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(54) **COOLED RING SEGMENT**

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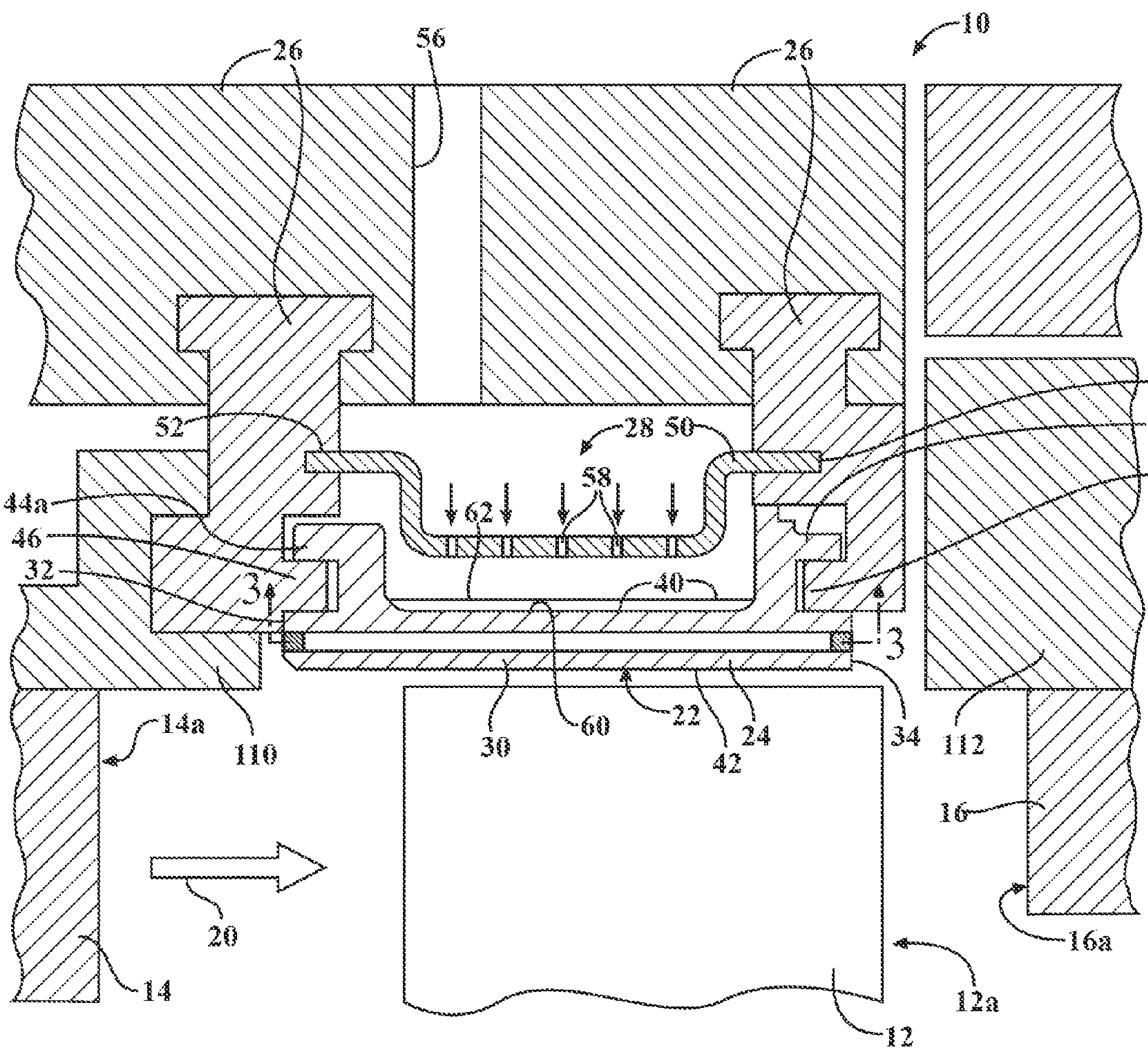
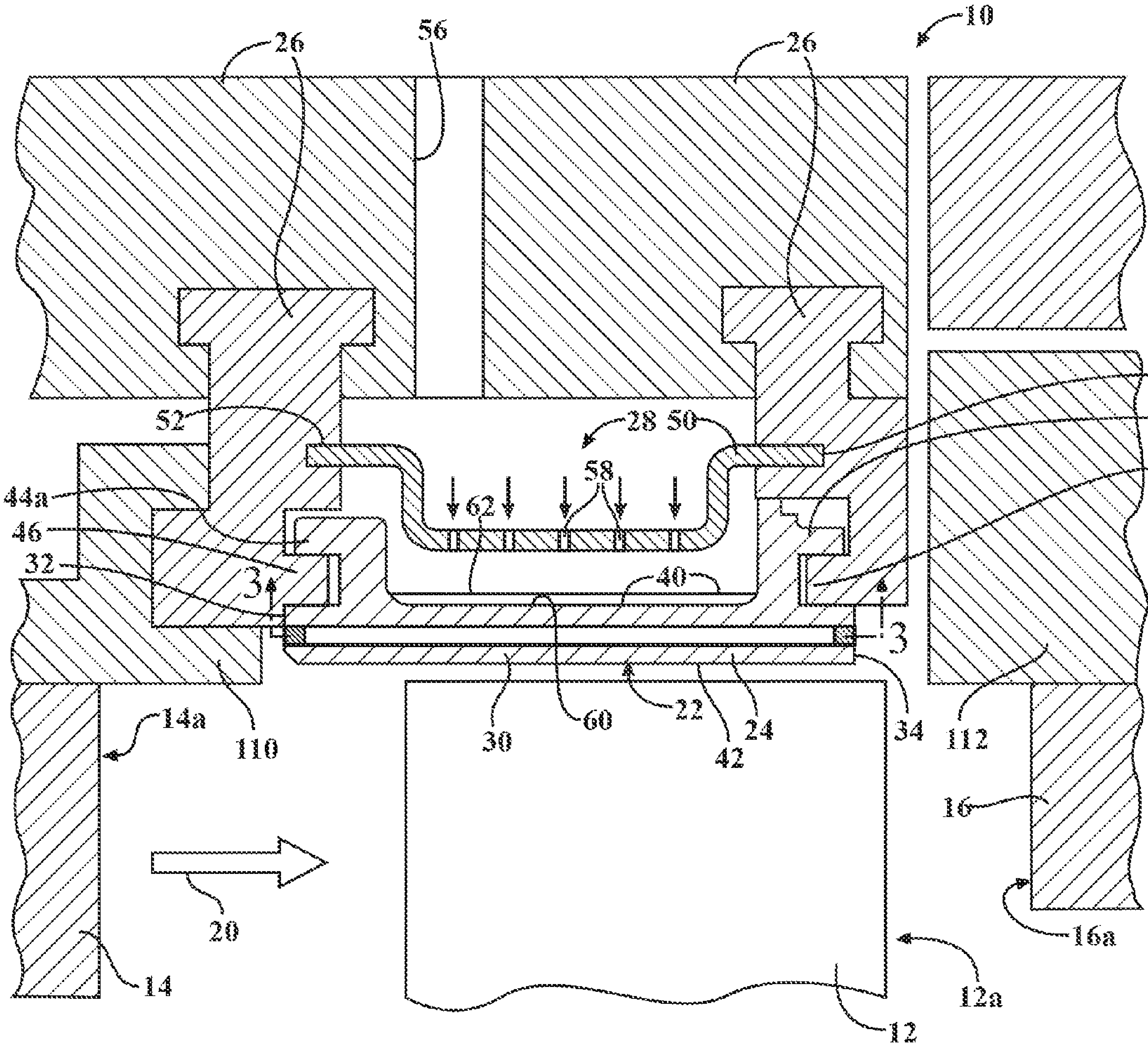
(57) **ABSTRACT**

A ring segment for a gas turbine engine includes a panel and a first mating edge cooling system. Cooling fluid is provided to an outer side of the panel and an inner side of the panel defines at least a portion of a hot gas flow path. A cooling system receives a portion of the cooling fluid provided to the outer side and includes at least one impingement chamber. Each impingement chamber includes at least one metering supply passage and at least one metering discharge passage. The metering supply passage(s) extends from the outer side of the panel to the impingement chamber. Cooling fluid impinges on a surface of the panel defining the impingement chamber as it flows therein through the metering supply passage(s). The metering discharge passage(s) extends from the impingement chamber to a first or second mating edge of the panel.





