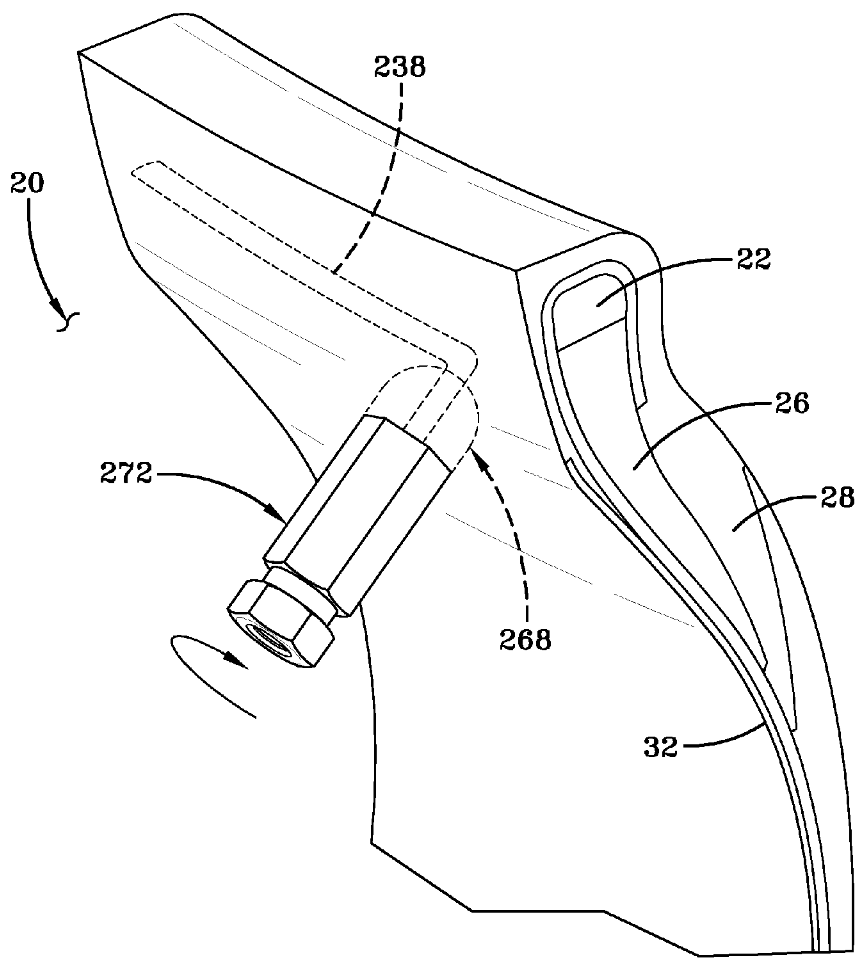



FIG-40

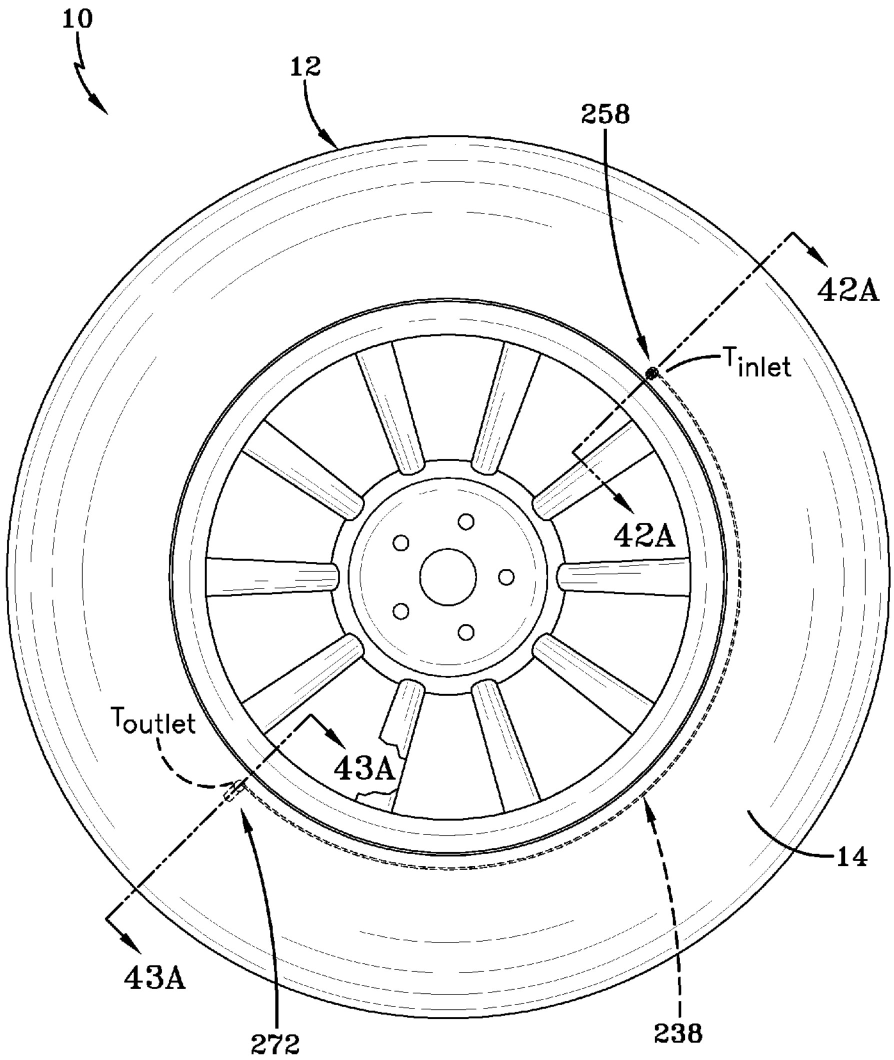



FIG-41

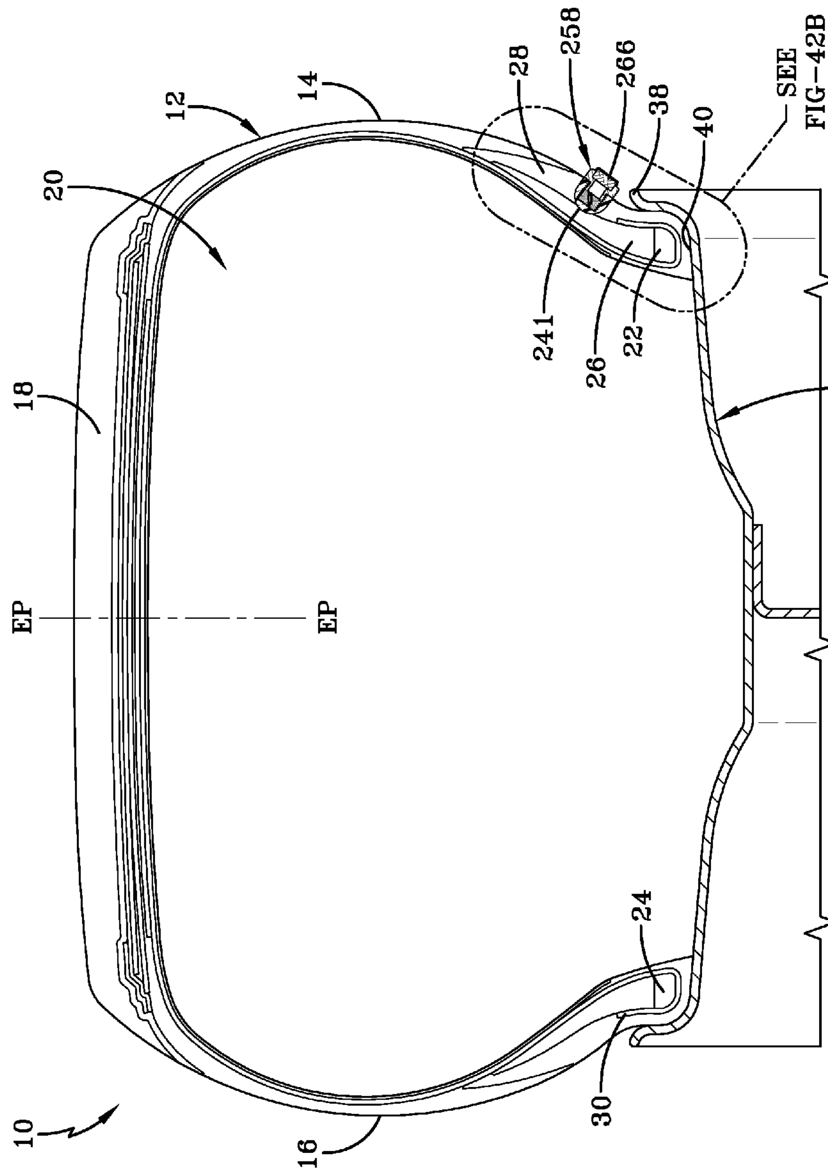
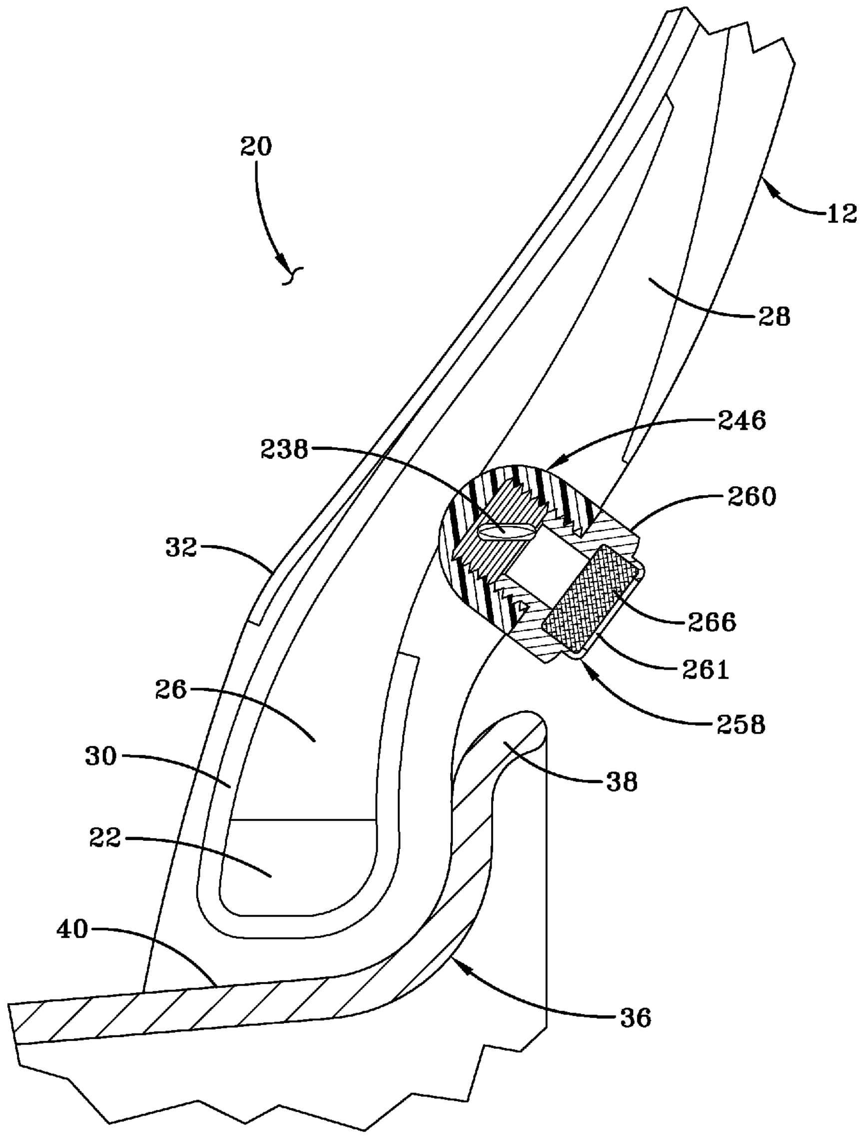

