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(54) **TWIN SEALING CHAMBER HUB**

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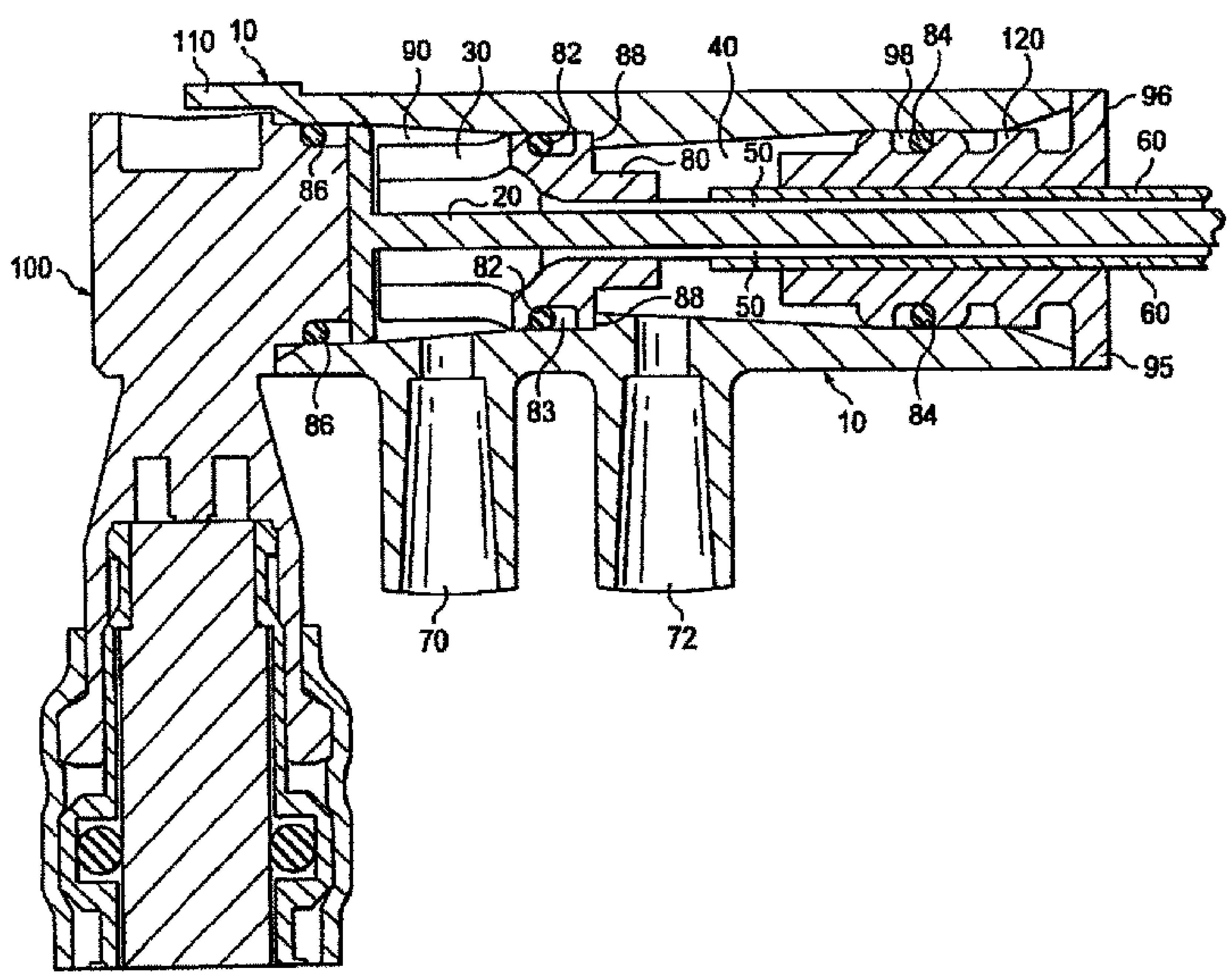
(57) **ABSTRACT**

Devices and methods for cooling microwave antennae and microwave hub construction are disclosed herein. The cooling system and hub can be utilized with a variety of microwave antenna types. A microwave hub is utilized to provide cooling fluids to a microwave antenna. The hub is constructed using no glue or adhesive for holding the different parts of the chambers in place. O-rings provide an increased reliability and consistency for fluid-tight seals in the hub. The various parts of the hub are form fitted and work together with the o-rings.