10
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28
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44b
58
48
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46
40
32
3
3
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42
30
112
14a
16
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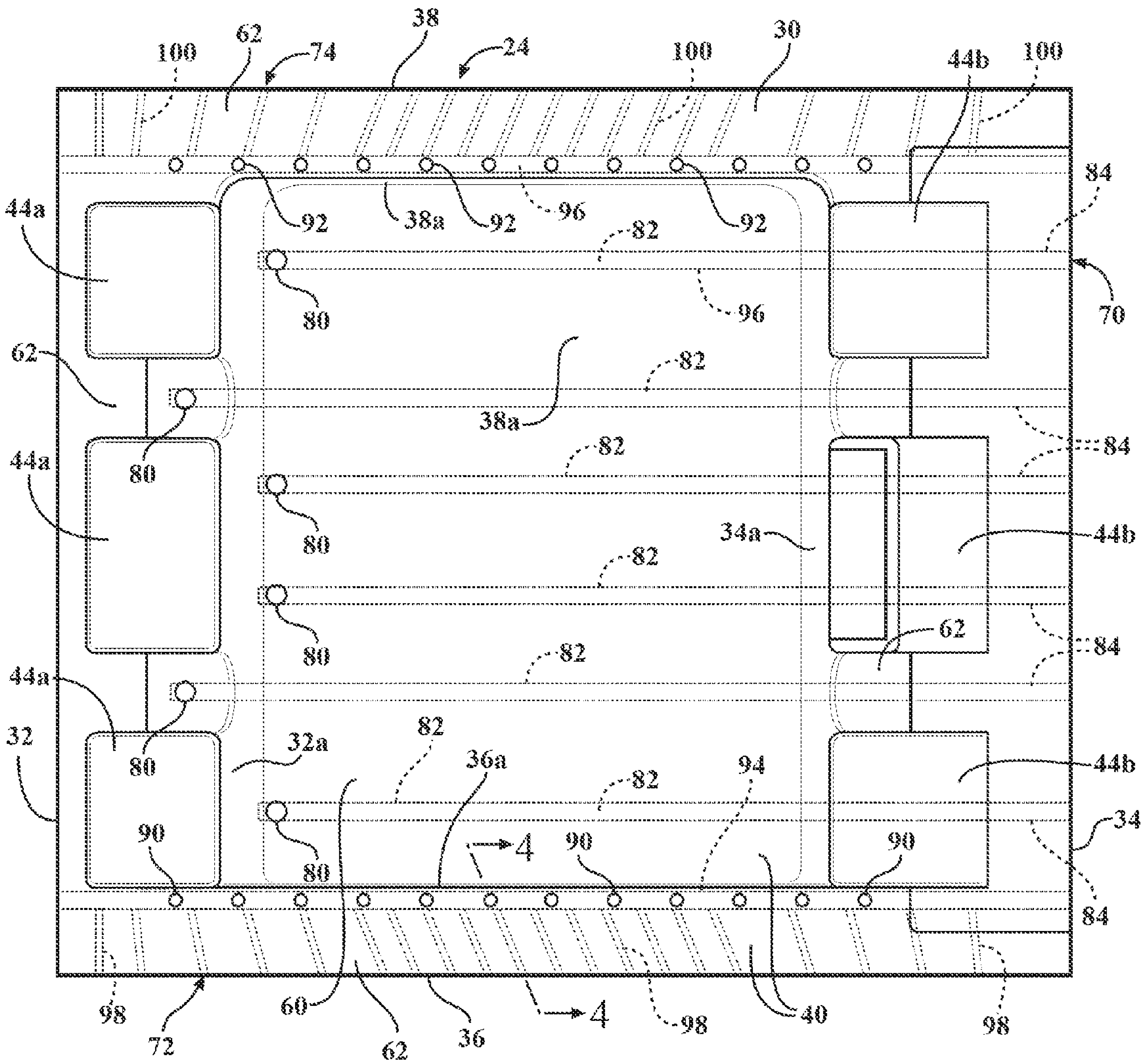
12a
12

FIG. 1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44a
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34a
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32a
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36a
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94
44b
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36
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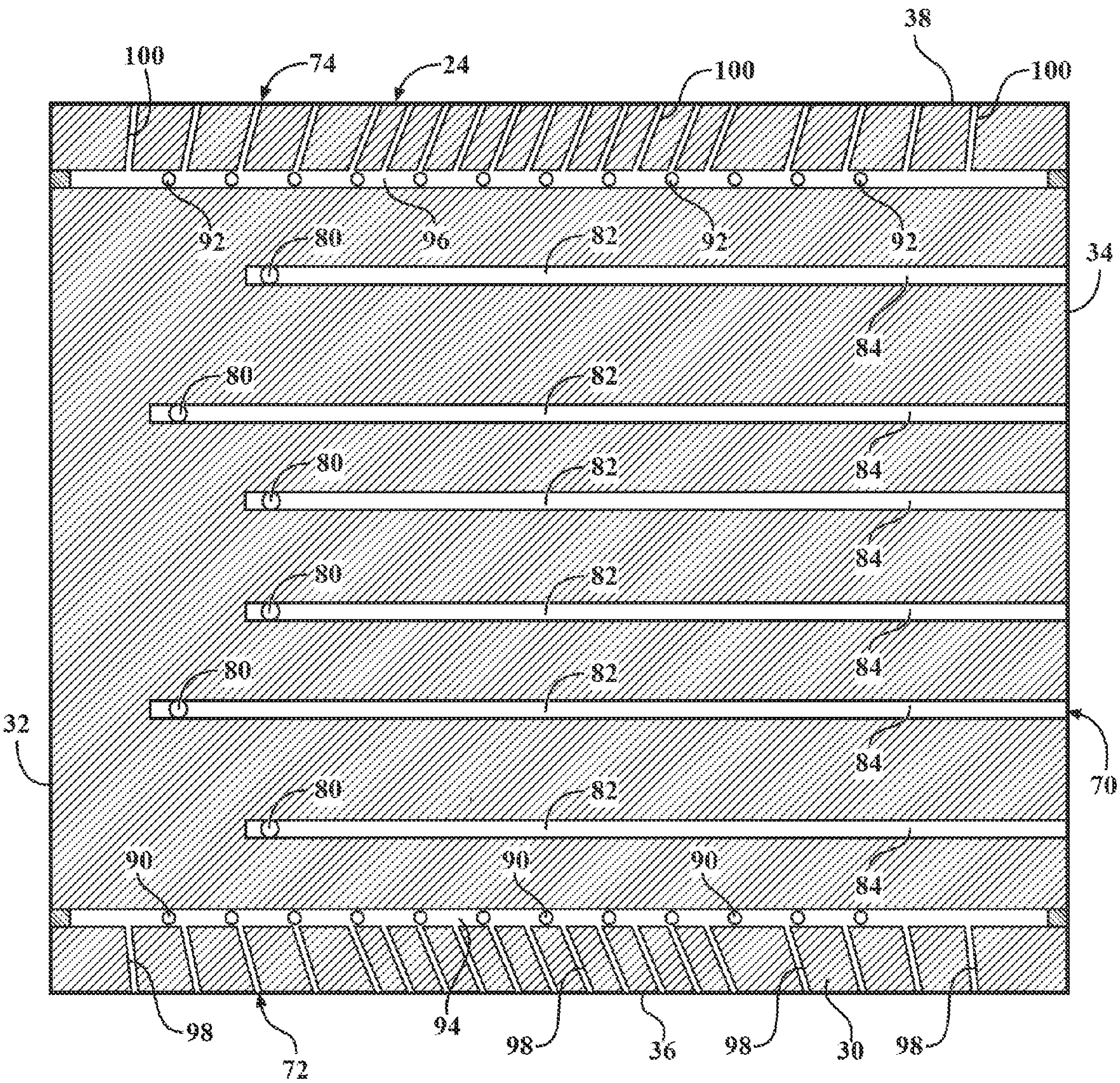
98

