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(54) **COMBUSTOR WALL CHANNEL COOLING SYSTEM**

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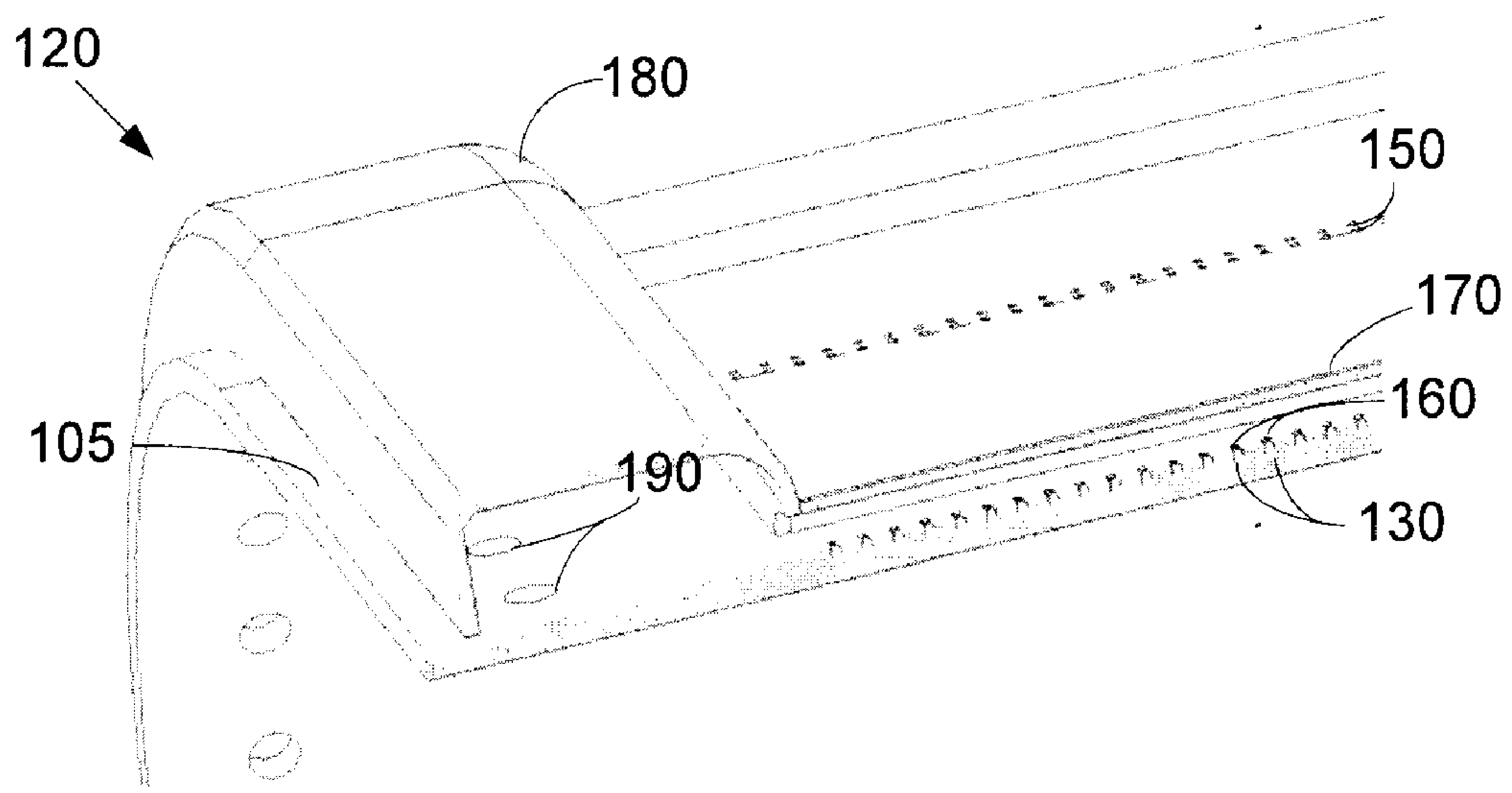
(57) **ABSTRACT**

The present application provides a combustor liner for use with a gas turbine engine. The combustor liner may include a liner wall extending from a head end to an aft end in whole or in part, a number of liner wall cooling channels positioned within the liner wall and extending from an inlet to an outlet, and a number of liner return ducts. The outlets of the liner wall cooling channels may be positioned about the liner return ducts.