14 Claims, 3 Drawing Sheets



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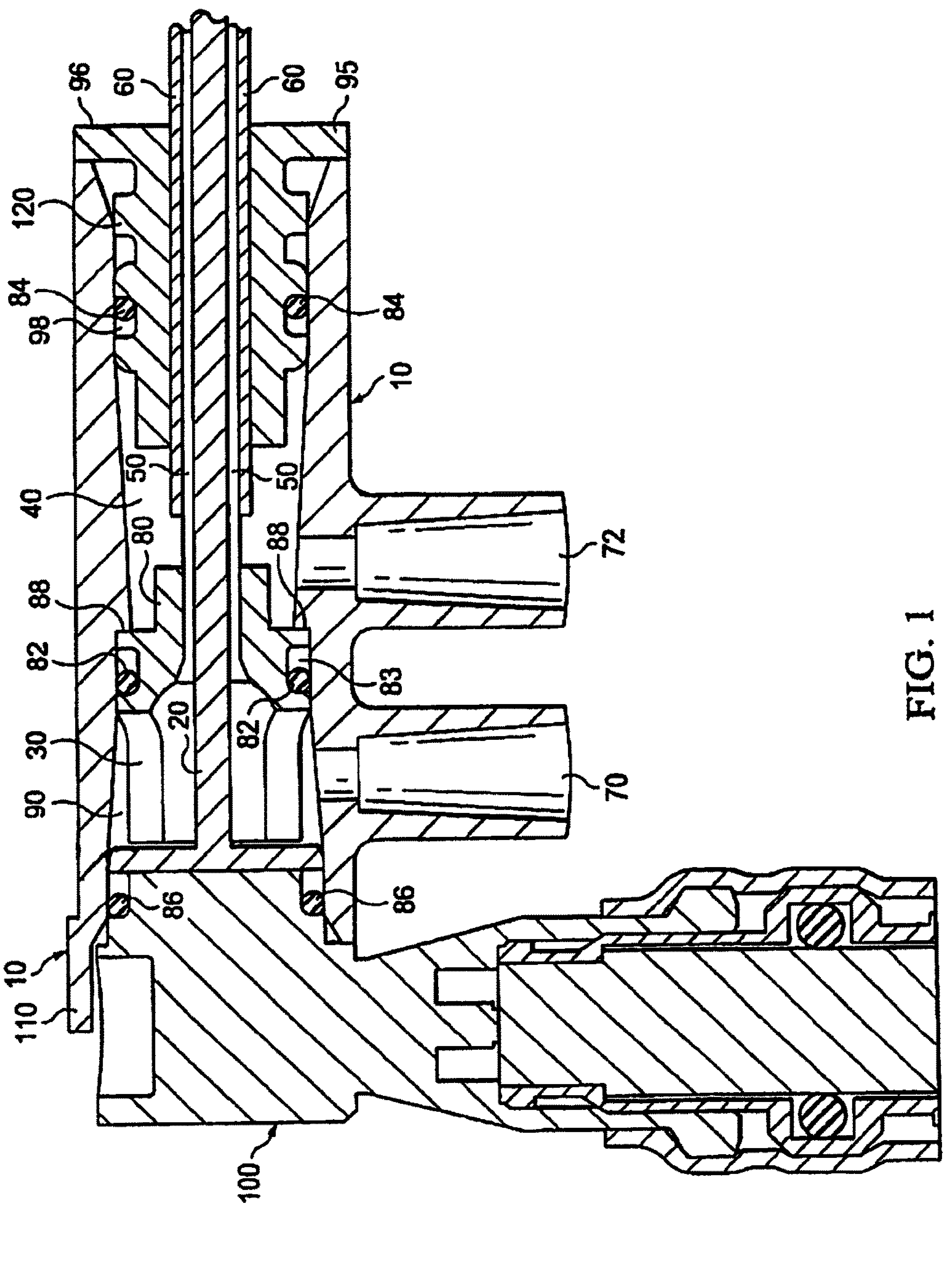
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FIG. 1