FIG. 2

FIG. 3


100
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32
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90
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94
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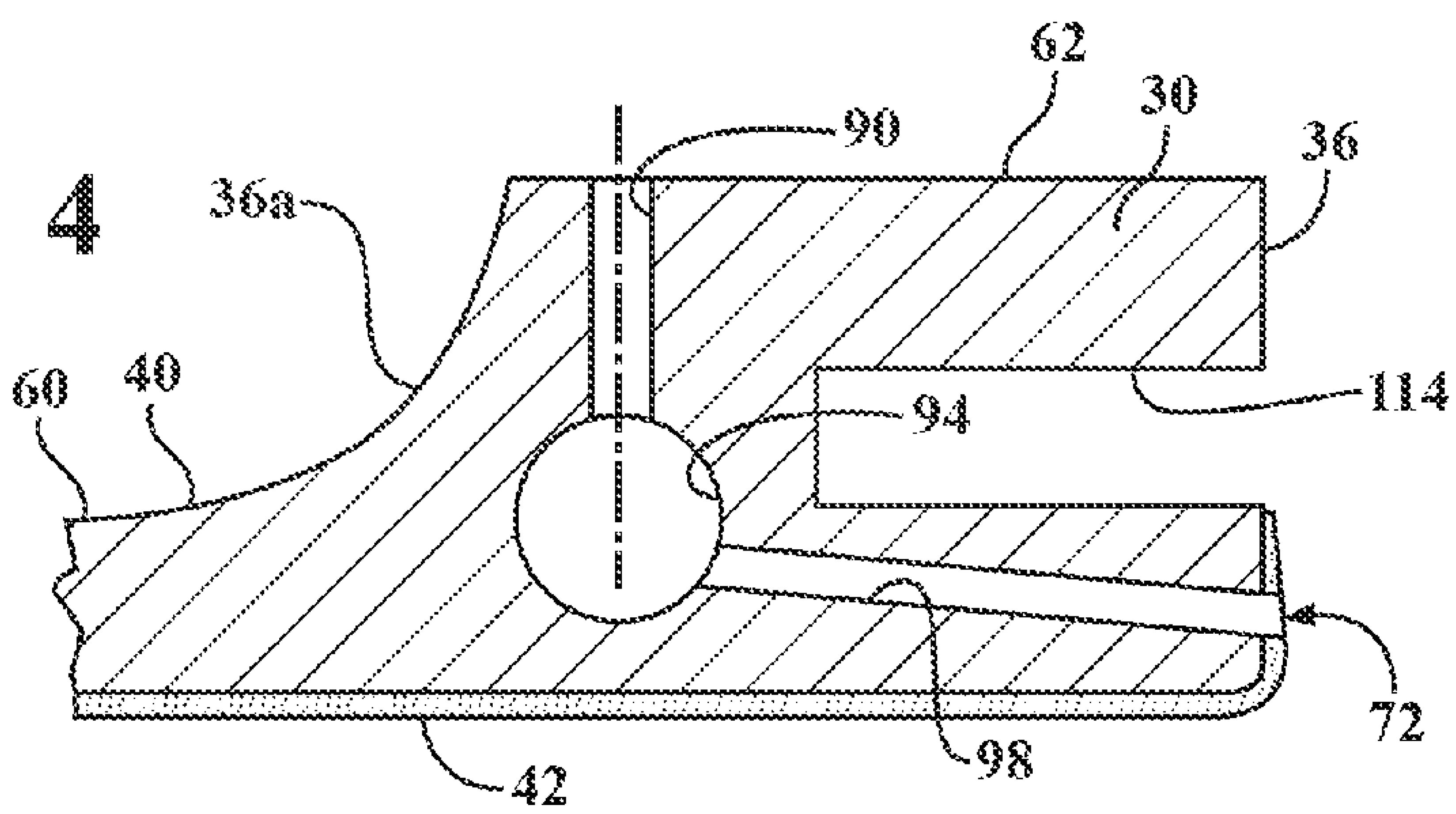
36
98
30
98

FIG. 4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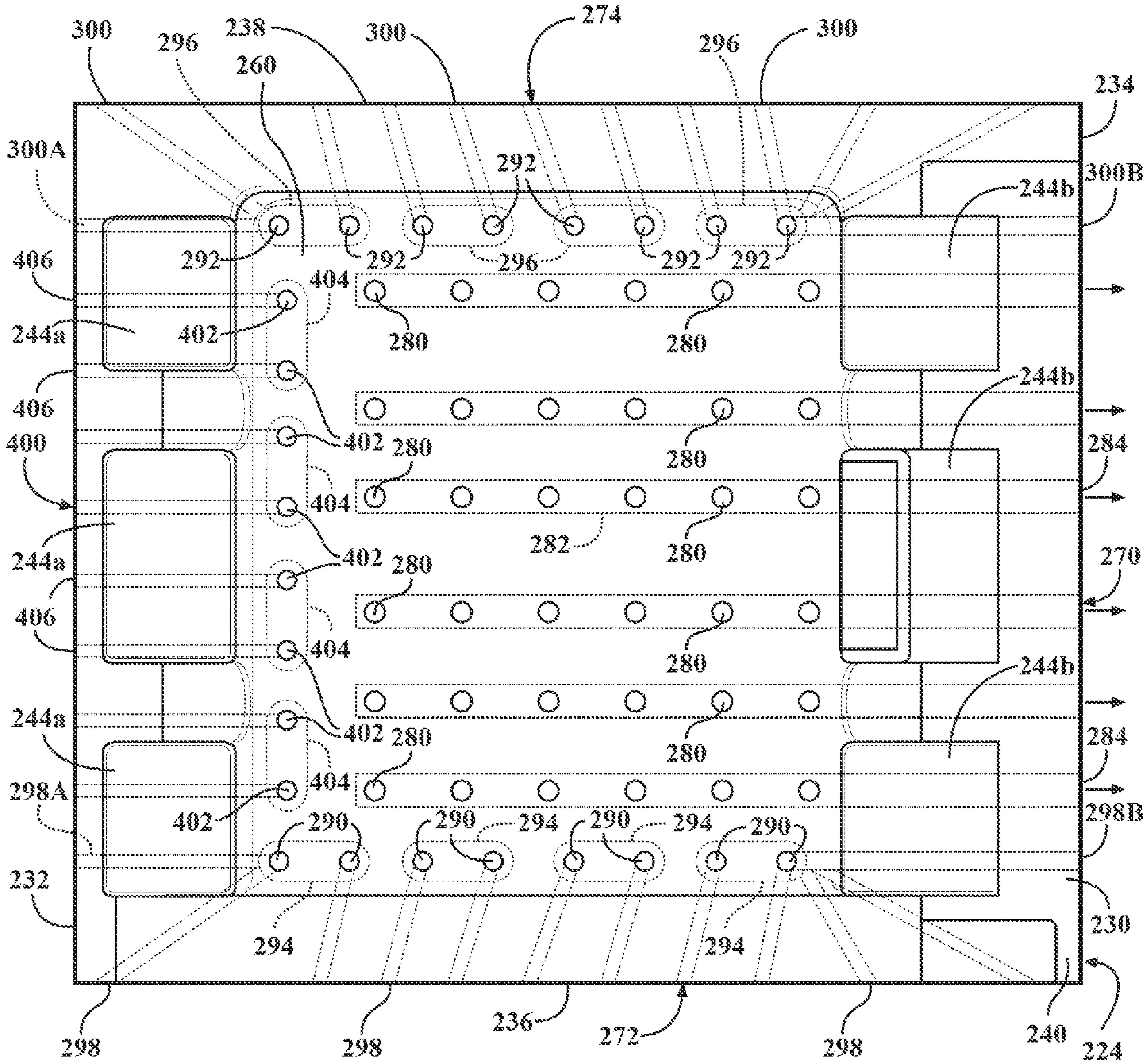
36
36a
114
60
40
94
98
72
42