10
12
14
16
18
20
EP
EP
22
24
26
28
30
36
38
40
241
258
266
SEE
FIG-42B

FIG-42A




FIG–42B

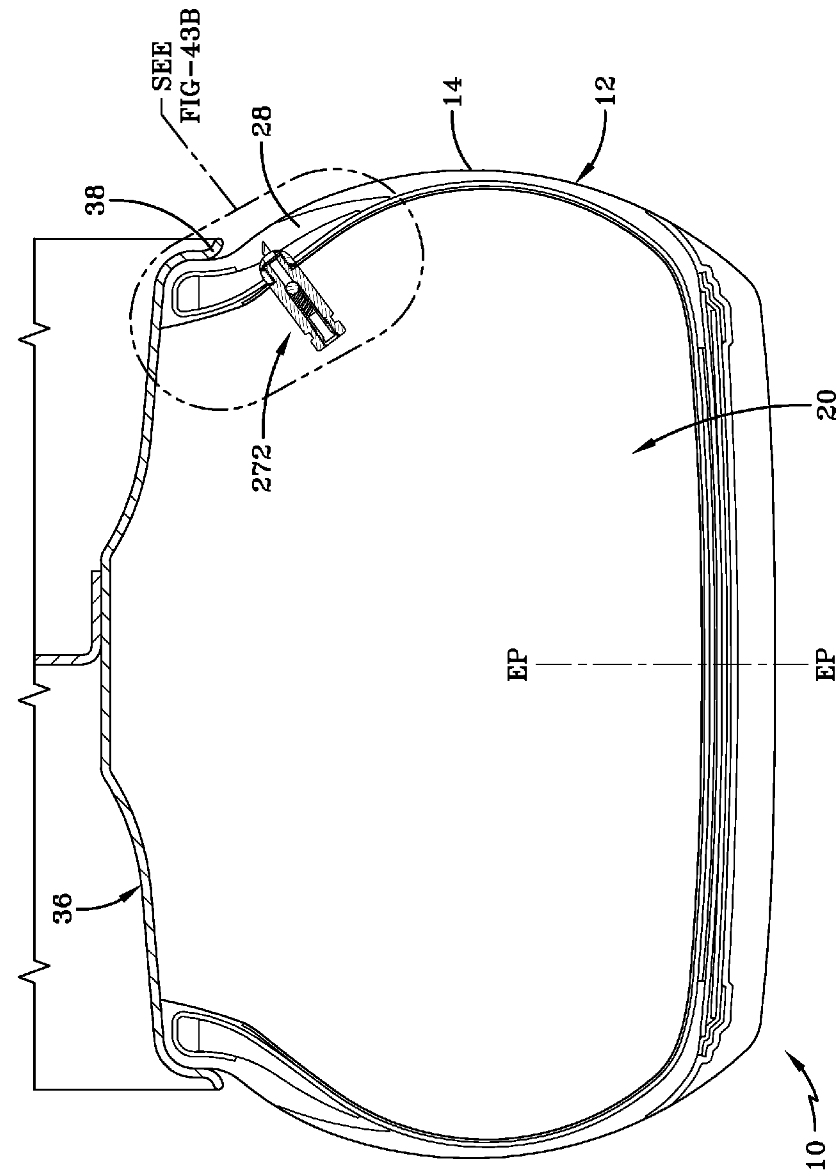



FIG-43A

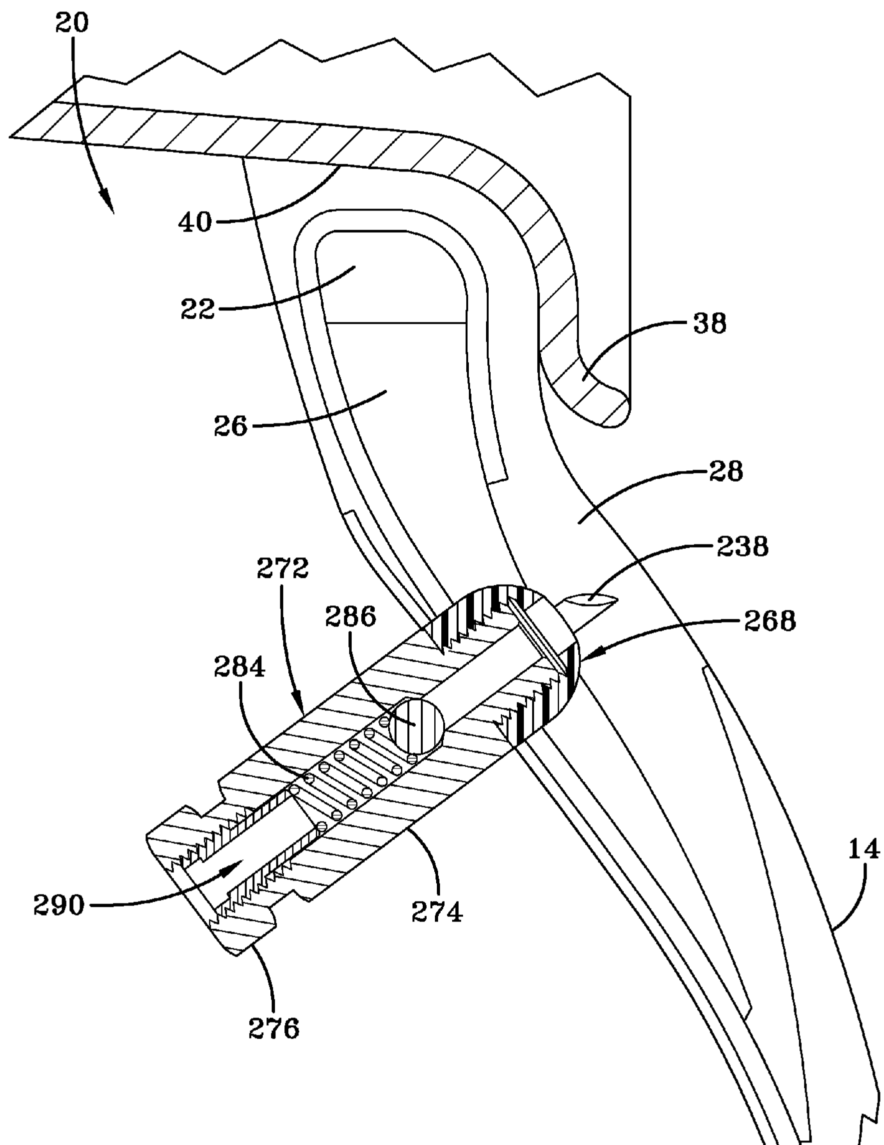



FIG-43B

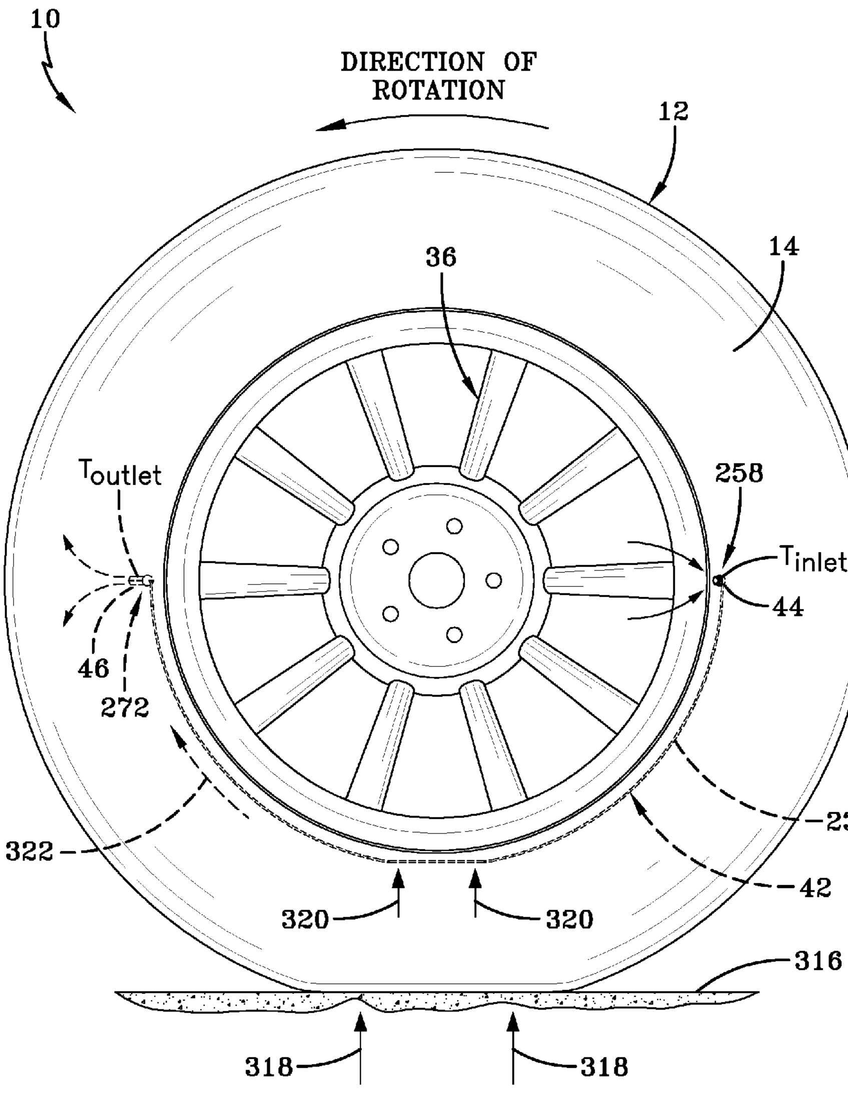

10
DIRECTION OF ROTATION
12
14
36
$T_{outlet}$
258
$T_{inlet}$
44
46
272
238
322
42
320
320
316
318
318

FIG-44

# CONNECTOR SYSTEM AND AIR MAINTENANCE TIRE ASSEMBLY

## FIELD OF THE INVENTION

**[0001]** The invention relates generally to air maintenance tires and, more specifically, to a connector system for construction of a built-in air maintenance pump assembly in a tire.

## BACKGROUND OF THE INVENTION

**[0002]** Normal air diffusion reduces tire pressure over time. The natural state of tires is under inflated. Accordingly, drivers must repeatedly act to maintain tire pressures or they will see reduced fuel economy, tire life and reduced vehicle braking and handling performance. Tire Pressure Monitoring Systems have been proposed to warn drivers when tire pressure is significantly low. Such systems, however, remain dependant upon the driver taking remedial action when warned to re-inflate a tire to recommended pressure. It is a desirable, therefore, to incorporate an air maintenance feature within a tire that will re-inflate the tire in order to compensate for normal air diffusion over time without the need for driver intervention.

## SUMMARY OF THE INVENTION

**[0003]** In one aspect of the invention, a connector system and tire assembly includes an elongate integral air passageway contained within a flexible tire component of a tire carcass, the air passageway extending between an air inlet cavity and an air outlet cavity in the flexible tire component, and the air passageway extending at least a partial circumferential path around the tire carcass. A connector assembly is seated within at least one of the inlet and outlet cavities, the connector assembly including a hollow dome-shaped nut body, a central chamber within the nut body opening to an outward body side; and a through-channel extending through the nut body operative to conduct air flow communication between the integral air passageway within the flexible tire component and the central chamber of the nut body.

**[0004]** In another aspect, the connector system and tire assembly includes a hollow dome-shaped inlet nut within the inlet cavity and a hollow dome-shaped outlet nut within the outlet cavity, wherein the outlet and inlet nuts face in opposite directions within respective cavities. The inlet nut couples to an air inlet device for conducting air external to the tire carcass into the inlet nut central chamber; and the outlet nut outward body side couples to a valve device positioned within the tire cavity, the valve device operative to regulate a flow of air from the outlet dome nut body to the tire cavity.

**[0005]** According to further aspect, the connector system and tire assembly provides a removable elongate core strip positioned within the air passageway of the tire carcass flexible component during a pre-cure build of the tire carcass. The core strip is withdrawn post-cure from the air passageway of the tire carcass. The through-channel in the nut bodies of the inlet nut and the outlet nut have a cross-sectional configuration to closely admit a respective opposite free end of the core strip therethrough. The through-channel in the nut bodies may be alternatively located at the crown apex region or in a sidewall location.

Definitions

**[0006]** "Aspect ratio" of the tire means the ratio of its section height (SH) to its section width (SW) multiplied by 100 percent for expression as a percentage.

**[0007]** "Asymmetric tread" means a tread that has a tread pattern not symmetrical about the center plane or equatorial plane EP of the tire.

**[0008]** "Axial" and "axially" means lines or directions that are parallel to the axis of rotation of the tire.

**[0009]** "Chafer" is a narrow strip of material placed around the outside of a tire bead to protect the cord plies from wearing and cutting against the rim and distribute the flexing above the rim.

**[0010]** "Circumferential" means lines or directions extending along the perimeter of the surface of the annular tread perpendicular to the axial direction.

**[0011]** "Equatorial Centerplane (CP)" means the plane perpendicular to the tire's axis of rotation and passing through the center of the tread.

**[0012]** "Footprint" means the contact patch or area of contact of the tire tread with a flat surface at zero speed and under normal load and pressure.

**[0013]** "Groove" means an elongated void area in a tire wall that may extend circumferentially or laterally about the tire wall. The "groove width" is equal to its average width over its length. A groove is sized to accommodate an air tube as described.

**[0014]** "Inboard side" means the side of the tire nearest the vehicle when the tire is mounted on a wheel and the wheel is mounted on the vehicle.

**[0015]** "Lateral" means an axial direction.

**[0016]** "Lateral edges" means a line tangent to the axially outermost tread contact patch or footprint as measured under normal load and tire inflation, the lines being parallel to the equatorial centerplane.