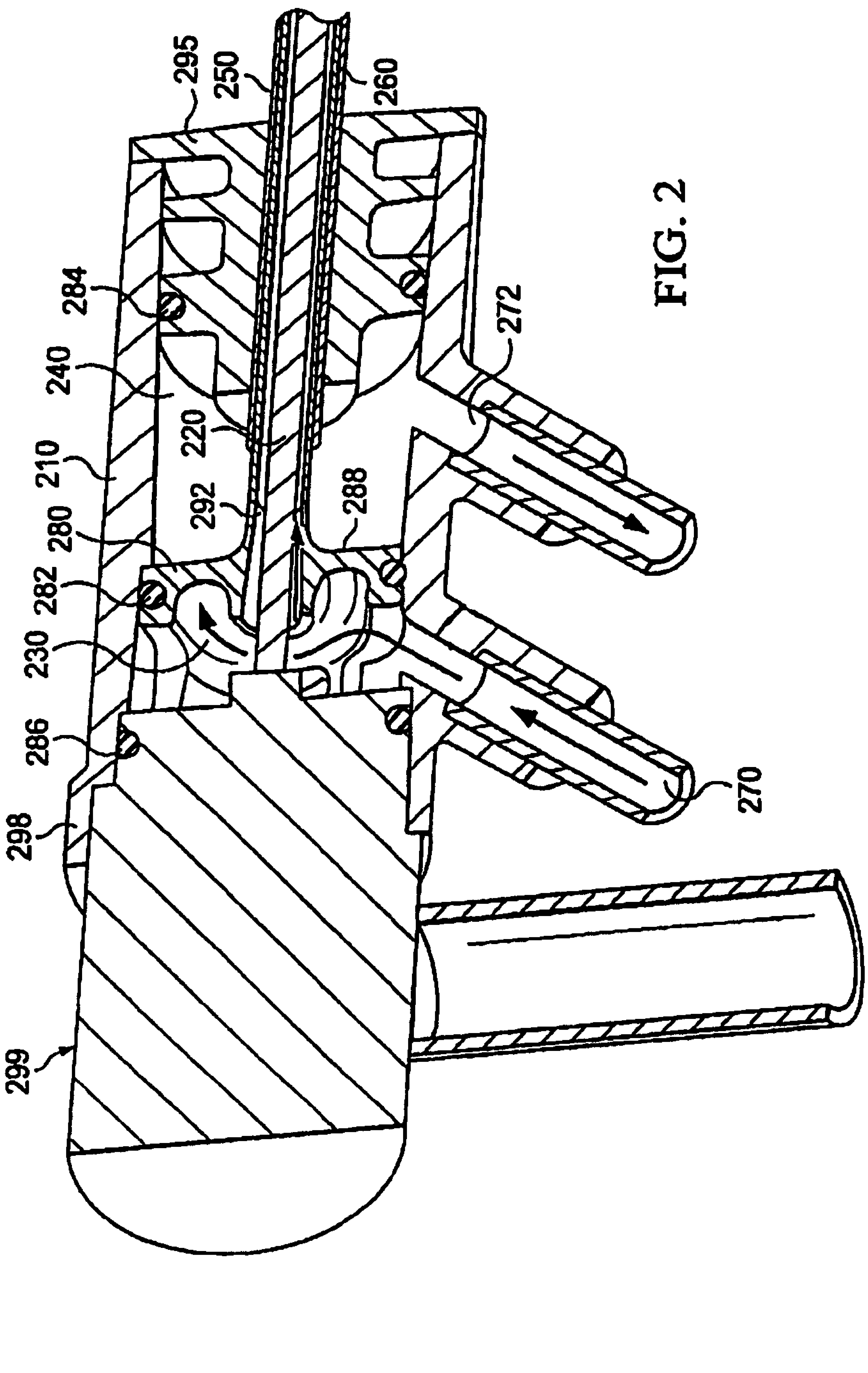
295
250
260
284
240
220
210
292
288
280
282
230
286
298
272
270
299