300
296
238
260
300
274
296
300
234
300A
292
300B
244b
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244a
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244b
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284
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244a
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244b
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244a
280
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284
404
298A
402
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298B
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232
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236
272
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240
224

FIG. 5

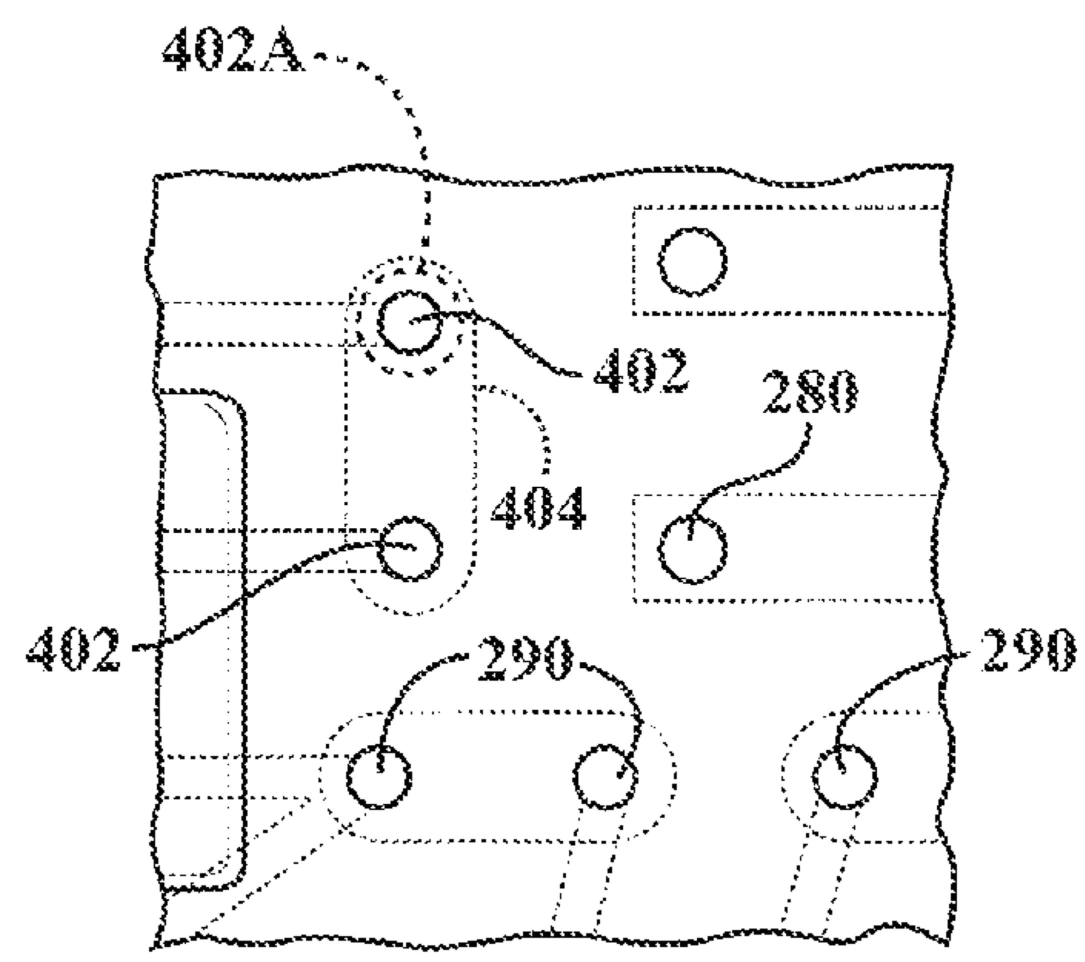
402A
402
280
404
402
290
290

FIG. 5A

COOLED RING SEGMENT

FIELD OF THE INVENTION

[0001] The present invention relates to ring segments for gas turbine engines and, more particularly, to cooling of ring segments in gas turbine engines.

BACKGROUND OF THE INVENTION

[0002] It is known that the maximum power output of a combustion turbine is achieved by heating the gas flowing through the combustion section to as high a temperature as is feasible. The hot gas, however, heats the various turbine components, such as the combustor and transition ducts, and vanes and ring segments, which it passes when flowing through the turbine section. One aspect limiting the ability to increase the combustion firing temperature is the ability of the turbine components to withstand increased temperatures. Consequently, various cooling methods have been developed to cool turbine hot parts.

[0003] In the case of ring segments, ring segments typically may include an impingement tube, also known as an impingement plate, associated with the ring segment and defining a plenum between the impingement tube and the ring segment. The impingement tube may include holes for passage of cooling fluid into the plenum, wherein cooling fluid passing through the holes in the impingement tube may impinge on the outer side of the ring segment to provide impingement cooling to the ring segment. In addition, further cooling structure, such as internal cooling passages, may be formed in the ring segment to facilitate cooling thereof.

SUMMARY OF THE INVENTION

[0004] In accordance with an aspect of the invention, a ring segment is provided for a gas turbine engine. The ring segment comprises a panel and a first mating edge cooling system. The panel includes a leading edge, a trailing edge, a first mating edge, a second mating edge, an outer side, and an inner side. Cooling fluid is provided to the outer side of the panel and the inner side of the panel defines at least a portion of a hot gas flow path through the gas turbine engine. The first mating edge cooling system is within the panel and receives a portion of the cooling fluid provided to the outer side of the panel for cooling the panel at one of the first and second mating edges. The first mating edge cooling system comprises at least one first mating edge impingement chamber. Each first mating edge impingement chamber includes at least one metering supply passage and at least one metering discharge passage. The at least one metering supply passage extends from the outer side of the panel to the first mating edge impingement chamber. Cooling fluid impinges on a surface of the panel defining the first mating edge impingement chamber as it flows into the first mating edge impingement chamber through the at least one metering supply passage. The at least one metering discharge passage extends from the first mating edge impingement chamber to the one of the first and second mating edges of the panel.