**[0017]** "Net contact area" means the total area of ground contacting tread elements between the lateral edges around the entire circumference of the tread divided by the gross area of the entire tread between the lateral edges.

**[0018]** "Non-directional tread" means a tread that has no preferred direction of forward travel and is not required to be positioned on a vehicle in a specific wheel position or positions to ensure that the tread pattern is aligned with the preferred direction of travel. Conversely, a directional tread pattern has a preferred direction of travel requiring specific wheel positioning.

**[0019]** "Outboard side" means the side of the tire farthest away from the vehicle when the tire is mounted on a wheel and the wheel is mounted on the vehicle.

**[0020]** "Peristaltic" means operating by means of wave-like contractions that propel contained matter, such as air, along tubular pathways.

**[0021]** "Radial" and "radially" means directions radially toward or away from the axis of rotation of the tire.

**[0022]** "Rib" means a circumferentially extending strip of rubber on the tread which is defined by at least one circumferential groove and either a second such groove or a lateral edge, the strip being laterally undivided by full-depth grooves.

**[0023]** "Sipe" means small slots molded into the tread elements of the tire that subdivide the tread surface and improve traction, sipes are generally narrow in width and close in the tires footprint as opposed to grooves that remain open in the tire's footprint.

[0024] "Tread element" or "traction element" means a rib or a block element defined by having a shape adjacent grooves.

[0025] "Tread Arc Width" means the arc length of the tread as measured between the lateral edges of the tread.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The invention will be described by way of example and with reference to the accompanying drawings in which:

[0027] FIG. **1** is a detail view of the silicone core die.

[0028] FIG. **2** is a perspective view of a basic silicone core extruder and conveyor.

[0029] FIG. **3** is a detail of a chafer die.

[0030] FIG. **4** is a perspective view of a basic chafer strip extruder and conveyor.

[0031] FIG. **5** is a dimensioned sectioned view of the silicone core.

[0032] FIG. **6** is a dimensioned sectioned view of extruded chafer strip.

[0033] FIGS. **7**A through **7**C are detailed views showing the silicone core strip being coated with soft rubber gum strip.

[0034] FIG. **8** is a detail view of the chafer strip with punched hole locations.

[0035] FIG. **9** is an enlarged perspective view of the silicone core strip being assembled into the chafer strip.

[0036] FIGS. **10**A through **10**C are sectioned views showing the coated silicone core and the chafer strip assembly.

[0037] FIG. **11**A is a perspective view of a tire build up drum with assembled 180 degree core/chafer strip being applied, with a normal chafer strip placement on opposite end.

[0038] FIG. **11**B is a perspective view of a tire build up drum with a normal 180 degree chafer strip being placed abutting the 180 degree core/chafer strip.

[0039] FIG. **12** is a perspective front view of a formed green tire showing inlet and outlet locations with the core strip extending from openings and the tire ready for core forming devices.

[0040] FIG. **13**A is an enlarged sectioned view showing the inlet cavity and the silicone core ready for placement of the inlet core device.

[0041] FIG. **13**B is an enlarged sectioned view showing the outlet cavity and the silicone core ready for placement of the outlet core device.

[0042] FIG. **14**A is a top perspective view showing a first embodiment outlet core assembly with screw punch attached.

[0043] FIG. **14**B is a bottom perspective view showing the outlet core assembly with screw punch removed and the nut attached.

[0044] FIG. **14**C is a top exploded view of the outlet core assembly showing top/bottom core halves and mounting screw with the screw punch and hold down nut.

[0045] FIG. **14**D is a bottom exploded view of FIG. **14**C.

[0046] FIG. **15**A is a top perspective view of a first embodiment inlet core assembly.

[0047] FIG. **15**B is a top exploded view of the inlet core assembly showing top/bottom core halves and magnetic inserts.

[0048] FIG. **15**C is a bottom exploded view of FIG. **15**B.

[0049] FIG. **16**A is a threaded elbow and valve housing assembly.

[0050] FIG. **16**B is an exploded view of FIG. **16**A showing the elbow, valve housing and Lee valve.

[0051] FIG. **17**A shows an alternative embodiment of threaded elbow and one-way valve assembly.

[0052] FIG. **17**B is an exploded view of FIG. **17**A showing the elbow valve housing with air passage ways and membrane cover.

[0053] FIG. **18**A is an enlarged sectioned view showing the inlet bottom core being inserted into the cavity under core strip and the chafer groove re-opened to allow room of the conical end of the inlet core to be fully seated into cavity.

[0054] FIG. **18**B is an enlarged sectioned view showing the inlet bottom core fully inserted into the cavity and the core strip being trimmed to length.

[0055] FIG. **18**C is an enlarged sectioned view showing the inlet top core ready for placement into the cavity.