FIG. 2

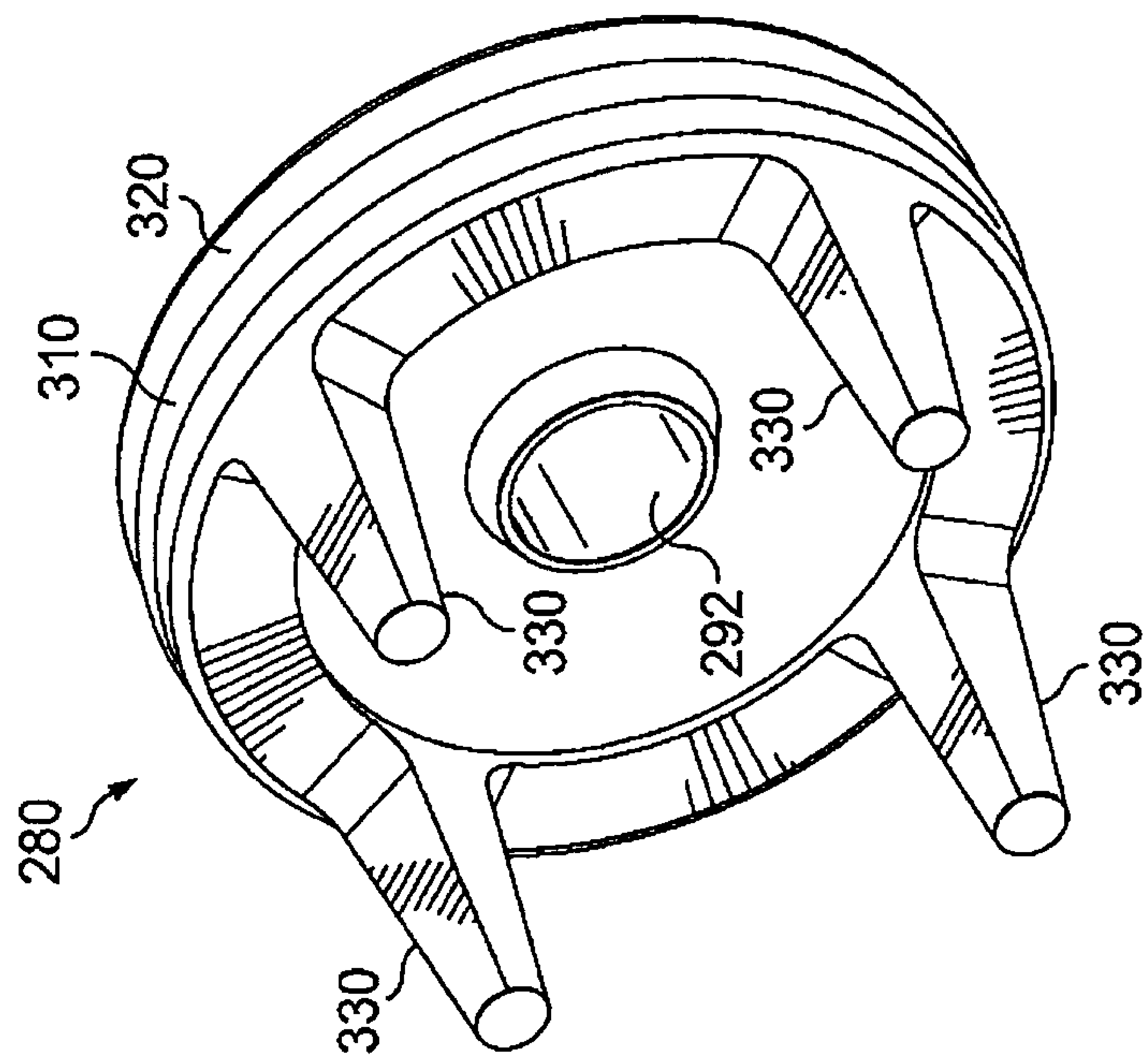

FIG. 3

TWIN SEALING CHAMBER HUB

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

BACKGROUND

The present invention relates generally to the field of ablation. More particularly, the present invention relates to apparatus, systems, and methods for cooling electrosurgical probes or microwave antennas. More particularly, the present invention relates to methods of assembly of electrosurgery and microwave antennas.

During the course of surgical procedures, it is often necessary for medical personnel to utilize electrosurgical instruments to ablate tissue in a body. High frequency probes or antennas are often utilized to ablate tissue in a body. In use, the probes or antennas are connected to a high frequency power source to heat body tissue when inserted into the tissue. Among the drawbacks of such devices is the potential that the probes or antennas will overheat, thus causing damage to the bodily tissue or causing damage to the instrument. A cooling system may be used in conjunction with the instrument to provide cooling of the instrument and often to the tissue adjacent to the instrument so as to provide optimal thermal characteristics in the instrument and the tissue. In the event that the heat is not dissipated in the instrument, charring of the tissue or failure of the instrument can occur.

Surgical systems exist that provide cooling systems for the instrument. Existing systems provide a flow of a cooling fluid to the instrument thus cooling the instrument and potentially the tissue adjacent to or abutting the targeted tissue. These systems generally employ a mechanism whereby the cooling fluid flows into a hub through a chamber. The fluid flows into a lumen path and down to the tip of the instrument, providing cooling along the shaft of the instrument. The fluid returns to another chamber in the hub and exits through a fluid egress channel.

The chambers, lumen paths, hub and seals of a hub are constructed in a manner requiring an adhesive, or glue, to maintain their integrity during stress. It is known that during use, pressure is created in the interior of the hub causing stress at the seal locations, in the chambers and at the connection points. However, adhesives or glue can be inconsistent and unreliable. Not only can adhesives breakdown under stress or heat conditions, but the application of the adhesives during the manufacturing process can be inconsistent. These breakdowns and inconsistencies can lead to malfunctions and inadequate cooling.

SUMMARY OF THE INVENTION

According to one embodiment of the present invention, there is provided an electro surgical hub. The hub is adapted to provide cooling fluid to probes that extend from a distal end of the hub. The probes are utilized by medical personnel to ablate tissue in a body.

Two chambers and a dual path lumen provide cooling liquid to a probe. Cooling fluid enters into the hub and is channeled from a first chamber through a lumen path which transports the fluid to the probes for cooling purposes. An

insert defines the boundary for the first chamber and causes the cooling fluid to spin, thus reducing the presence of air bubbles. The insert is adapted to accommodate a first o-ring to form a seal between the first chamber and a second chamber. A connector connected to the probes which conducts power to the probe, is also adapted to accommodate a second o-ring to form a seal on the back side of the first chamber.