[0005] In accordance with another aspect of the invention, a ring segment is provided for a gas turbine engine. The ring segment comprises a panel, a central recessed portion, recess portion walls, and at least one impingement chamber. The panel includes side edges comprising a leading edge, a trailing edge, a first mating edge, and a second mating edge. The panel further includes an outer side and an inner side, wherein cooling fluid is provided to the outer side and the inner side defines at least a portion of a hot gas flow path through the gas turbine engine. The central recessed portion defines a recessed surface formed in the outer side of the panel and is surrounded by a rim portion comprising an unrecessed portion extending around an outer periphery of the recessed portion along each of the side edges. The recess portion walls define the outer periphery of the recessed portion. Each recess portion wall extends radially between the recessed surface and the unrecessed portion. The at least one impingement chamber is located in the panel and includes at least one metering supply passage extending from the outer side for passage of cooling fluid into the impingement chamber to impinge on and cool a surface of the impingement chamber and at least one metering discharge passage extending from the impingement chamber to one of the side edges for passage of cooling fluid from the impingement chamber to the one side edge.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed that the present invention will be better understood from the following description in conjunction with the accompanying Drawing Figures, in which like reference numerals identify like elements, and wherein:

[0007] FIG. **1** is cross sectional view of a portion of a turbine section of a gas turbine engine, including a ring segment constructed in accordance with the present invention;

[0008] FIG. **2** is a top plan view of the ring segment illustrated in FIG. **1**;

[0009] FIG. **3** is a cross sectional view taken along line **3-3** in FIG. **1**;

[0010] FIG. **4** is a cross sectional view taken along line **4-4** in FIG. **2**; and

[0011] FIG. **5** is a top plan view of a ring segment constructed in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] In the following detailed description of the preferred embodiment, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration, and not by way of limitation, a specific preferred embodiment in which the invention may be practiced. It is to be understood that other embodiments may be utilized and that changes may be made without departing from the spirit and scope of the present invention.

[0013] FIG. **1** illustrates in cross section a portion of a turbine section **10** of a gas turbine engine. Within the turbine section **10** are a series of rows of stationary vanes and rotating blades. In FIG. **1**, a single blade **12** forming a row **12*a*** of blades is illustrated. Also illustrated in FIG. **1** is part of an upstream vane **14** forming a row **14*a*** of upstream vanes, and part of a downstream vane **16** forming a row **16*a*** of downstream vanes. The blades **12** are coupled to a disc (not shown) of a rotor assembly. A hot working gas from a combustor (not shown) in the engine flows in a hot gas flow path **20** passing through the turbine section **10**. The working gas expands through the turbine **10** and causes the blades **12**, and therefore the rotor assembly, to rotate.

[0014] In accordance with an aspect of the invention, an outer seal structure **22** is provided about and adjacent the row

12*a* of blades. The seal structure **22** comprises a plurality of ring segments **24**, which, when positioned side by side in a circumferential direction, define the seal structure **22**. The seal structure **22** has a ring shape so as to extend circumferentially about its corresponding row **12***a* of blades. A corresponding one of the seal structures **22** may be provided about each row of blades provided in the turbine section **10**.

[0015] The seal structure **22** comprises an inner wall of a turbine housing in which the rotating blade rows are provided and defines sealing structure for preventing or limiting the working gas from passing through the inner wall and reaching other structure of the turbine housing, such as a blade ring carrier **26** and an associated annular cooling fluid plenum **28**. It is noted that the terms "inner", "outer", "radial", "axial", "circumferential", and the like, as used herein, are not intended to be limiting with regard to orientation of the elements recited for the present invention.

[0016] Referring to FIGS. **2** and **3**, a single one of the ring segments **24** of the seal structure **22** is shown. The ring segment **24** comprises a panel **30** including side edges comprising a leading edge **32**, a trailing edge **34**, a first mating edge **36**, and a second mating edge **38**. The panel **30** further includes an outer side **40** (FIGS. **1** and **2**) and an inner side **42** (FIG. **1**), wherein the inner side **42** defines a corresponding portion of the hot gas flow path **20**. The panel **30** defines a structural body for the ring segment **24**, and includes a plurality of front flanges or hook members **44***a* and a plurality of rear flanges or hook members **44***b*, see FIGS. **1** and **2**. The front and rear hook members **44***a*, **44***b* are rigidly attached to the panel **30**, and may be formed with the panel **30** as an integral casting, or may be formed separately and subsequently rigidly attached to the panel **30**. Moreover, if formed separately from the panel **30** the hook members **44***a*, **44***b* may be formed of the same material or a different material than the panel **30**. Each ring segment **24** is mounted within the turbine section **10** via the front hook members **44***a* engaging a corresponding structure **46** of the blade ring carrier **26**, and the rear hook members **44***b* engaging a corresponding structure **48** of the blade ring carrier **26**, as seen in FIG. **1**.

[0017] Referring to FIG. **1**, the blade ring carrier **26** defines, in cooperation with an impingement tube **50**, also known as an impingement plate, the annular cooling fluid plenum **28**, which defines a source of cooling fluid for the ring segment **24**, as is described further below. The impingement tube **50** is secured to the blade carrier ring **26** at fore and aft locations **52**, **54**, as shown in FIG. **1**. The cooling fluid plenum **28** receives cooling fluid through a channel **56** formed in the blade ring carrier **26** from a source of cooling fluid, such as bleed air from a compressor (not shown) of the gas turbine engine. As shown in FIG. **1**, the impingement tube **50** includes a plurality of impingement holes **58** therein. Cooling fluid in the cooling fluid plenum **28** flows through the impingement holes **58** in the impingement tube **50** and impinges on the outer side **40** of the panel **30** during operation, as will be discussed herein.

[0018] Referring to FIGS. **1** and **2**, the outer side **40** of the illustrated panel **30** is formed with an indented or central recessed portion **60** defining a recessed surface of the panel **30**. The outer side **40** of the panel **30** further comprises a rim portion **62** surrounding the central recessed portion **60**. The rim portion **62** comprises an unrecessed portion extending around a periphery of the central recessed portion **60** along each of the side edges, i.e., the leading edge **32**, the trailing edge **34**, the first mating edge **36**, and the second mating edge **38**. Recess portion walls **32***a*, **34***a*, **36***a*, **38***a* (see FIG. **2**) extend at least partially in the radial direction between the recessed surface and the unrecessed portion and define the outer periphery of the central recessed portion **60**. It should be noted that the outer side **40** of the panel **30** need not comprise the central recessed portion **60** and the rim portion **62** and may comprise, for example, an area that is substantially entirely planar.

[0019] Each ring segment **24** of the seal structure **22** comprises a plurality of cooling systems, each of which will be discussed below. However, the cooling systems of only a single one of the ring segments **24** will be described herein, it being understood that the cooling systems of the remaining ring segments **24** are substantially the same as the cooling systems of the ring segment **24** described.

[0020] Referring to FIGS. **2** and **3**, the ring segment **24** according to this embodiment includes a trailing edge cooling system **70**, a first mating edge cooling system **72**, and a second mating edge cooling system **74** formed within the panel **30**. It is noted that the ring segment **24** could comprise additional or fewer cooling systems without departing from the spirit and scope of the invention.

[0021] The trailing edge cooling system **70** comprises a plurality of metering supply passages **80** formed in the central recessed portion **60** of the panel **30**. The metering supply passages **80** of the trailing edge cooling system **70** in the embodiment shown are located toward the leading edge **32** of the panel **30** but could be located elsewhere. The metering supply passages **80** direct a portion of the cooling fluid provided from the cooling fluid plenum **28** to the outer side **40** of the panel **30** into impingement chambers **82** of the trailing edge cooling system **70**. As the cooling fluid enters the trailing edge impingement chambers **82** through the metering supply passages **80** it impinges on a surface of the panel **30** that defines the corresponding impingement chamber **82**. Sizing of diameters of the trailing edge metering supply passages **80** will be discussed below. While six circumferentially spaced apart trailing edge impingement chambers **82** are illustrated in FIGS. **2** and **3**, additional or fewer trailing edge impingement chambers **82** could be provided for the trailing edge cooling system **70**.

[0022] As shown in FIGS. **2** and **3**, the trailing edge impingement chambers **82** comprise an elongated axial dimension extending parallel to the first and second mating edges **36**, **38**. The axial dimension of the impingement chambers **82** is substantially greater than a circumferential width dimension of the impingement chambers **82** extending generally perpendicular to the first and second mating edges **36**, **38**.