[0056] FIG. **18**D is an enlarged section view showing the inlet core assembly fully assembled into cavity.

[0057] FIG. **18**E is an enlarged section view showing the inlet core assembly held in place with thin rubber patches is ready for curing.

[0058] FIG. **19**A is an enlarged sectioned view showing the outlet bottom core unit being inserted into the cavity under the core strip and the punch forced through the tire wall into the cavity chamber with the chafer groove re-opened to allow room for the conical end of the outlet core bottom unit to be fully seated into cavity.

[0059] FIG. **19**B is an enlarged sectioned view of the bottom outlet core unit fully seated into the cavity.

[0060] FIG. **19**C is an enlarged sectioned view from cavity side showing the screw punch fully inserted through the tire wall.

[0061] FIG. **19**D is an enlarged sectioned view of the screw punch removed from the outlet bottom core half component with the nut attached to thread shaft.

[0062] FIG. **19**E is an enlarged sectioned view showing the nut fully attached to the outlet bottom core shaft.

[0063] FIG. **19**F is an enlarged sectioned view of the core strip cut to length at the outlet bottom core strip cavity.

[0064] FIG. **19**G is an enlarged sectioned view of the outlet top core component placed into the cavity and screwed into place.

[0065] FIG. **19**H is an enlarged sectioned view showing the outlet core halves and screw fully assembled.

[0066] FIG. **19**I is an enlarged sectioned view showing the conical end of outlet core assembly covered with a rubber patch.

[0067] FIG. **20** is a side view of a tire showing the inlet and outlet core locations before curing.

[0068] FIG. **21**A is a section view taken from FIG. **20** showing the inlet core location.

[0069] FIG. **21**B is an enlarged view of the inlet core taken from FIG. **21**A.

[0070] FIG. **22**A is a section view taken from FIG. **20** showing the outlet core.

[0071] FIG. **22**B is an enlarged view of the outlet core taken from FIG. **22**A.

[0072] FIG. **23** is an enlarged sectioned view showing the inlet core halves being removed after curing.

[0073] FIG. **24** is an enlarged sectioned view showing the nut removed from the outlet core threaded shaft.

[0074] FIG. **25** is an exploded view of the outlet core halves disassembled and removed from the sidewall cavity.

[0075] FIG. **26** is a side elevation showing the silicone core strip removed from the tire sidewall.

**[0076]** FIG. **27** is an enlarged sectioned view showing the finished inlet cavity ready for permanent inlet insert placement.

**[0077]** FIG. **28**A is an enlarged sectioned view showing the threaded elbow component placed into the outlet cavity.

**[0078]** FIG. **28**B is an enlarged sectioned view showing the elbow component fully inserted through the sidewall to the cavity chamber with a leading end placed into conical opening and a rubber plug/patch ready to fill the opening.

**[0079]** FIG. **28**C is enlarged sectioned view showing the patched area after 30 minute cure.

**[0080]** FIG. **29**A is an enlarged sectioned view from the cavity chamber showing the outlet valve ready to be threaded onto outlet elbow component.

**[0081]** FIG. **29**B is an enlarged sectioned view of the outlet valve shown fully seated onto the elbow component to thus complete the first embodiment operation.

**[0082]** FIGS. **30**A through **30**D are detailed views of a second, alternative, embodiment of the assembly including an inlet dome nut.

**[0083]** FIGS. **30**E through **30**H are detailed views of the outlet dome nut embodiment.

**[0084]** FIGS. **31**A through **31**C are detailed views of a second, alternative, embodiment of the inlet filter assembly.

**[0085]** FIGS. **32**A through **32**D are detailed views of a second embodiment of the outlet dome nut.

**[0086]** FIGS. **33**A through **33**C are detailed views of a second embodiment outlet valve.

**[0087]** FIGS. **34**A and **34**B are detailed views of dome nut cap.

**[0088]** FIGS. **35**A and **35**B are detailed views of a hollow needle component.

**[0089]** FIG. **36**A is an enlarged sectioned view of a tire showing the core strip inserted through the inlet dome nut and the dome nut being placed into the formed inlet chafer opening.

**[0090]** FIG. **36**B is an enlarged sectioned view showing a void around the inlet dome nut filled with chafer compound and the core strip inserted through the protective cap.

**[0091]** FIG. **36**C is an enlarged sectioned view of the protective cap threaded into the inlet dome nut at the inlet location in anticipation of tire curing.

**[0092]** FIG. **37**A is an enlarged tire section showing the core strip inserted through the outlet dome nut and pressed into the hollow needle opening.

**[0093]** FIG. **37**B is an enlarged sectioned view showing the outlet dome nut and hollow needle assembled and placed into the formed outlet chafer opening and forced though the tire sidewall.

**[0094]** FIG. **37**C is an enlarged detail view from the tire cavity showing the hollow needle fully inserted through the green tire sidewall.

**[0095]** FIG. **37**D is an enlarged detail view showing the hollow needle removed from the outlet dome nut and the core strip inserted through the protective cap.

**[0096]** FIG. **37**E is a detail view showing the protective cap threaded into the outlet dome nut.

**[0097]** FIG. **37**F is an enlarged detail view showing the outlet chafer opening fully filled with chafer compound at the outlet location in anticipation of tire curing.

**[0098]** FIG. **38** is a side elevation view of the tire after curing, showing the protective caps removed from both the inlet and outlet dome nuts and the silicone core strip being removed from tire sidewall.

**[0099]** FIG. **39** is an enlarged detail view showing the filter threaded into the inlet dome nut.

**[0100]** FIG. **40** is an enlarged detail view showing the one-way valve threaded into the outlet dome nut.

**[0101]** FIG. **41** is a side view of the finished 2nd embodiment tire assembly.

**[0102]** FIG. **42**A is a section view taken from FIG. **41** showing the location of the inlet dome nut with attached filter.

**[0103]** FIG. **42**B is an enlarged view of the inlet and filter taken from FIG. **42**A.

**[0104]** FIG. **43**A is a section view taken from FIG. **41** showing the location of the outlet dome nut with attached one-way valve.

**[0105]** FIG. **43**B is an enlarged view of the outlet dome nut and one-way valve taken from FIG. **43**A.

**[0106]** FIG. **44** is a side view of the finished tire showing air flow from inlet to outlet located in the tire cavity.

## DETAILED DESCRIPTION OF THE INVENTION

**[0107]** Referring initially to FIGS. **38**, **41**, **44**, **42**A and **42**B, an air maintenance assembly and tire system **10** is shown. The system incorporates air maintenance apparatus with a tire for the purpose of maintaining air pressure within the tire at a desired level without operator intervention. The system **10** includes a tire **12** of generally conventional construction and including a pair of sidewall components **14**, **16** and a tread **18** enclosing a tire cavity **20**. The sidewalls **14**, **16** extend from a pair of tire beads **22**, **24** to the tread **18**. Pursuant to conventional construction, the tire **12** has an apex component **26** disposed radially adjacent each bead and a chafer component **28** surrounding each bead region. The tire **12** mounts to a wheel **36** and is seated on a rim surface **40**. An air maintenance assembly **42**, as will be explained, may be provided within one or both sides of the tie **12** if desired. Each air maintenance assembly **42** is configured to extend between an air entry or inlet cavity **44** and an air exit/outlet cavity **46**. Pursuant to the invention, the air maintenance assembly **42** incorporates a thin tube as a hollow within a flexible tire component such as the chafer **28** during tire construction. The location selected for the hollow tube within the tire is in a tire component residing within a high flex region of the tire sufficient to progressively collapse the peristaltic internal tire tube as the tire rotates, whereby forcing air along the tube from the inlet to the outlet where the air is directed to the tire cavity for pressure maintenance. The AMT assembly **42** thus operates as an internal peristaltic air pump to the tire.

**[0108]** With reference to FIGS. **1**, **2**, **3**, **4**, **5** and **6**, a silicone core strip **58** is formed by means of die **48** having a profiled orifice **50** therethrough. The orifice is elongate and generally lens shaped in section with the extruded strip **58** of like sectional geometry. The lens shape may have a dimension of, by way of example without limitation intent, 2.7 mm length D2×0.5 mm at D1. While the preferred composition of the strip **58** is silicone, other materials such as cable or monofilament may be used if desired. The die **48** is affixed to a basic extruder of conventional configuration and deposits a formed core strip **58** on a conveyer belt moved by drive roller **56**. The length of the strip **58** is predetermined as will be appreciated from the explanation following. As shown in FIGS. **3** and **4**, a chafer strip **70** is formed by extrusion die **60** affixed to extruder **66** and deposited on roller **68**. The die **60** is formed having along a chafer forming opening **62** along a bottom side and a downward projection finger **64** projecting into the opening **62**. FIG. **6** shows a sectioned view of the extruded chafer strip. As seen, the strip **70** widens in section from a low width or thinner end region **72** to a stepped wider or thicker region **74** to a wider or thicker opposite region **88**. The die finger **64** forms an incut, arching chafer channel or tube **80** extending the length of the chafer strip, defined by channel sidewalls **82**, **84** and bottom wall **86**. The channel is open initially as shown at **90**. Representative dimensions as seen in FIG. **6** are within a range of 25 to 100 mm; L**2**=13+/−10; L**3**=1+/−0.5; H**1**=5+/−4; and H**2**=4.5+/−4; however the chafer strip dimensions may be varied to suit the particular tire sizing needs and the tire construction characteristics desired. In addition, if so desired, the silicone strip **58** may be molded instead of extruded.