The cooling fluid returns through a second lumen path and enters a second chamber. A plug is adapted to accommodate a third o-ring to form a second seal on the second chamber. The plug has an annular ring utilized to center the plug in the hub and maintain the third o-ring in position during high stress conditions.

In general, the apparatus of the present invention is directed to a twin sealing chamber ablation hub constructed without glues or adhesives. The system offers a method of construction that improves reliability in the chamber seals. The apparatus includes a geometry whereby air bubbles which can cause hot spots on the ablation probe are substantially removed from the cooling liquid.

There is accordingly a need for an electrosurgical hub that provides consistency in manufactured result as well as reliability under stress conditions. There is a need for a hub that overcomes the breakdown of adhesives. There is also a need for a hub that allows for consistent manufacturing procedures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view of an embodiment of the invention showing twin chambers in a hub with inserts providing separation of the chambers;

FIG. **2** is an alternate view of an embodiment of the invention showing twin chambers in a hub with inserts providing separation of the chambers; and

FIG. **3** is a view of an insert of an embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In one embodiment of the invention, a twin chamber microwave ablation hub comprises a plurality of inserts and o-rings causing seals between the chambers. A first chamber provides fluidic connection to an input port and a second chamber provides fluidic connection to an exit port. A dual path lumen provides fluidic connection from the first chamber to the second chamber. The first and second chambers are adapted to minimize the presence of air bubbles in a cooling fluid as the fluid travels through the input port and the first chamber, through a first path in the lumen to the distal end of an ablation probe. The cooling fluid returns via a second path in the lumen to the second chamber and exits the hub via the exit port. The first path and second path are concentric.

The term "probe" is not limited to the present embodiment or depiction. Naturally, the efficacy of the present invention may be optimized by different types of devices intended to facilitate energy focalization in a body, such as electrodes, antennas or other suitable device. The term "probe" is used to include any device, mechanism or structure capable of being inserted into a body and allowing an energy source to be focalized for ablation or other medical treatment.

FIG. **1** is a view of an embodiment of the invention showing a hub **10** and probe **20**. Hub **10** comprises a first chamber **30**, a second chamber **40**, a first lumen path **50**, a second lumen path **60**, a first port **70** and a second port **72**. First port **70** fluidicly couples to first chamber **30**. First chamber **30** fluidicly couples to first lumen path **50**. First lumen path **50** extends along a substantial portion of the probe **20**. The second lumen path **60** extends around and along the first lumen path **50** and fluidicly couples with the second chamber **40**.

The first **30** and second **40** chambers are defined by inserts inside the hub **10**. A first insert **80** fits inside one end of hub **10**. In one embodiment, the first chamber **30** is at one end by the first insert toward the handle end of the hub **10**. The first insert **80** is positioned against stops **88**. Stops **88** provide a positioning stop on the interior walls **90** of the hub for the first insert **80**. The stops **88** provide a more precise positioning for the first insert **80** and eliminate placement guesswork. This allows for ease of insertion by providing a physical indicator of the proper insertion position.

The interior walls **90** of the hub **10** may be graduated so that they are of decreasing diameter from the handle end of the hub to the stops **88**. This also allows for ease of insertion as well as precision in placement. In an embodiment of the invention, the graduation of the interior walls ceases prior to the stop **88**, creating a zone where the interior wall **90** is flat. As discussed below, the flat zone in wall **90** allows for more reliable sealing of the first chamber **30**.

An o-ring **82** is positioned in space **83** of the insert first **80**. It is understood that the space **83** is a groove or other indentation in the first insert **80**. When the first insert **80** in inserted into the hub **10** to the proper depth, the o-ring **82** will contact the flat portion of the interior wall. The o-ring **82** provides for continued sealing in the event of slight movement or slight inaccuracies in the manufacture of the first insert **80** or hub **10**. The flat area allows for continued contact of the o-ring **82** in the event of slight movement. The o-ring **82** provides a water-tight seal for the first chamber **30**. Accordingly, any cooling fluid will not flow around chamber **30** and past stops **88**.

The second chamber **40** is positioned distally of the first chamber **30**, toward the probe end of the hub **10**. As noted above, the first insert **80** is inserted inside the hub **10** to stops **88**. One end of the second chamber **40** is formed by the back side of the first insert **80**. The second chamber **40** is completed by second insert **95** opposite the first insert **80**. Insert **95** is inserted into the distal end of the hub **10** opposite the first insert **80**. In one embodiment, the interior walls of the hub **10** at the distal end are graduated so that they are of decreasing diameter from the end of hub **10** to the interior. The graduation of the interior walls ceases at the location where the o-ring **84** reside. This creates a flat zone which allows continued sealing in the event of slight movement or slight inaccuracies in the manufacture of the insert **95** or hub **10**. The graduation of the interior walls of hub **10** allow for ease of insertion of insert **95** as well as precision in placement.