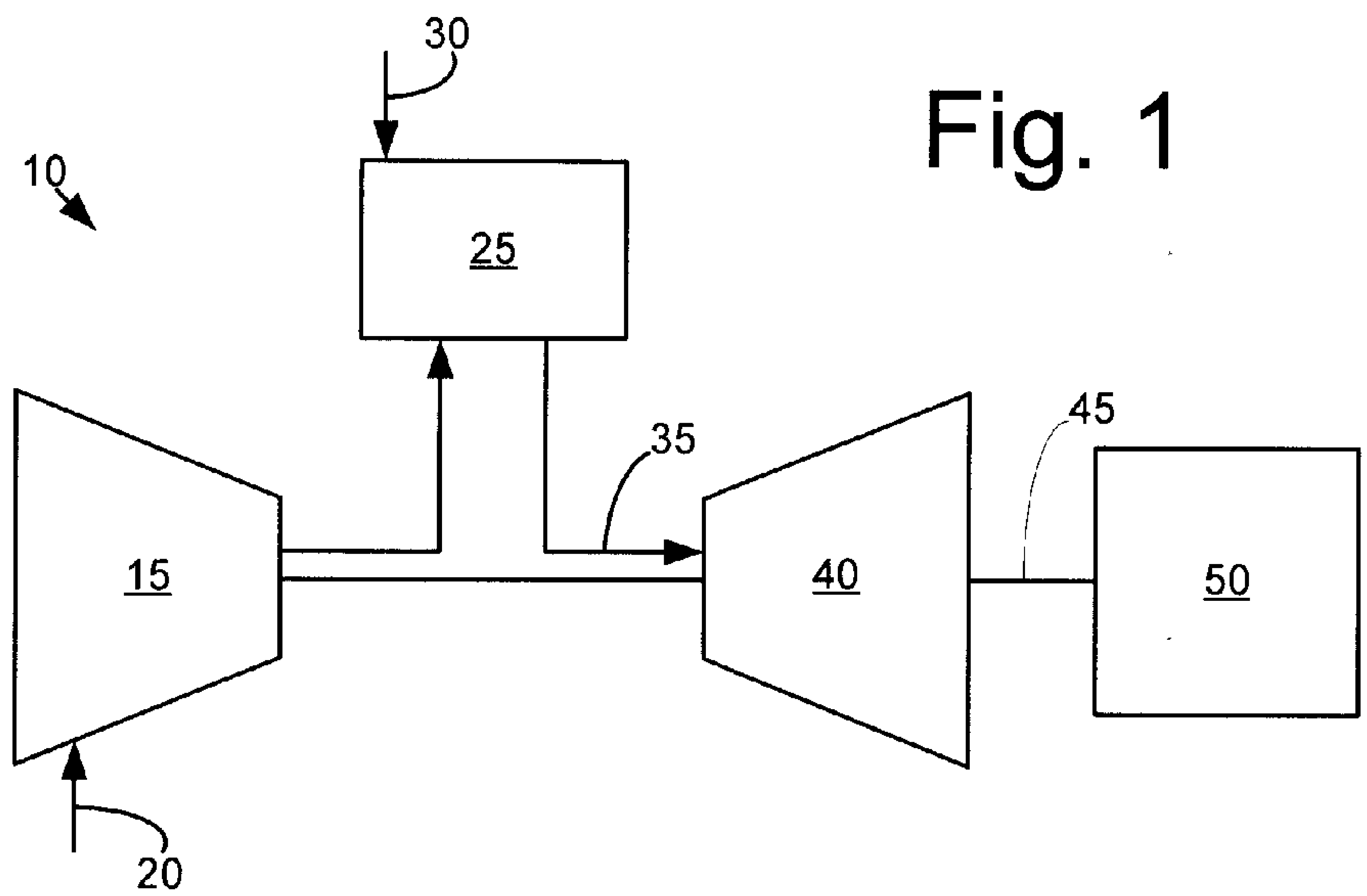

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Fig. 1