**[0109]** A flexible tire component, such as a chafer segment, is provided with a groove **80**, as best seen in section from FIG. **6**, is defined by groove lips **82**, **84** that angle inwardly from top to bottom to a bottom groove wall **86**. The groove **80**, formed within a axially outward thicker side **88** of the chafer strip is accordingly open at groove opening **90**. The groove **80** formed within the chafer is as a result angles axially outward from the opening **90** to the bottom wall **86** at an acute angle θ preferably within a range of −20 to +20 degrees. As shown in FIGS. **7**A through **7**C, the silicone strip **58** can be enveloped within an outer sheath or covering **92** formed of rubber gum or other suitable material. The rubber gum strip **92** is folded over the strip **58** to form an overlap seam **94** to enclose the silicone strip **58** and thus forms therewith a sheathed silicone strip assembly **104**. The strip assembly **104**, as explained following, will be used to form peristaltic tube within a green tire during green tire construction. The general purpose of strip assembly **104** is to form within a green tire component, such as chafer **28**, a core air passageway which, once the strip assembly is removed, forms a peristaltic tube integrally within and enclosed by the tire component. The angled groove **80** is formed within the chafer strip as a slot, with the lips **82**, **84** in a close opposed relationship. The groove **80** is then opened to receive the strip assembly **104** by an elastic spreading apart of groove lips **82**, **84**. Thereafter, the assembly **104** is positioned downward into the groove **80** until reaching a position adjacent to the bottom wall **86**. A release of the lips **82**, **84** causes the lips to elastic resume their close opposed original orientation. The lips **82**, **84** are then stitched together in a rolling operation wherein a roller (not shown) presses the lips **82**, **84** into the closed orientation shown in FIGS. **6** and **8** and become entrapped within the chafer strip by a folding over the chafer strip over the top as seen in FIG. **10**C. The angle θ of the channel **80** with respect to a bottom surface of the chafer strip enables a complete capture of the silicone strip assembly **104** within the tire component, chafer **28**, entirely surrounded by the chafer strip material composition.

**[0110]** With reference to FIGS. **8**, **9**, **10**A through **10**C and **7**A through **7**C, the channel **80** is destined to become the tube component to a peristaltic pump assembly within the tire chafer **70** and generally extends from chafer strip end **96** to end **98**. The chafer is cut at a given length depending on the pump length that is desired when the tire is cured. Formed within each end of the chafer by a punching operation or cutting operation are enlarged diameter circular holes **100**, **102**. The holes **100**. **102** are adjacent the ends of the channel **80** and are sized to accommodate receipt of peristaltic pump inlet and outlet devices as will be explained. The lips **82**, **84** of the chafer channel **80** are pulled apart. The wrapped silicone strip assembly **104** is inserted at direction arrow **110** into the channel **80** as shown in FIGS. **10**A through **10**C until adjacent and contacting the lower wall **86** of the channel **80**. Thereupon, the silicone strip assembly **104** is enclosed by the chafer by a folding over of the chafer lip flap **82** in direction **112**. The channel **80** is thus closed and subsequently stitched in the closed position by a pair of pressure contact rolls (not shown). So enclosed, the assembly **104** will preserve the geometry of the channel **80** from green tire build until after tire cure when the assembly **104** is removed. The silicone strip assembly **104** is dimensioned such that assembly ends **106**, **108** extend free from the chafer strip **70** and the chafer strip channel **80**, and extend a distance beyond the punched holes **100**, **102** at opposite ends of the chafer strip.

**[0111]** Referring to FIGS. **11**A, **11**B and **12**, a conventional green tire building station is depicted to include a build drum **116** rotational about an axial support **118**. The chafer strip **70** containing silicone strip assembly **104** and an opposite chafer strip **122** that does not incorporate a strip assembly **104** are positioned along opposite sides of the build drum **116** in direction **124** in an initial 180 degree chafer build-up. The chafer strip **70** is thus combined with a normal chafer strip **126** length to complete the circumference. The second strip **126** is applied to the building drum in alignment with and abutting strip **70** as shown in FIG. **11**B to complete a 360 degree chafer construction on the drum. The opposite side of the drum receives two 180 degree normal strips **122** in abutment to complete the chafer build on that side. It will be noted that the chafer strip **70** contains the silicone strip assembly while the abutting strip **126** does not. However, if desired, both of the chafer strips **70**, **126** as well as one or both of the strips **122** may be configured to contain a silicone strip assembly **104** to create a 360 degree peristaltic pump tube on one side or both sides of the green tire. For the purpose of explanation, the embodiment shown creates a pumping tube of 180 degree extent in one chafer component only. In FIG. **11**B, it will be noted that chafer strip **126** is configured to complement the construction of strip **70** shown in FIGS. **8** and **9**. Circular punch holes **100**, **102** are at opposite ends of the complementary strip **126**. When abutted against the strip **70**, the punch holes **100**, **102**, create 180 degree opposite cavities **132**, **134** as seen in FIGS. **13**A and **13**B.

**[0112]** The free end **106** for the purpose of explanation will hereafter be referred to as the "outlet end portion" of the silicone assembly **104** extending through the outlet cavity **134**; and the free end **108** the "inlet end portion" of the assembly **104** extending through the circular inlet cavity **132**. FIG. **12** illustrates the 180 degree extension of the silicone assembly **104** and FIGS. **13**A, **13**B show the relative location of the assembly **104** to the lower tire bead and apex components. FIG. **13**A shows the inlet cavity **132** and silicone core assembly **104** ready for placement of a temporary inlet core device and FIG. **13**B shows the outlet cavity **134** ready for placement of a temporary outlet core device.

**[0113]** FIGS. **14**A through **14**D show a first embodiment of a pre-cure, temporary outlet core assembly **136** with attached screw punch **138** and replacement nut **140**. The temporary outlet core assembly **136** includes mating bottom half-housing component **142** and a top half-housing component **144** connecting by means of a coupling screw **160**. The bottom half-housing component **142** has a dependent cylindrical screw threaded sleeve **146**; an upper socket **148** extending downward into the component **142** and communicating with the upward facing opening of sleeve **146**; and a half-protrusion **150** having an axial half-channel formed to extend across housing **142**. The top-half-housing component **144** has a central through bore **154**, a half-protrusion housing **156** and a half-channel formed to extend side to side across an underside of the housing **144**. United as shown in FIGS. **14**A and **14**B, the two half-housing components **142**, **144** are assembled by screw **160** threading bolt **162** down through the bore **154** and into the sleeve **146**. So assembled, the half-protrusion housings **150** and **156** unite as well as the half-channels **152**, **158**. In the assembled state, as seen in FIGS. **14**A and **14**B, the protrusion housings **150**, **156** form an outwardly projecting conical tube-coupling protrusion **164** away from the combined housing halves **142**, **144** and defining an axial air passageway channel **165** having a sectional shape and dimension corresponding with the silicone strip assembly **104** within chafer strip **126** of the tire.

**[0114]** The inwardly and outwardly threaded shaft **146** of the temporary outlet core assembly **136** receives and couples with an externally threaded shaft **168** of the screw punch accessory device **138**. As will be explained below, screw punch device **138** will in the course of peristaltic tube assembly formation be replaced with the threaded collar or nut **140** as shown in FIG. **14**B.

**[0115]** With reference to FIGS. **15**A through **15**C, a metallic first embodiment of a pre-cure, temporary inlet core assembly **170** is shown forming a housing body **174** from which a conical coupling housing protrusion **172** extends. An axial air passageway through-channel **176** extends through the housing body **174** and the protrusion **172** having a sectional shape and dimension corresponding with the shape and dimensions of the silicone strip assembly **104** within the chafer strip **126** of the green tire. The housing body **175** is formed by a combination of half-housing **178**, **180**, each providing a half-coupling protrusion **182**, **194**, respectively in which a half-channel **184**, **196** is formed, respectively. A central assembly socket **186** extends into the internal underside of half-body **178** and receives an upright post **188** from the lower half-body **180** to center and register the two half-bodies together. Three sockets **190** are formed within the lower half-body **180** with each socket receiving a magnetic insert **192**. The magnets **192** operate to secure the metallic half-housings **178**, **180** together.

**[0116]** Referencing FIGS. **16**A and **16**B, a threaded elbow and valve housing assembly **198** is shown for use as a permanent outlet core valve assembly. The housing assembly **198** is formed of a suitable material such as a nylon resin. The assembly **198** includes an elbow housing **200** having a conical remote end **202** and a cylindrical valve housing **2004** affixed to an opposite end. A one-way valve, such as a Lee valve, is housed within the valve housing **204**. An axial air passageway **2008** extends through the L-shaped assembly **198** and through the Lee valve seated in-line with the passageway. A Lee valve is a one-way valve which opens at a prescribed air pressure to allow air to pass and is commercially available from The Lee Company, located in Westbrook, Conn., U.S.A. Other valve devices may be employed alternatively, such as a Norgren valve commercially available from Norgren Nev., located in Lot, Belgium, or a Beswick valve commercially available from Beswick Engineering located in Greenland, N.H., U.S.A.

**[0117]** FIGS. **17**A and **17**B show an alternative embodiment of an elbow connector and one-way post-cure outlet valve assembly **210**. An L-shaped elbow connector housing **212** has a conical forward arm end **214** and an axial passageway **216** that extends through the L-shaped housing **212**. An umbrella-type valve **218** of a type commercially available from MiniValve International located in Oldenzaal, The Netherlands, attaches to a threaded end of housing **212** by means of nut **220**. The valve **218** has a circumferential array of air passages **227** that allow the passing of air from the housing of the valve. The valve **218** includes an umbrella stop member **222** having a frustro-conical depending protrusion **224** that fits and locks within a valve central bore **226** and a flexible circular stop membrane **223**. The protrusion **224** of stop member **222** locks into the axial bore **226**. The flexible membrane **223** is in a closed or down position when air pressure on the membrane is at or greater than a prescribed pressure setting. In the down position, membrane **223** covers the apertures **227** of the valve body and prevents air from passing. The membrane **223** moves to an up or open position when the air pressure outside the membrane falls to a pressure less than the preset pressure setting. In the up or open position, air can flow from the apertures **227** into the tire cavity.