The insert **95** comprises an end portion **96** adapted to provide a stopping mechanism. The end portion **96** acts to contact the end of hub **10**. End portion **96** abuts the hub **10** and provides for precision in placement. An o-ring **84** is positioned in the second insert **95** to contact the interior wall **90** when the second insert **95** is inserted into the hub **10**. The O-ring **84** is positioned in space **98** of the second insert **95**. The o-ring **84** provides a water-tight seal for the second chamber **40**. Accordingly, cooling fluid will not flow around chamber **40** or into the first chamber **30**. The second insert **95** is molded to hub **10** on the opposite end of the hub **10** from handle **100**. The molding maintains closure and sealing during high pressure conditions.

When the second insert **95** is inserted, a centered position in the hub is desired to help eliminate any leakage that may occur otherwise. An annular ring **120** is utilized to maintain a centered position of the second insert **95** and the o-ring **84** within the hub **10**. When the second insert **95** in inserted so that the end portion **96** abuts the hub **10**, the annular ring **120** contacts the interior wall **90** and disallows movement of the second insert **95**.

A third o-ring **86** is positioned in handle **100**. The third o-ring **86** provides a fluid seal on the back side of chamber **30**. The handle **100** in inserted into the end of the hub **10** opposing the position of insert **95**. In an embodiment, the handle **100** is molded to hub **10**. The handle **100** is adapted to abut or closely abut first insert **80**. The position of insert **80** is maintained by the handle **100** under high pressure conditions.

Handle **100** connects to the probe **20**. Box **110** disallows improper insertion of the handle **100** and ensures that the probe **20** is connected properly through the hub **10**. Box **110** protrudes away from the hub to disallow upside down insertion of the handle **100**. The probe **20** protrudes through the first **30** and second **40** chambers and first **80** and second **95** inserts.

FIG. **2** is a perspective view of an embodiment of the invention showing hub **210** and probe **220** extending from within the handle **299** out through the distal end of the hub **210**. The probe **220** connects within the handle **299** to a power source (not shown). Hub **210** comprises a first chamber **230**, a second chamber **240**, a first lumen path **250**, a second lumen path **260** and a first **270** and second **272** port. In an embodiment, the first **270** and second **272** ports are angled in relation to the axis of the hub **210** so that they are not perpendicular to the axis. The angle of the ports **270**, **272** forms an acute angle toward the proximal end of the hub **210**. The handle **299** forms a seal at the proximal end of the hub **210**.

A first insert **280** forms the first chamber **230** between the handle **299** and the first insert **280**. A second insert **295** forms the second chamber **240** between the first insert **280** and the second insert **295**. The first chamber **230** is sealed by an o-ring **282** on the distal end of the chamber **230** and an o-ring **286** on the proximal end of the chamber **230**. The second chamber **240** is sealed by o-ring **282** and an o-ring **284** on the distal end of the second chamber **240**. Each O-ring **282**, **284**, **286** resides in a groove, or other formation, formed to receive the o-ring in the first insert **280**, the second insert **295** and the handle **299**, respectively.

The first lumen path **250** forms a fluid passage allowing a cooling fluid to travel from the first chamber **230** along the probe **220** to the distal end of the probe **220**. The cooling fluid provides a cooling action along the length and tip (not shown) of the probe **220**. The second lumen path **260** provides a return passage for the cooling liquid and is fluidicly coupled to the second chamber **240**. The cooling liquid returns concentrically and outside the first lumen path **250** and empties into the second chamber **240**.

As noted above relating to FIGS. **1** and **2**, the first insert (**80** in FIGS. **1** and **280** in FIG. **2**) defines a boundary for the first chamber (**30** in FIGS. **1** and **230** in FIG. **2**) and causes the cooling fluid to spin and thus reduce the presence of air bubbles. FIG. **3** provides a detailed view of the first insert **280**. As noted above, the first insert **280** creates the first chamber (**230** FIG. **2**). The first insert **280** creates the chamber by using a seal **310** in the hub (**210** FIG. **2**). In an embodiment, the seal **310** is an o-ring which fits in a grooved portion **320**, or other formed recess, of the insert. The grooved portion **320** is adapted to accommodate the o-ring **310**.