[0023] The trailing edge impingement chambers **82** are each associated with a corresponding discharge passage **84** of the trailing edge cooling system **70**. The trailing edge discharge passages **84** extend from the respective trailing edge impingement chambers **82** to the trailing edge **34** of the panel **30** for discharging cooling fluid from the trailing edge impingement chambers **82**.

[0024] As shown in FIGS. **2** and **3**, the first and second mating edge cooling systems **72**, **74** each comprise a plurality of metering supply passages **90**, **92** formed in the rim portion **62** of the panel **30**. The metering supply passages **90** of the first mating edge cooling system **72** in the embodiment shown are located toward the first mating edge **36** of the panel **30**, see also FIG. **4**. The first mating edge metering supply passages **90** direct a portion of the cooling fluid provided from the cooling fluid plenum **28** to the outer side **40** of the panel **30**

into a single impingement chamber **94** of the first mating edge cooling system **72**. The metering supply passages **92** of the second mating edge cooling system **74** in the embodiment shown are located toward the second mating edge **38** of the panel **30**. The second mating edge metering supply passages **92** direct a portion of the cooling fluid provided from the cooling fluid plenum **28** to the outer side **40** of the panel **30** into a single impingement chamber **96** of the second mating edge cooling system **74**. Sizing of diameters of the first and second mating edge metering supply passages **90**, **92** will be discussed below.

[0025] As the cooling fluid enters the first and second mating edge impingement chambers **94**, **96** through the respective metering supply passages **90**, **92** it impinges on surfaces of the panel **30** that define the respective first and second mating edge impingement chambers **94**, **96**. Due to the location and spacing of the metering supply passages **90**, **92**, impingement cooling is provided across a substantial area of the panel **30** near the respective first and second mating edges **36**, **38** of the panel **30**. While the first and second mating edge impingement chambers **94**, **96** are illustrated in FIGS. **2** and **3** as comprising single chambers, additional first and second mating edge impingement chambers **94**, **96** could be provided, e.g., as shown in the embodiment illustrated in FIG. **5** to be discussed below.

[0026] As shown in FIGS. **2** and **3**, the first and second mating edge impingement chambers **94**, **96** comprise elongated axial dimensions extending parallel to the first and second mating edges **36**, **38**. The axial dimensions of the first and second mating edge impingement chambers **94**, **96** are substantially greater than circumferential width dimensions of the first and second mating edge impingement chambers **94**, **96** extending generally perpendicular to the first and second mating edges **36**, **38**.

[0027] It is noted that the trailing edge impingement chambers **82** and the first and second mating edge impingement chambers **94**, **96** are not in fluid communication with one another, as illustrated in FIGS. **2** and **3**. This is to promote desired amounts of cooling fluid to be provided to the respective cooling systems **70**, **72**, **74**, as will be discussed herein. It is further noted that the trailing edge impingement chambers **82** (and the trailing edge discharge passages **84**) and the first and second mating edge impingement chambers **94**, **96** can be EDM drilled into the panel **30** to facilitate an advantageous manufacture of the ring segment **24**. Still further, if it is desirable that cooling fluid not be able to escape out of the ends of the first and second mating edge impingement chambers **94**, **96** these ends can be sealed closed, e.g., by a suitable weld plugging procedure.

[0028] The first and second mating edge impingement chambers **94**, **96** are each associated with a plurality of corresponding metering discharge passages **98**, **100**. The metering discharge passages **98**, **100** extend from the respective first and second mating edge impingement chambers **94**, **96** to the corresponding mating edges **36**, **38** of the panel **30** for discharging cooling fluid from the first and second mating edge impingement chambers **94**, **96**. As illustrated in FIGS. **2** and **3**, the metering discharge passages **98**, **100** may be angled toward the trailing edge **34** of the panel **30** to promote a flow of cooling fluid discharged from the metering discharge passages **98**, **100** in a downstream direction, i.e., in the direction of the hot working gases passing through the hot gas flow path **20**. Further, as illustrated in FIG. **4**, the metering discharge passages **98**, **100** may be angled slightly radially inwardly to discourage hot gas from flowing radially outwardly, i.e., by pushing the hot gas radially inwardly.

[0029] The panel **30** may include circumferential seal slots (not shown) along the leading and trailing edges **32**, **34** for engaging circumferential seals (not shown) extending between the leading and trailing edges **32**, **34** and respective edges of adjacent vane platforms **110**, **112**, see FIG. **1**. The panel **30** may also include axial slots **114** (see FIG. **4**) for engaging axial seals (not shown) extending to edges of adjacent ring segments (not shown).

[0030] During operation of the engine, cooling fluid may be supplied to the cooling fluid plenum **28** via the channel **56** formed in the blade ring carrier **26**. The cooling fluid in the cooling fluid plenum **28** flows through the impingement holes **58** in the impingement tube **50** where the cooling fluid impinges on the outer side **40** of the panel **30** to provide impingement cooling to the outer side **40** of the panel **30**. Portions of this cooling fluid pass into the metering supply passages **80**, **90**, **92** of the trailing edge cooling system **70** and the first and second mating edge cooling system **72**, **74**.

[0031] The portion of the cooling fluid passing into the metering supply passages **80** of the trailing edge cooling system **70** impinges on the respective portions of the panel **30** that define the trailing edge impingement chambers **82**. Thereafter, this portion of the cooling fluid provides convective cooling to the panel **30** as it flows axially downstream through the trailing edge impingement chambers **82**. The cooling fluid then exits the panel **30** through the trailing edge discharge passages **84**. Upon exiting the trailing edge discharge passages **84**, this portion of the cooling fluid may provide impingement cooling for the adjacent downstream vane platform **112** and then may be mixed with the hot working gas flowing through the hot gas flow path **20**.

[0032] The portions of the cooling fluid passing into the metering supply passages **90**, **92** of the first and second mating edge cooling system **72**, **74** impinge on the respective portions of the panel **30** that define the first and second mating edge impingement chambers **94**, **96**. Thereafter, these portions of the cooling fluid exit the panel **30** through the respective first and second mating edge discharge passages **98**, **100**. These portions of the cooling fluid flow provide convective cooling to the panel **30** as they flow within the first and second mating edge impingement chambers **94**, **96** and the first and second mating edge discharge passages **98**, **100**. Upon exiting the first and second mating edge discharge passages **98**, **100**, these portions of the cooling fluid may provide impingement cooling for the respective adjacent ring segments and then may provide a cooling air barrier to discourage hot working gases from flowing radially outwardly before being mixed with the hot working gas flowing through the hot gas flow path **20**.

[0033] It is believed that the present configuration for the ring segment **24** provides an efficient cooling of the panel **30** via the impingement and convective cooling provided by the cooling fluid, and that the efficient cooling of the ring segment **24** may result in a lower cooling fluid requirement than prior art ring segments. Hence, enhanced cooling may be provided within the ring segment **24** while minimizing the volume of cooling fluid discharged from the ring segment **24** into the hot working gas, with an associated improvement in engine efficiency. Further, the distributed cooling provided to the panel **30** may improve the uniformity of temperature distribution across the ring segment **24**, with an associated reduction in the metal temperature and reduction in thermal stress, resulting in an improved or extended life of the ring segment **24**.