**[0118]** FIGS. **18**A through **18**D represent sequential views showing the installation of the inlet core assembly embodiment of FIGS. **15**A through **15**C connecting into the green tire silicone strip assembly **104** after green tire build and prior to curing of the green tire. In FIG. **18**A, the bottom half housing component **180** is inserted into the inlet cavity **132** after the cavity **132** has been enlarged into generally a key shape as indicated by the scissor representation. The cutting implement opens the chafer strip groove, still occupied by silicone strip assembly **104**, to accommodate receipt of the conical half-protrusion **194** of half-housing **180**. The tapered end of conical half-protrusion **194** fits into the chafer channel occupied by strip assembly **104** as shown in FIG. **18**B, as the strip assembly **104** is position within the half-channel **196** across the housing **180**. The extra length of inlet end portion **108** is cut and removed, whereby positioning a terminal end of the strip assembly **104** within the housing component **180**. The upper, outer, top half-housing component **178** is thereupon assembled over the housing component **180**, as seen in FIG. **18**D, capturing the strip assembly **104** within the channel formed by upper and lower half-channels **184**, **196**. The magnets **192** secure the metallic half-housings **178**, **180** together. Rubber patches **228**, **230** as seen in FIG. **18**D are applied over the temporary inlet core assembly **170** to secure the assembly in place for the tire cure cycle. The hollow metallic housings **178**, **180** are held together by the magnets. It will be appreciated that a non-metallic hollow housing may be employed if desired, such as a hollow housing made of molded plastic, with housing components held together by locking detent techniques known in the plastic casing art.

**[0119]** FIGS. **19**A through **19**I show sequential assembly of the outlet core assembly embodiment of FIGS. **14**A through **14**D into the green tire outlet cavity **134** and to the outlet end portion **106** of the silicone strip assembly **104**. In FIG. **19**A, the bottom half-component **142** is inserted into the cavity **134** after the circular cavity **134** has been enlarged into a keyhole configuration to accommodate the geometry of the component **142**. The screw punch **138** is pushed through to protrude through tire wall into the tire cavity **20** from the cavity **134** as seen in FIG. **19**C. FIG. **19**B shows the component **142** fully seated into the cavity **134**, the tapered conical half-protrusion **159** projecting into the chafer channel occupied by strip assembly **104** with the strip assembly **104** residing within half-channel **152**. In FIGS. **19**D and **19**E, the screw punch **138** is removed and replaced by the nut **140** attached to the screw thread **146**. In FIG. **19**F, the outlet end portion **106** of silicone core strip **104** is cut to length at the outlet cavity **134** and placement of the outlet top half-housing **144** over the bottom half-housing **142** within cavity **134**. The screw **160** is threaded at **162** into socket **148** to affix both half-housings **142**, **144** together as shown in FIGS. **19**G and **19**H. A rubber patch **234** is affixed over the outlet core assembly **136** in place for tire cure.

**[0120]** FIGS. **20**, **21**A, **21**B, **22**A and **22**B show the tire with the inlet and outlet temporary core assemblies in place before curing. As seen, the silicone core assembly **104** enclosed within a chafer component **28** of the green tire extends 180 degrees between the pre-cure outlet core assembly **136** and the pre-cure inlet core assembly **170**. An enlarged depiction of the inlet core location is shown in FIG. **21**B from section view FIG. **21**A and the outlet core location is shown enlarged in FIG. **22**B from the section view of FIG. **22**A. The silicone core assembly **104** resides enclosed within the chafer channel and thereby preserves the structural integrity of the chafer channel through tire cure. The sectional configuration of the assembly **104**, as seen, is complementary to chafer channel in which it is encased surrounded by chafer composition, and thereby maintains the configuration of the chafer channel throughout tire cure.

**[0121]** Referring to FIG. **23**, the post-cure removal of the half-housings **178**, **180** from the inlet cavity **132** is shown. The cavity **132** is thus opened including a funnel-shaped cavity portion **233**. FIGS. **24** and **25** show the nut **140** removed from the outlet core threaded shaft **146** to initiate a post-cure removal of the outlet core assembly **136**. The assembly components **142**, **144** are removed from the outlet cavity **134**, leaving the cavity **134** including funnel-shaped adjacent cavity portion **237** open. Thereafter, as shown by FIGS. **26** and **27**, the silicone core strip assembly **104** is removed from the tire chafer channel, whereby the chafer channel left by the vacated core strip assembly **104** becomes an elongate unobstructed 180 degree air passageway **238** from the inlet cavity **132** to the outlet cavity **134**, wholly integrated within the chafer component **28**. FIG. **27** shows the post-cure insertion of permanent inlet cavity assembly **240** into the inlet cavity **132**. The assembly **240** includes a hollow casing **241** having an internal cavity (not shown) housing a porous air filter (not shown). The installed casing **241** replicates the configuration and shape of the hollow housing **170** described in reference to FIG. **15**A. A conical coupling protrusion **235** extends from the casing **241** and into the funnel cavity **233** off the inlet cavity **132**. The protrusion **235** has an internal air passageway which communicates with the cavity within casing **241**. An air inlet opening **239** is disposed within an outward face of the casing **241** to allow air to enter into the casing **241** and, from there, to the air passageway within protrusion **235**, and then into the integral chafer air passageway **238**.

**[0122]** With reference to FIGS. **28**A, **28**B and **28**C, the permanent outlet cavity insert assembly **198** in the embodiment shown in FIGS. **16**A and **16**B is inserted post-cure into the outlet cavity **134**. The conical coupling protrusion **202** is seated within the funnel cavity **237** off the outlet cavity **134** while the L-shaped housing **200** seats within the cavity **134**. The threaded coupling end **242** of the assembly **198** depends from the cavity **134** and projects into the tire cavity as shown in FIGS. **29**A and **29**B. Air flow along post-cure air passageway **238** toward the outlet assembly **198** is captured within the axial bore **208** and directed within the housing **200** to the threaded end **242**. As seen in FIG. **28**B, a plug **244** formed from rubber or a rubber composite or other suitable material, is inserted into the outlet cavity **134** to enclose the assembly **198** therein.

**[0123]** In FIGS. **29**A and **29**B, a valve mechanism such as valve assembly **198** (FIGS. **16**A and **16**B), that attaches to the screw threaded end **342** of the post-cure outlet cavity insert assembly **198** from the tire cavity **20** side. The valve assembly **198** opens when the pressure inside the pump tube is greater than the pressure inside the cavity **20** (plus the valve cracking pressure). The L-shaped elbow assembly **198** directs air from the chafer air passageway **338**, through the axial passageway **208** of housing **200**, into the housing **204** of the valve mechanism. The conical seating between end **202** and the conical entryway **237** into passageway **338** ensures that that air from the chafer passageway **338** is effectively routed into the elbow valve assembly **198**.

**[0124]** FIGS. **30**A through **30**D are views of an alternative, second embodiment of an inlet cavity insert assembly incorporating a dome nut **246**. The dome nut **246** has a rounded domed body **248**, a center cavity **250**, and internal coupling threads **252**. Extending through a side of the dome body **248** is an elongate through-slot **254** dimensioned to accommodate close receipt of the silicone strip assembly **104** therethrough. Through slot **254** can be either on the side for the inlet insert or on the crown for the outlet insert. The through-slot **254** communicates with the internal center cavity **250** of the dome nut **246**. Four spaced apart elongate indentations **256** are placed within an external surface of the domed body **248** to avoid rotation of the nut when screwing either the filter or the valve to the thread.

**[0125]** FIGS. **30**E through **30**H are views showing a third embodiment of the inlet cavity insert assembly employing an alternative dome nut **270**. The dome nut **270** has a domed body **248**, center cavity **250**, and coupling threads **252**. A pair of gripping flanges **272** extend from opposite sides of the dome body **248**. In the alternative dome nut embodiment, the through-slot **254** is placed at the crown of the nut body as shown. Thus, through slot **254** can be either on the side for the inlet insert or on the crown for the outlet insert. The slot **254** in the FIGS. **30**E through **30**H is likewise dimensioned for close receipt of the silicone strip assembly **104**.

**[0126]** FIGS. **31**A through **31**C show a filter assembly **258** which couples to the inlet dome nut of FIGS. **30**A through **30**D or the alternative inlet dome nut of FIGS. **20**E through **30**H to complete the alternative post-cure inlet cavity insert assembly. The filter assembly **258** includes a hex nut body **260** having an internal chamber **262** and an externally threaded coupling post **264**. The chamber **262** is sized to seat a porous filter member **266** therein. The body **260** has an opening **261** communicating with the chamber **262** to admit air into the body **260**, through the filter member **266** therein, and out of an axial passage **263** through post **264**. The post **264** threads into the dome nut **246** or **270**.

**[0127]** FIGS. **32**A through **32**D show an embodiment of an outlet cavity insert assembly dome nut **268** in which the indentations **256** in the dome body are deployed as in the embodiment of inlet dome nut embodiment FIGS. **30**A through **30**D while the crown placement of slot **254** is similar to the inlet dome nut of FIGS. **30**E through **30**H. The outlet dome nut **268** has an internal chamber **250**, coupling threads **252** and through-slot **254** sized to admit closely the silicone strip assembly **104**.

**[0128]** Referring to FIGS. **33**A through **33**C, a second embodiment of an outlet valve assembly **272** is shown. The valve assembly **272** is an alternative to the valve assembly **204**. Valve assembly **272** is a one-way ball valve including a hexagonal valve body **274**, a coupling nut **276**, an axial bore **278** extending through the body **274** to an outlet bore **290**, a compression spring **284** seated within body **274**, a threaded stop plug **282** coupled into threads **280** within bore **278**, and a ball valve **286** seated within the housing **274** at the shoulder separating the axial bore **278** with the outlet passage **290**. The housing **274** has an externally threaded coupling neck **288** at a forward end adapted to couple into the outlet dome nut shown in FIGS. **32**A and **32**B in a post-cure assembly procedure. A one-way ball valve of the type shown is commercially available, such as from Beswick Engineering located in Greenland, N.H., U.S.A. The ball valve **286** under bias from spring **284** seats against shoulder **227**. The compression pressure is set by threaded insertion of plug **282** into the axial bore **278**. Air pressure from the tire cavity impinges the ball **286** and forces the ball valve against shoulder **287** so long as the tire cavity pressure is at or exceeds a pressure threshold. When the pressure from the tire cavity falls below the threshold, upstream air pressure from air forced along air passageway **238** pressures on the ball **286**, forcing the ball **286** away from the shoulder **227** and allowing air to flow from passageway **290**, along the bore **278**, out of housing **274**, and into the tire cavity.