Cooling fluid flows into the first chamber and fills the space within the first insert **280**. The geometry **325** on the insert **280** is concave and induces spin in the cooling fluid as it enters the first chamber. The vortex type action induced on the cooling fluid allows it to move around the probe as it moves down the first lumen path. The vortex action aids in the elimination of air bubbles which may cause overheating of the probe.

The first insert **280** comprises a plurality of legs **330**. In one embodiment, four legs **330** provide support for the first insert **280**. The legs **330** provide a mechanism to abut the handle (not shown in FIG. **3**) when the hub (not shown in FIG. **3**) is assembled. The legs **330** will push against the handle to force the insert **280** against the stops on the interior of the hub.

Referring again to FIG. **1**, regarding the operation of the invention. Cooling fluid flows into the first port **70** and fills the first chamber **30**. In one embodiment, the first chamber **30** is sized so that it fills with fluid relatively rapidly. The first insert **80** is shaped so that the fluid entering the first chamber **30** spins in a circular manner. The spinning of the fluid causes any residual air bubbles to be removed from the probe **20** and the walls of the first chamber **30**. Air bubbles are known in the art to cause over-heating of the probe **20** and lead to failure of the device. The o-ring **82** in the first insert **30** seals the chamber **30**, thus not allowing fluid to enter the second chamber **40**. It is understood by those skilled in the art that the first insert **30** provides sealing. The o-ring **82** provides an extra level of sealing to ensure integrity under pressure conditions.

The handle **100** has the O-ring **86** to create a seal on the back side of the first chamber **30**. It is understood by those skilled in the art that the handle **100** provides a level of sealing. The o-ring **86** provides an extra level of sealing to ensure integrity under pressure conditions. The cooling fluid flows out of chamber **30** and through the first lumen path **50**. The first lumen path **50** carries the cooling fluid to the proximal end of the probe **20** providing a cooling effect on the probe **20**. The cooling fluid returns to the hub **10** via the second lumen path **60**. The cooling fluid empties from the second lumen path **60** into the second chamber **40**. The second chamber is sealed by the o-ring **82** on one end which is positioned in the first insert **80** and the o-ring **84** which is positioned in the second insert **95**. It is understood by those skilled in the art that the second insert **95** provides a level of sealing. The o-ring **84** provides and extra level of sealing to ensure integrity under pressure conditions.

As the cooling fluid pressure increases in the hub **10**, the pressure will cause a separating force on the components within the hub **10**. This pressure will stress the position of the o-ring **82** in the first insert **80** and the o-ring **84** of the second insert **95**. An external geometry (not shown) positioned on the outside of the handle **100** will hold the handle **100** in place and resist movement of the inserts **80**, **95** and o-rings **82**, **84**.

Referring again to FIG. **2**, the microwave assembly is easily manufactured with the hub **210**, the first insert **280**, the second insert **295** and the handle **299**. The first insert **280** is inserted into the hub **210** until it abuts the stops **288** which are formed on the inside of the hub **210**. The o-ring **282** in the first insert provides a seal against the interior wall of hub **210**. In an embodiment, the wall of the hub **210** is graduated so that the circumference lessens toward the middle of the hub **210**. The graduation levels off and ceases as the wall nears the stop **288** to allow a location for the o-ring **282** to seal.

The interior lumen path **260** connects to the central hole **292** in the first insert **280**. The lumen paths **250**, **260** protrude through the end of the hub **210**. The second insert **295** is inserted over the lumen paths **250**, **260** and into the distal end of the hub **210**. O-ring **284** fits in a groove around the second insert **295** and forms a seal against the interior wall of the hub **210**. In one embodiment, the wall at the distal end of the hub **210** is also graduated so that the circumference lessens toward the middle of the hub **210**. The graduation levels off and ceases at a predetermined location which coincides with the position of the o-ring **284**. The second insert **295** is molded to the distal end of the hub **210** to provide stability during high pressure situations.

The handle **299** and the probes are inserted into the proximal end of the hub **210**. The probe **220** passes through the central holes in the inserts **280**, **295** and helps create and enforce the lumen paths **250**, **260**. In an embodiment, the handle **299** and probe **220** are pre-assembled to maintain a sound electrical connection. A lip portion **298** extends from the portion of the hub **210** opposite the ports **270**, **272**. The lip portion **298** allows the insertion of the handle **299** in only one way to assure proper insertion of the handle **299**. Insertion of the handle **299** provides sufficient pressure on the first insert **280** to maintain the insert **280** in the proper position. The stop **288** on the interior of the hub **210** wall prevents the first insert from being inserted too far inside the hub **210**. The handle **299** is then molded to the hub **210**.

It is understood that the above described embodiments are only illustrative of the application of the principles of the present disclosure. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present disclosure. The appended claims are intended to cover such modifications and arrangements.