[0034] Further, the diameters of the metering supply passages **80**, **90**, **92** of the trailing edge cooling system **70** and the first and second mating edge cooling systems **72**, **74** may be configured as to allow desired amounts of cooling fluid into the respective cooling systems **70**, **72**, **74**. For example, it may be desirable to size the first and second mating edge metering supply passages **90**, **92** relative to the trailing edge metering supply passages **80** such that adequate cooling fluid is provided into each of the cooling systems **70**, **72**, **74**. Variables that may be considered are, for example, a pressure gradient that exists between the trailing edge **34** and the first and second mating edges **36**, **38**, and/or the number of metering supply passages **80**, **90**, **92** that are provided for the associated cooling system **70**, **72**, **74**. For example, since the pressure at the trailing edge **34** is lower than pressures at the first and second mating edges **36**, **38** during operation, larger first and second mating edge metering supply passages **90**, **92** may be desirable. However, if the number of first and second mating edge metering supply passages **90**, **92** is greater than the number of trailing edge metering supply passages **80**, larger trailing edge metering supply passages **80** may be desirable. Moreover, it may be desirable that ones of the first and second mating edge metering supply passages **90**, **92** closer to the leading edge **32** of the panel **30** be larger than ones of the first and second mating edge metering supply passages **90**, **92** closer to the trailing edge **34**. This could be due to a pressure gradient that exists between the leading edge **32** and the trailing edge **34** and/or a larger need for cooling fluid near the leading edge **32**, i.e., due to higher working gas temperatures at the leading edge **32**.

[0035] Moreover, as the cooling fluid associated with the first and second mating edge cooling systems **72**, **74** is metered twice, i.e., a first time at the metering supply passages **90**, **92** and a second time at the metering discharge passages **98**, **100**, amounts of cooling fluid provided to the first and second mating edge cooling systems **72**, **74** are believed to be more accurately controlled.

[0036] Referring now to FIG. **5**, a ring segment **224** according to another embodiment of the invention is illustrated. In this embodiment, structure similar to that described above with reference to FIGS. **1-4** includes the same reference number increased by 200. The ring segment **224** forms part of a seal structure in a turbine section of a turbine engine, as discussed above with reference to FIG. **1**.

[0037] The ring segment **224** includes a panel **230** having side edges including a leading edge **232**, a trailing edge **234**, a first mating edge **236**, and a second mating edge **238**. The panel **230** further includes an outer side **240** and an inner side (not shown in this embodiment), wherein the inner side defines a corresponding portion of a hot gas flow path as discussed above. The panel **230** defines a structural body for the ring segment **224**, and includes a plurality of front flanges or hook members **244*a*** and a plurality of rear flanges or hook members **244*b*** for mounting the ring segment **224** to a blade ring carrier (not shown in this embodiment) as discussed above.

[0038] In this embodiment, the ring segment **224** includes a trailing edge cooling system **270**, a first mating edge cooling system **272**, a second mating edge cooling system **274**, and a leading edge cooling system **400** formed within the panel **230**.

[0039] The trailing edge cooling system **270** comprises a plurality of metering supply passages **280** formed in a central recessed portion **260** of the panel **230**. The metering supply passages **280** of the trailing edge cooling system **270** direct a portion of cooling fluid provided from a cooling fluid plenum (not shown in this embodiment) to the outer side **240** of the panel **230** into impingement chambers **282** of the trailing edge cooling system **270**. As the cooling fluid enters the trailing edge impingement chambers **282** from the metering supply passages **280** it impinges on a surface of the panel **230** that defines the corresponding impingement chamber **282**. As shown in FIG. **5**, each impingement chamber **282** of the trailing edge cooling system **270** according to this embodiment includes a plurality of metering supply passages **280**. Hence, the cooling fluid flowing through the impingement chambers **282** is replenished by cooling fluid along an axial length of the impingement chambers **282**. Thus, although the cooling fluid is heated as it flows along the length of the impingement chambers **282**, it does not experience overheating in that the impingement cooling fluid is supplied to the impingement chambers **282** at regular intervals to ensure cool fluid is available for convective cooling along the length of the impingement chambers **282**.

[0040] As shown in FIG. **5**, the trailing edge impingement chambers **282** comprise an elongated axial dimension extending parallel to the first and second mating edges **236**, **238**. The axial dimension of the impingement chambers **282** is substantially greater than a circumferential width dimension of the impingement chambers **282** extending generally perpendicular to the first and second mating edges **236**, **238**.

[0041] The trailing edge impingement chambers **282** are each associated with a corresponding discharge passage **284** of the trailing edge cooling system **270**. The trailing edge discharge passages **284** extend from the respective trailing edge impingement chambers **282** to the trailing edge **234** of the panel **230** for discharging cooling fluid from the trailing edge impingement chambers **282**.

[0042] The first and second mating edge cooling systems **272**, **274** each comprise a plurality of metering supply passages **290**, **292** formed in the central recessed portion **260** of the panel **230** in this embodiment. The metering supply passages **290** of the first mating edge cooling system **272** in the embodiment shown are located toward the first mating edge **236** of the panel **230** and direct a portion of the cooling fluid provided from the cooling fluid plenum to the outer side **240** of the panel **230** into a plurality of impingement chambers **294** of the first mating edge cooling system **272**. The metering supply passages **292** of the second mating edge cooling system **274** in the embodiment shown are located toward the second mating edge **238** of the panel **230** and direct a portion of the cooling fluid provided from the cooling fluid plenum to the outer side **240** of the panel **230** into a plurality of impingement chambers **296** of the second mating edge cooling system **274**.

[0043] As the cooling fluid enters the first and second mating edge impingement chambers **294**, **296** through the metering supply passages **290**, **292** it impinges on respective surfaces of the panel **230** that define the corresponding first and second mating edge impingement chambers **294**, **296**. The metering supply passages **290**, **292** provide impingement cooling fluid across areas of the panel **230** near the respective first and second mating edges **236**, **238** of the panel **230**. While the first and second mating edge impingement chambers **294**, **296** are illustrated in FIG. **5** as comprising a plurality of individual chambers, additional or fewer first and second mating edge impingement chambers **294**, **296** could be provided.

[0044] The first and second mating edge impingement chambers **294**, **296** are each associated with a plurality of corresponding metering discharge passages **298**, **300**. The metering discharge passages **298**, **300** extend from the first and second mating edge impingement chambers **294**, **296** to the respective mating edges **236**, **238** of the panel **230** for discharging cooling fluid from the first and second mating edge impingement chambers **294**, **296**. As illustrated in FIG. **5**, at least one of the metering discharge passages **298**A, **300**A of the axially foremost mating edge impingement chambers **294**, **296** may be angled toward the leading edge **232** of the panel **230** to provide cooling fluid to the leading edge **232**. Further illustrated in FIG. **5**, at least one of the metering discharge passages **298**B, **300**B of the axially aftmost mating edge impingement chambers **294**, **296** may be angled toward the trailing edge **234** of the panel **230** to provide cooling fluid to the trailing edge **234**. Although the first and second mating edge impingement chambers **294**, **296** in the embodiment shown in FIG. **5** each include two or more metering discharge passages **298**, **300**, additional or fewer metering discharge passages **298**, **300** could be provided for each first and second mating edge impingement chamber **294**, **296**.

[0045] The leading edge cooling system **400** comprises a plurality of metering supply passages **402** formed in the central recessed portion **260** of the panel **230**. The metering supply passages **402** of the leading edge cooling system **400** in the embodiment shown are located toward the leading edge **232** of the panel **230** and direct a portion of the cooling fluid provided from the cooling fluid plenum to the outer side **240** of the panel **230** into a plurality of impingement chambers **404** of the leading edge cooling system **400**. As the cooling fluid enters the leading edge impingement chambers **404** through the respective metering supply passages **402** it impinges on respective surfaces of the panel **230** that define the corresponding leading edge impingement chambers **404** such that the metering supply passages **402** provide impingement cooling fluid across an area of the panel **230** near the leading edge **232** of the panel **230**. While the leading edge impingement chambers **404** are illustrated in FIG. **5** as comprising a plurality of individual chambers, additional or fewer leading edge impingement chambers **404** could be provided.