**[0129]** FIGS. **34**A and **34**B show detail views of a dome nut cap **268** for use in the dome nut system. The cap **292** includes an axial through-passageway sized and configured for receipt of an end of silicone strip assembly **104**; a threaded cylindrical body **296**, and a circular cap head **298**. FIGS. **35**A and **35**B show details of the hollow needle component or punch **300** for the dome nut system embodiment. The punch **300** includes a cylindrical body **402**, a conical punch nose portion **304**, a blind, rearwardly open axial bore **306**, and a coupling shank **308** having external threads **310**.

**[0130]** FIGS. **36**A through **36**B show in sequence the deployment of the dome nut inlet cavity insert assembly into a pre-cure tire. The silicone strip assembly **104** of the green tire extends through the chafer passageway as previously described with a surplus assembly end portion **108** protruding from the inlet cavity **132**. The inlet dome nut embodiment of FIG. **30**A through **30**D is inverted and press inserted into the cavity **132** after free end portion **108** of the silicone strip assembly **104** is routed through the slot **254** of the dome nut **246** and free of the dome nut cavity **250**. A void around the inlet dome nut **248** is filled with a chafer compound **312**. The cap **292** threads into the inserted and seated dome nut **248** with free end portion **108** projected through the slit **294** of the cap **292** in anticipation of tire cure.

**[0131]** FIGS. **37**A through **37**F show in sequence the deployment of the dome nut embodiment of the outlet cavity insert assembly into a tire. The outlet free end **106** of the silicone strip assembly **104** is inserted through the crown slit **254** of an inverted outlet dome nut **268** (FIGS. **32**A through **32**D) and routed into the axial bore **306** of the needle component **300**. The component **300** and dome nut **268** are then coupled (FIG. **37**B) and inserted through the outlet cavity **134** as shown in FIG. **37**C, with the needle conical tip forcing through the inner side of the tire sidewall defining cavity **20**. The needle component **300** projects into the tire cavity **20** as shown. The needle component **300** is removed and replaced with the cap **292**, with the free end **106** of the strip assembly **104** extending through the cap slot as shown in FIGS. **37**D and **37**E. From the outward side of the cavity **134**, a plug **314** composed of chafer material is inserted into the cavity **134** to fill the cavity for the cure procedure.

**[0132]** FIG. **38** shows a post-cure tire with the protective caps **292** being removed from both the inlet and outlet dome nuts **246**, **268** respectively. The silicone strip assembly **104** is removed from the tire sidewall inlet cavity **132**, leaving the vacated air passageway **238** enclosed within the chafer tire component **28** and extending between the inlet and outlet cavities **132**, **134**. FIG. **39** shows the filter assembly **258** threaded into the inlet dome nut **246**. Air from outside of the tire accordingly follows a path through the filter **266**, the dome nut **246**, and into the air passageway **238**. FIG. **40** shows the one-way valve assembly **272** previously described threaded onto the outlet dome nut **268** and positioned to reside and project into the tire cavity **20**. FIG. **41** shows the post-cure second embodiment of the tire assembly with the chafer enclosed air passageway extending 180 degrees between the inlet cavity insert assembly **258** and the outlet cavity insert assembly **272**.

**[0133]** FIGS. **42**A and **42**B show the location of the inlet dome nut **246** and filter assembly **258** within the chafer **28** at a lower region of sidewall **14**. At such a location, the inlet assembly is located radially above the rim flange **38** so that damage to the assembly from the rim flange is avoided. FIGS. **43**A and **43**B show the location of the outlet dome nut **268** and valve assembly **272** connected and located within the chafer **28** at a lower region of sidewall **14**, radially above rim flange **38**.

**[0134]** FIG. **44** shows the air maintenance assembly **42** in the post-cure tire **12** in operation and rolling against the ground surface **316**. The air maintenance assembly **42** represents a peristaltic air pump system in which a compressible air passageway **238** progressively pumps air along the passageway from the inlet to the outlet and there to the tire cavity as required to maintain internal tire cavity pressure at a required level. As will be appreciated from FIG. **44**, the inlet assembly **258** and the outlet assembly **272** are positioned generally 180 degrees apart, separated by the internal chafer air passageway **238**. The tire rotates in a direction of rotation indicated, causing a footprint to be formed against the ground surface **316**. A compressive force **318** is directed into the tire from the footprint and acts to flatten a segment of the air passageway **238** opposite the footprint as shown at **320**. Flattening of the segment of the passageway **238** forces air from the segment along internal passageway **238** in the direction **322**, toward the outlet assembly **272**.

**[0135]** As the tire continues to rotate in the direction indicated along the ground surface **316**, the air passageway **238** within the chafer component will be sequentially flattened or squeezed opposite the tire footprint segment by segment in direction **322** opposite to the direction of tire rotation. The sequential flattening of the air passageway **238** segment by segment causes evacuated air from the flattened segments to be pumped to the outlet assembly **272**. When the air flow pressure is sufficient against the outlet valving mechanism, whether embodied as the ball valve (FIGS. **33**A, **33**B, **33**C), the membrane valve (FIGS. **17**A, **17**B), the Lee valve (FIGS. **16**A, **16**B) or other known substitute valving mechanisms, the valve will open and allow air to flow through the outlet assembly **272** to the tire cavity **20**. Air exiting the outlet assembly **272** is routed to the tire cavity **20** and serves to re-inflate the tire to a desired pressure level.

**[0136]** With the tire rotating in direction **322**, flattened tube segments are sequentially refilled by air flowing into the filtered inlet assembly **258** along the passageway **238**. The inflow of air from the inlet assembly **258** continues until the outlet assembly **272** passes the tire footprint. When the tire rotates further, the inlet assembly **258** will eventually pass the tire footprint against ground surface **316**, and airflow resumes to the outlet assembly **272** along the passageway

**[0137]** The above-described cycle is then repeated for each tire revolution, half of each rotation resulting in pumped air going to the tire cavity and half of the rotation the pumped air is directed back out the inlet assembly filter. It will be appreciated that while the direction of rotation is indicated, the subject tire assembly and its peristaltic pump assembly **42** will function in like manner in a (clockwise) reverse direction of rotation. The peristaltic pump is accordingly bi-directional and equally functional with the tire assembly moving in a forward or a reverse direction of rotation.

**[0138]** The location of the peristaltic pump, air maintenance assembly **42** will be understood from FIGS. **42**A, **42**B, **43**A, **43**B and **44**. In the chafer component, the air passageway **238** is in a high flex region of the tire which causes a requisite flattening pressure from the tire rolling against ground surface **316** to be applied to passageway **238**. The air maintenance passageway **238** is integrated into and enclosed by the chafer tire component to prevent air leakage that would otherwise degradate the operational efficiency of the pump. Other tire components having high-flex regions may alternatively employed for location of the air maintenance assembly **42** if so desired. For example, without intent to delimit such alternative components and locations, the assembly **42** may be incorporated at a more radially outward location in the tire sidewall **14**. The passageway **238** would, in similar manner to that described previously, be deployed within a sidewall ply component during green tire build.

**[0139]** Pursuant to the foregoing, it will be appreciated that a method of constructing a tire having an associate air maintenance pumping assembly results. The method includes: constructing an elongate strip core **58**; encasing the strip core **58** into a containment within an uncured flexible tire component (preferably but not necessarily chafer strip **70**), the strip core extending between an air inlet cavity or cavity **132** and an air outlet cavity or cavity **134** in the flexible tire component; building on a tire building drum **116** a green tire carcass from tire components including the flexible tire component and encased strip core; curing the green tire carcass into a cured finished tire **10** including the flexible tire component **170** containing the strip core **58**; removing the encased strip core **58** from the cured flexible tire component to leave within the flexible tire component a substantially unobstructed air passageway **238**; and inserting a post-cure air inlet assembly **240** or **258** or **272** into the air inlet cavity **132** and a post-cure air inlet assembly **198** or **210** into the air outlet cavity **134**.

**[0140]** It will further be appreciated in the preferred method that the strip core **58** (or **104** as encased by rubber gum strip **92**) is longitudinally removed by a free end from the cured flexible tire component, chafer strip **70**, generally tangential to the tire carcass, by means of drawing on the free end **108** of the strip core and extending the air outlet assembly **198**, **210** inward through a tire sidewall by means of utilization of punch **138** into communication with the tire cavity **20**.

**[0141]** The preferred method further includes inserting a pre-cure temporary air inlet assembly **170** into the air inlet cavity **132** prior to curing the green tire carcass; and inserting a temporary air outlet assembly **136** into the air outlet cavity **134** prior to curing the green tire carcass; and removing the temporary air inlet assembly **170** and the temporary air outlet assembly **136** after curing the green tire carcass, to be replaced by the permanent post-cure inlet assembly (**240** or **258** or **272**) and post-cure permanent outlet assembly. The temporary inserts at the inlet and outlet positions serve to keep the cavities **132**, **134** open during tire cure for eventual post-cure insertion of the permanent inlet and outlet cavity assemblies.

**[0142]** The method also includes encasing the strip core into a containment within the uncured flexible tire component by forming, preferably by an extrusion, a channel or tube **80** into the uncured flexible tire component (chafer strip **70**) defined by channel sidewalls **82**, **84** and a channel bottom wall **86**; inserting the strip core **104** into the channel; and collapsing a flexible channel sidewall or flap **114** to enclose the sidewall **82** over the strip core **104**. The uncured flexible tire component is preferably a tire chafer component but other alternative tire components may be substituted so long as the tire components exhibit sufficiently high flexure during tire rotation to progressively collapse the air passageway **238** in a rolling tire footprint.