What is claimed is:

1. A microwave assembly, comprising:

a hub, the hub comprising a proximal end, a distal end, an input port and an output port;

a first insert, the first insert having a center hole;

a second insert; the second insert having a center hole, and an end portion;

a first lumen path and a second lumen path concentrically oriented respective to each other and wherein the first lumen path is connected to the center hole of the first insert and the second lumen path is connected to the center hole of the second insert;

a handle, the handle functionally connected to a probe;

a first chamber defined by the first insert; and

a second chamber defined by the first insert and the second insert,

wherein the first insert is inserted into the proximal end of the hub, the proximal end of the hub being adapted to receive the first insert, the second insert is inserted into the distal end of the hub, the hub adapted to receive the second insert, the first lumen path and the second lumen path extend through the center hole of the second insert and through the distal end of the hub, and the handle is inserted into the proximal end of the hub in abutting engagement with the first insert.

2. The microwave assembly of claim **1**, wherein the hub further comprises an interior surface, and further comprising:

a first o-ring adapted to fit around the first insert creates a seal against the interior surface;

a second o-ring adapted to fit around the handle creates a seal against the interior surface; and

a third o-ring adapted to fit around the second insert creates a seal against the interior surface.

3. The microwave assembly of claim **2**, wherein the first chamber is between the first and second o-rings and the second chamber is between the first and third o-rings, wherein the first chamber is in fluid communication with the input port and the second chamber is in fluid communication with the output port.

4. The microwave assembly of claim **1**, wherein the second insert is attached to the distal end of the hub.

5. The microwave assembly of claim **1**, wherein the hub comprises a stop in the interior surface and the first insert abuts the stop.

6. The microwave assembly of claim **1**, wherein the hub comprises a stop in the interior surface and the first insert abuts the stop, and the interior surface circumferentially decreases from the proximal end to a predetermined location toward a center point of the hub and ceases to decrease circumferentially before the stop; and wherein the interior surface circumferentially decreases from the distal end to a predetermined location toward the center point of the hub and ceases to decrease circumferentially.

7. The microwave assembly of claim **1**, wherein the hub comprises a stop in the interior surface and the first insert abuts the stop, the interior surface circumferentially decreases from the proximal end to a predetermined location toward a center point of the hub and ceases to decrease circumferentially before the stop; and wherein the interior surface circumferentially decreases from the distal end to a predetermined location toward the center point of the hub and ceases to decrease circumferentially, and the hub further comprises an extension adapted to extend laterally away from the center of the hub and to engage the handle to disallow incorrect insertion of the handle into the proximal end of the hub.

8. A microwave assembly, comprising:

a hub, the hub comprising a proximal end, a distal end, an input port and an output port;

a first insert, the first insert having a center hole;

a second insert; the second insert having a center hole, and an end portion;

a first lumen path and a second lumen path concentrically oriented respective to each other and wherein the first lumen path is received in the center hole of the first insert and the second lumen path is received in the center hole of the second insert;

a first chamber defined by the first insert and the hub; and

a second chamber defined by the first insert, the second insert, and the hub.

9. The microwave assembly of claim 8, wherein the hub further comprises an interior surface, and further comprising:

a first o-ring adapted to fit around the first insert creates a seal against the interior surface;

a second o-ring adapted to fit around the handle creates a seal against the interior surface; and

a third o-ring adapted to fit around the second insert creates a seal against the interior surface.

10. The microwave assembly of claim 9, wherein the first chamber is between the first and second o-rings and the second chamber is between the first and third o-rings, wherein the first chamber is in fluid communication with the input port and the second chamber is in fluid communication with the output port.

11. The microwave assembly of claim 8, wherein the second insert is attached to the distal end of the hub.

12. The microwave assembly of claim 8, wherein the hub comprises a stop in the interior surface and the first insert abuts the stop.

13. The microwave assembly of claim 8, wherein the hub comprises a stop in the interior surface and the first insert abuts the stop, and the interior surface circumferentially decreases from the proximal end to a predetermined location toward a center point of the hub and ceases to decrease circumferentially before the stop; and wherein the interior surface circumferentially decreases from the distal end to a predetermined location toward the center point of the hub and ceases to decrease circumferentially.

14. The microwave assembly of claim 8, wherein the hub comprises a stop in the interior surface and the first insert abuts the stop, the interior surface circumferentially decreases from the proximal end to a predetermined location toward a center point of the hub and ceases to decrease circumferentially before the stop; and wherein the interior surface circumferentially decreases from the distal end to a predetermined location toward the center point of the hub and ceases to decrease circumferentially, and the hub further comprises an extension adapted to extend laterally away from the center of the hub and to engage the handle to disallow incorrect insertion of the handle into the proximal end of the hub.

* * * * *