[0046] The leading edge impingement chambers **404** are each associated with a plurality of corresponding metering discharge passages **406**. The metering discharge passages **406** extend from the leading edge impingement chambers **404** to the leading edge **232** of the panel **230** for discharging cooling fluid from the leading edge impingement chambers **404**.

[0047] It is noted that the trailing edge impingement chambers **282**, the first and second mating edge impingement chambers **294**, **296**, and the leading edge impingement chambers **404** are not in fluid communication with one another, as illustrated in FIG. **5**. This is to promote desired amounts of cooling fluid to be provided to the respective cooling systems **270**, **272**, **274**, **400**. Further, diameters of the metering supply passages **280**, **290**, **292**, **402** of the respective cooling systems **270**, **272**, **274**, **400** can be sized to provide desired amounts of cooling fluid into the respective impingement chambers **282**, **294**, **296**, **404**. As one example, it may be desirable that diameters of the leading edge metering supply passages **402** be larger than diameters of the trailing edge metering supply passages **280** due to the pressure gradient that exists between the leading edge **232** and the trailing edge **234** of the panel **230**.

[0048] It is further noted that the trailing edge impingement chambers **282** (and the trailing edge discharge passages **284**) and the leading edge discharge passages **406** can be EDM drilled into the panel **230** to facilitate an advantageous manufacture of the ring segment **224**.

[0049] While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

1. A ring segment for a gas turbine engine comprising:

a panel having a leading edge, a trailing edge, a first mating edge, a second mating edge, an outer side, and an inner side, wherein cooling fluid is provided to said outer side and said inner side defines at least a portion of a hot gas flow path through the gas turbine engine;

a first mating edge cooling system within said panel that receives a portion of the cooling fluid provided to said outer side of said panel for cooling said panel at one of said first and second mating edges, said first mating edge cooling system comprising at least one first mating edge impingement chamber, each first mating edge impingement chamber including:

at least one metering supply passage extending from said outer side of said panel to said first mating edge impingement chamber, wherein cooling fluid impinges on a surface of said panel defining said first mating edge impingement chamber as it flows into said first mating edge impingement chamber through said at least one metering supply passage; and

at least one metering discharge passage that extends from said first mating edge impingement chamber to said one of said first and second mating edges of said panel.

2. The ring segment of claim **1**, further comprising a second mating edge cooling system within said panel that receives a portion of the cooling fluid provided to said outer side of said panel for cooling said panel at the other of said first and second mating edges, said second mating edge cooling system comprising at least one second mating edge impingement chamber, each second mating edge impingement chamber including:

at least one metering supply passage extending from said outer side of said panel to said second mating edge impingement chamber, wherein cooling fluid impinges on a surface of said panel defining said second mating edge impingement chamber as it flows into said second mating edge impingement chamber through said at least one metering supply passage; and

at least one metering discharge passage that extends from said second mating edge impingement chamber to the other of said first and second mating edges of said panel.

3. The ring segment of claim **2**, further comprising a trailing edge cooling system within said panel that receives a portion of the cooling fluid provided to said outer side of said panel for cooling said panel at said trailing edge, said trailing edge cooling system comprising at least one trailing edge impingement chamber, each trailing edge impingement chamber including:

at least one supply passage extending from said outer side of said panel to said trailing edge impingement chamber; and

at least one discharge passage that extends from said trailing edge impingement chamber to said trailing edge of said panel.

4. The ring segment of claim **3**, wherein said impingement chambers of said trailing edge cooling system and said first and second mating edge cooling systems are not in fluid communication with one another.

5. The ring segment of claim **3**, further comprising a leading edge cooling system within said panel that receives a portion of the cooling fluid provided to said outer side of said panel for cooling said panel at said leading edge, said leading edge cooling system comprising at least one leading edge impingement chamber, each leading edge impingement chamber including:

at least one supply passage extending from said outer side of said panel to said leading edge impingement chamber; and

at least one discharge passage that extends from said leading edge impingement chamber to said leading edge of said panel.

6. The ring segment of claim **5**, wherein said supply passages of said leading edge cooling system and said trailing edge cooling system comprise metering supply passages, wherein said metering supply passages of said leading edge cooling system include diameters that are larger than diameters of said metering supply passages of said trailing edge cooling system.

7. The ring segment of claim **1**, wherein said at least one first mating edge impingement chamber comprising a single first mating edge impingement chamber extending from near said leading edge to near said trailing edge of said panel.

8. The ring segment of claim **1**, further comprising an impingement tube located radially outwardly from said panel, said impingement tube comprising a plurality of impingement holes, wherein the cooling fluid that is provided to said outer side of said panel passes through said impingement holes in said impingement tube and impinges on said outer side of said panel.

9. A ring segment for a gas turbine engine comprising:

a panel having side edges comprising a leading edge, a trailing edge, a first mating edge, and a second mating edge, said panel further including an outer side, and an inner side, wherein cooling fluid is provided to said outer side, and said inner side defines at least a portion of a hot gas flow path through the gas turbine engine;

a central recessed portion defining a recessed surface formed in said outer side and surrounded by a rim portion comprising an unrecessed portion extending around an outer periphery of the recessed portion along each of said side edges;

recess portion walls defining said outer periphery of said recessed portion, each said recess portion wall extending radially between said recessed surface and said unrecessed portion; and

at least one impingement chamber located in said panel, said at least one impingement chamber including:

at least one metering supply passage extending from said outer side for passage of cooling fluid into said impingement chamber to impinge on and cool a surface of said impingement chamber; and

at least one metering discharge passage extending from said impingement chamber to one of said side edges for passage of cooling fluid from said impingement chamber to said one side edge.

10. The ring segment of claim **9**, wherein said at least one impingement chamber comprises an elongated dimension extending parallel to said one side edge that is substantially greater than a width dimension extending generally perpendicular to said one side edge.

11. The ring segment of claim **10**, wherein said at least one metering supply passage comprises a plurality of metering supply passages located along said elongated dimension of said at least one impingement chamber.

12. The ring segment of claim **11**, wherein said at least one impingement chamber comprises a plurality of impingement chambers located along said one edge.

13. The ring segment of claim **11**, wherein said at least one metering discharge passage comprises a plurality of metering discharge passages located along said elongated dimension of said at least one impingement chamber.

14. The ring segment of claim **13**, wherein said at least one impingement chamber comprises a plurality of said impingement chambers located along both said first and second mating edges.

15. The ring segment of claim **14**, wherein:

said impingement chambers are EDM drilled into said panel from one of said leading edge and said trailing edge of said panel; and

openings of said impingement chambers at said one of said leading edge and said trailing edge are sealed to effect a discharge of cooling fluid from said impingement chambers only through said metering discharge passages.

16. The ring segment of claim **9**, wherein said at least one impingement chamber is located in said panel between at least one of said recess portion walls and one of said mating edges.

17. The ring segment of claim **9**, further comprising a trailing edge cooling system comprising a plurality of circumferentially spaced apart impingement chambers having an elongated dimension extending parallel to said mating edges and located between said recessed surface and said inner side, each said impingement chamber of said trailing edge cooling system including:

at least one metering supply passage extending from said recessed surface to said impingement chamber for passage of cooling fluid into said impingement chamber to impinge on and cool a surface of said impingement chamber; and

a discharge passage extending from said impingement chamber to said trailing edge for passage of cooling fluid from said impingement chamber to said trailing edge.

18. The ring segment of claim **17**, wherein:

at least one metering supply passage of at least one of said impingement chambers of said trailing edge cooling system is located near said leading edge; and

said discharge passage of said at least one impingement chamber of said trailing edge cooling system is located at said trailing edge.

19. The ring segment of claim **9**, wherein said at least one impingement chamber comprising a single impingement chamber extending from near said leading edge to near said trailing edge of said panel.

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