**[0143]** It will further be appreciated that the temporary cavity insert assemblies at the inlet and outlet cavities **132**, **134** provide a connector system that is flexible and multi-purpose. In the air maintenance tire and connector system thus provided, the elongate integral air passageway formed by the silicone strip assembly **104** at the pre-cure tire build stage, and by the vacated air passageway **238** post-removal of the assembly **104** in a post-cure procedure. The connector assembly represented by the connectors in FIGS. **14**A through **14**D (outlet core assembly **136**) and in FIGS. **15**A through **15**C (inlet core assembly **170**) each include a hollow body having a central chamber, a protruding coupling funnel housing end extending from the hollow body to couple into the air passageway, and a through-channel extending through the funnel housing end to the central chamber. The connector assembly further provides, in the outlet core assembly **136**, a dependant coupling post **146** extending from the hollow body. The coupling post **146** an axial length sufficient to project inward from the cavity **134** through a tire wall thickness to the tire central cavity **20**. The axial air conducting through-bore extends through the coupling post **146** from the hollow housing central cavity **148** to a remote end of the coupling post positioned within the tire central cavity **20**. The remote end of the coupling post **146** is operative for sequential alternative attachment to: the punch device **138** for penetrating through the tire wall thickness to the tire central cavity **20** in post-tire build, pre-tire cure procedure in which the assembly **136** is inserted into its cavity **134**; a capping nut **140** attaching to the remote end of the coupling post **146** operative to enclose the axial post through-bore throughout the tire curing procedure; and a valve device attaching post-curing of the tire to the remote end of the coupling post, the valve device such as at numeral **204** operative to regulate air flow between the hollow housing into the tire cavity.

**[0144]** The connector system described and shown in the dome nut embodiment of FIGS. **30**A through **30**G, **31**A through **31**C, **32**A through **32**D and **33** through **44** (inclusive) includes a hollow dome-shaped nut body **246**, **268**, **270** having a central chamber **250** within the nut body opening to an outward body side; and a through-channel **254** extending through the nut body operative to conduct air flow communication between the integral air passageway **238** within the chafer **28** (or other flexible tire component selected) and the central chamber **250** of the nut body. A hollow dome-shaped inlet nut **246**, **270** is seated within the inlet cavity **132** and a hollow dome-shaped outlet nut **268** within the outlet cavity **134**, with the outlet and inlet nuts oriented within respective cavities to face in opposite directions. The inlet nut **268** or **270** couples to air inlet filter device **258** (an air inlet device) for conducting air external to the tire carcass into the inlet nut central chamber **250**; and the outlet nut **268** couples to outlet valve assembly **272** (a valve device) positioned within the tire cavity **20**. The valve device **272** is operative to regulate a flow of air from the outlet dome nut body **248** to the tire cavity **20**.

**[0145]** It will further be noted that the connector and tire assembly utilizes and includes the removable elongate silicone strip assembly **104** to form the air passageway **238** during a pre-cure build of the tire carcass as described. As explained, the strip assembly is withdrawn post-cure from the air passageway **238** of the tire carcass. The through-channel **254** in the nut bodies of the inlet nut and the outlet nut have a cross-sectional configuration to closely admit a respective opposite free end **106**, **108** of the core strip therethrough. The through-channel **254** in the nut bodies may be alternatively located at the crown apex region or in a sidewall location.

**[0146]** The chafer component strip **70**, as will be appreciated from FIGS. **6** through **11** inclusive, represents a flexible tire component strip forming a portion of the tire carcass **12**. The tire component strip in the form of chafer strip **70** provides the channel **90** within an upper surface defined by opposed strip lip portions **82**, **84** and a channel bottom wall **86**; the air passageway **238** formed within the flexible chafer tire component **70** extending between the air inlet cavity **132** and the air outlet **134** cavity in at least a partial circumferential, and preferably a 180 degree, path around the tire carcass **12**. The elongate passageway-shaping strip assembly **104** occupies and forms the air passageway **238** of the flexible chafer tire component **70** during green tire build and tire cure. The passageway-shaping, silicone strip assembly **104** is operative to form and maintain the air passageway **238** to a desired cross-sectional configuration which replicates the cross-sectional configuration of the silicone strip assembly **104**.

**[0147]** The passageway-shaping, silicone strip assembly **104** is removable from the air passageway **238** in a post-cure procedure. The free end portions **106**. **108** are accessible at the air inlet and air outlet cavities, respectively, whereby the silicone strip assembly **104** may be removed by an axial withdrawal force application to the free end portion **106** or **108** of the silicone strip assembly **104**.

**[0148]** It will be noted in FIGS. **5** and **10**A through **10**C, that the passageway-shaping strip assembly **104** has a generally elliptical cross-sectional configuration and is configured having a silicone core **58** encased by a sheath **92** composed of a release material such as a rubber composition. The flexible chafer tire component **70** increases side-to side (the axial direction in the tire carcass **12**) in sectional thickness from the radially outward region **72** to the radially inward region **88**. The channel **90** which becomes air passageway **238** resides within the radially inward, thicker region **88**. The channel **90** is formed to extend into region **88**, angling radially inward toward the radially outward region **72** as seen in FIGS. **10**A through **10**C at an angle θ within a preferred range −20 to +20 degrees.

**[0149]** With reference to FIG. **26**, the preferred method of extracting the elongate strip assembly **104** from the air passageway defined by the assembly **104** occurs in a post-cure procedure. The assembly **104** is extracted longitudinally from occupancy within the flexible tire component (chafer **28**), whereby defining the air passageway in **238** within the chafer component by the space previously occupied by the elongate strip assembly **104**. The elongate strip free end portion **108** is accessible at the air inlet cavity **132** and the free end portion **106** at the air outlet cavity **134**. The elongate strip assembly **104** is moved and extracted tangentially end to end relative to the tire carcass from the air inlet cavity **132** by a withdrawal force applied to the elongate strip free end **108**. Alternatively, the assembly **104** may be extracted from the outlet opening **134** by means of free end **106**. Application of the withdrawal force may be in the form of a tensile force applied to the free end portion **108** of the elongate strip assembly **104** alone or in conjunction with other extraction techniques. For example, without restriction intended, an extraction pneumatic system may be deployed to push the assembly **104** from the chafer channel. As will be understood, a pneumatic system (not shown) of known type may consist of an air blow gun on to which a nozzle is attached. The nozzle may be configured to thread into the outlet dome nut **268** (FIGS. **32**A through **32**D) cured into the outlet cavity **134**. The gun delivers a volume of pressurized air into the passageway **238**, forcing the silicone strip assembly **104** tangential to the tire carcass and out the inlet cavity **132**. A lubricant such as a mixture of water and detergent may be injected along the silicone strip assembly to assist in achieving its extraction. Once the silicone strip **104** is withdrawn, an air inlet device as explained is inserted into the air inlet cavity **132** and an air outlet device into the air outlet cavity **134** in air flow communication with opposite ends of the defined air passageway **238**.

**[0150]** Variations in the present invention are possible in light of the description of it provided herein. While certain representative embodiments and details have been shown for the purpose of illustrating the subject invention, it will be apparent to those skilled in this art that various changes and modifications can be made therein without departing from the scope of the subject invention. It is, therefore, to be understood that changes can be made in the particular embodiments described which will be within the full intended scope of the invention as defined by the following appended claims.

What is claimed is:

**1**. A connector system and tire assembly comprising:

a tire carcass;

an elongate integral air passageway contained within a flexible tire component, the air passageway extending between an air inlet cavity and an air outlet cavity in the flexible tire component, the air passageway extending at least a partial circumferential path around the tire carcass;

a connector assembly within at least one of the inlet and outlet cavities, the connector assembly including a hollow dome-shaped nut body, a central chamber within the nut body opening to an outward body side; and a through-channel extending through the nut body operative to conduct air flow communication between the integral air passageway within the flexible tire component and the central chamber of the nut body.

**2**. The connector system and tire assembly of claim **1**, wherein the flexible tire component comprises a chafer component of the tire carcass.

**3**. The connector system and tire assembly of claim **1**, wherein the connector assembly further includes a cover component coupling to the nut body to enclose the outward body side.

**4**. The connector system and tire assembly of claim **1**, wherein the connector assembly further includes a punch device coupling to the nut body and extending from the nut body axially inward through a tire wall thickness to a tire central cavity.

**5**. The connector system and tire assembly of claim **4**, wherein the connector assembly further includes a valve device interchangeable with the punch device in coupling to the nut body, the valve device positioned within the tire cavity and operative to regulate a flow of air from the nut body to the tire cavity.

**6**. The connector system and tire assembly of claim **1**, wherein further comprising an elongate core strip positioned within the air passageway of the tire carcass flexible component, the through-channel in the nut body having a cross-sectional configuration to closely admit a free end of the core strip therethrough.

**7**. The connector system and tire assembly of claim **6**, wherein the through-channel comprises a through-slit.

**8**. The connector system and tire assembly of claim **7**, wherein the through-slit is located within a crown apex region of the nut body.

**9**. The connector system and tire assembly of claim **7**, wherein the through-slit is located within a side of the nut body.

**10**. The connector system and tire assembly of claim **1**, wherein the connector assembly includes a hollow dome-shaped inlet nut within the inlet cavity and a hollow dome-shaped outlet nut within the outlet cavity, each of the inlet and outlet nuts includes a dome nut body, a central chamber within the dome nut body opening to an outward body side,; and a through-channel extending through the dome nut body operative to conduct an air flow communication between the integral air passageway of the flexible tire component and the central chamber of the respective dome nut body.

**11**. The connector system and tire assembly of claim **10**, wherein the outlet nut outward body side is directed axially inward toward a tire cavity and the inlet nut outward body side is directed axially outward.

**12**. The connector system and tire assembly of claim **11**, wherein the inlet nut outward body side is coupled to an air inlet device for conducting air external to the tire carcass into the inlet nut central chamber; and the outlet nut outward body side is coupled to a valve device positioned within the tire cavity and operative to regulate a flow of air from the outlet dome nut body to the tire cavity.

**13**. The connector system and tire assembly of claim **12**, wherein the flexible tire component comprises a chafer component of the tire carcass.

**14**. The connector system and tire assembly of claim **12**, wherein further comprising a removable elongate core strip positioned within the air passageway of the tire carcass flexible component during a pre-cure build of the tire carcass and withdrawn from the air passageway of a post-cure tire carcass, the through-channel in the nut bodies of the inlet nut and the outlet nut having a cross-sectional configuration to closely admit a respective opposite free end of the core strip therethrough.

**15**. The connector system and tire assembly of claim **14**, wherein each through-channel comprises a through-slit.

**16**. The connector system and tire assembly of claim **15**, wherein each through-slit is located within a crown apex region of a respective nut body.

**17**. The connector system and tire assembly of claim **16**, wherein each through-slit is located within a side of the nut body.

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