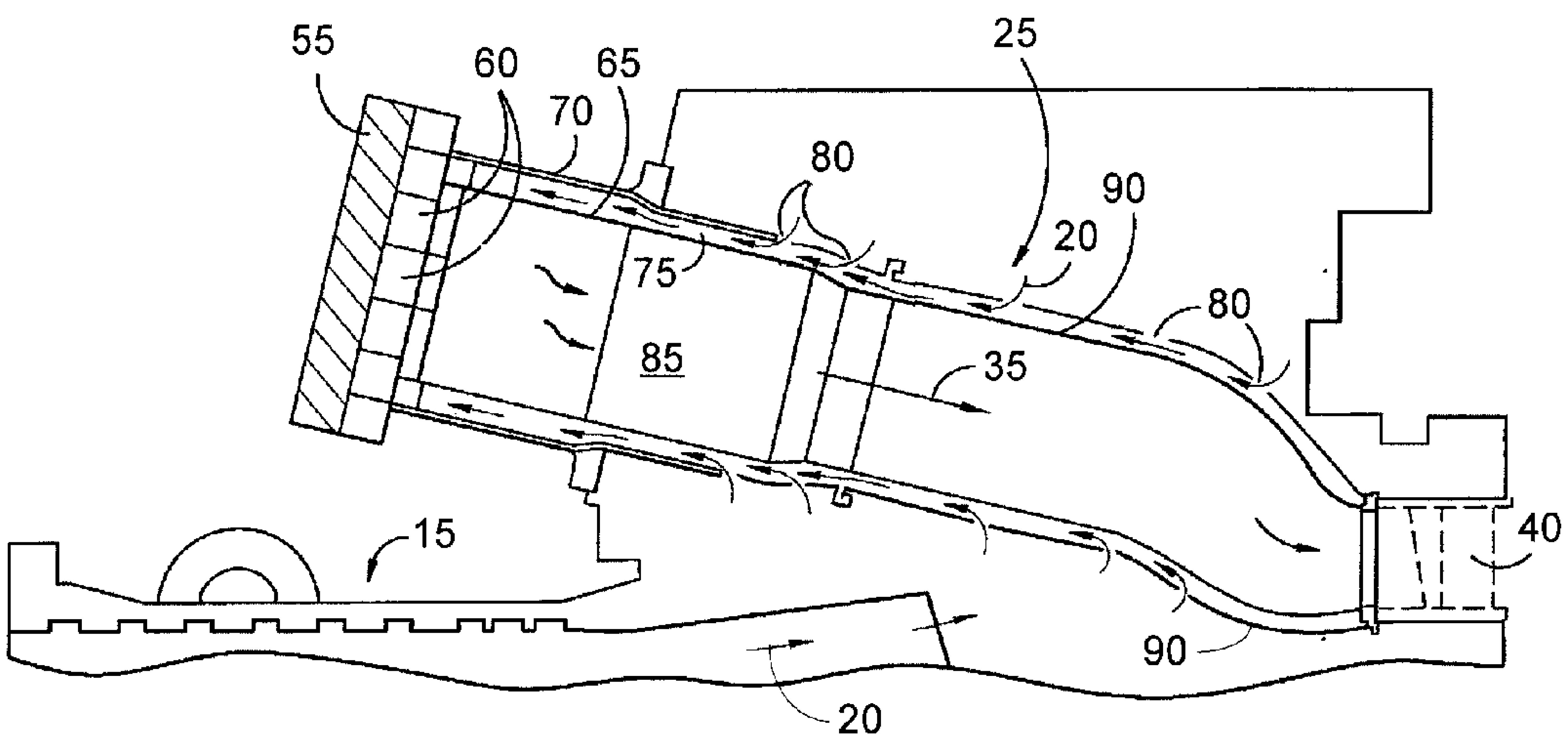
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Fig. 2

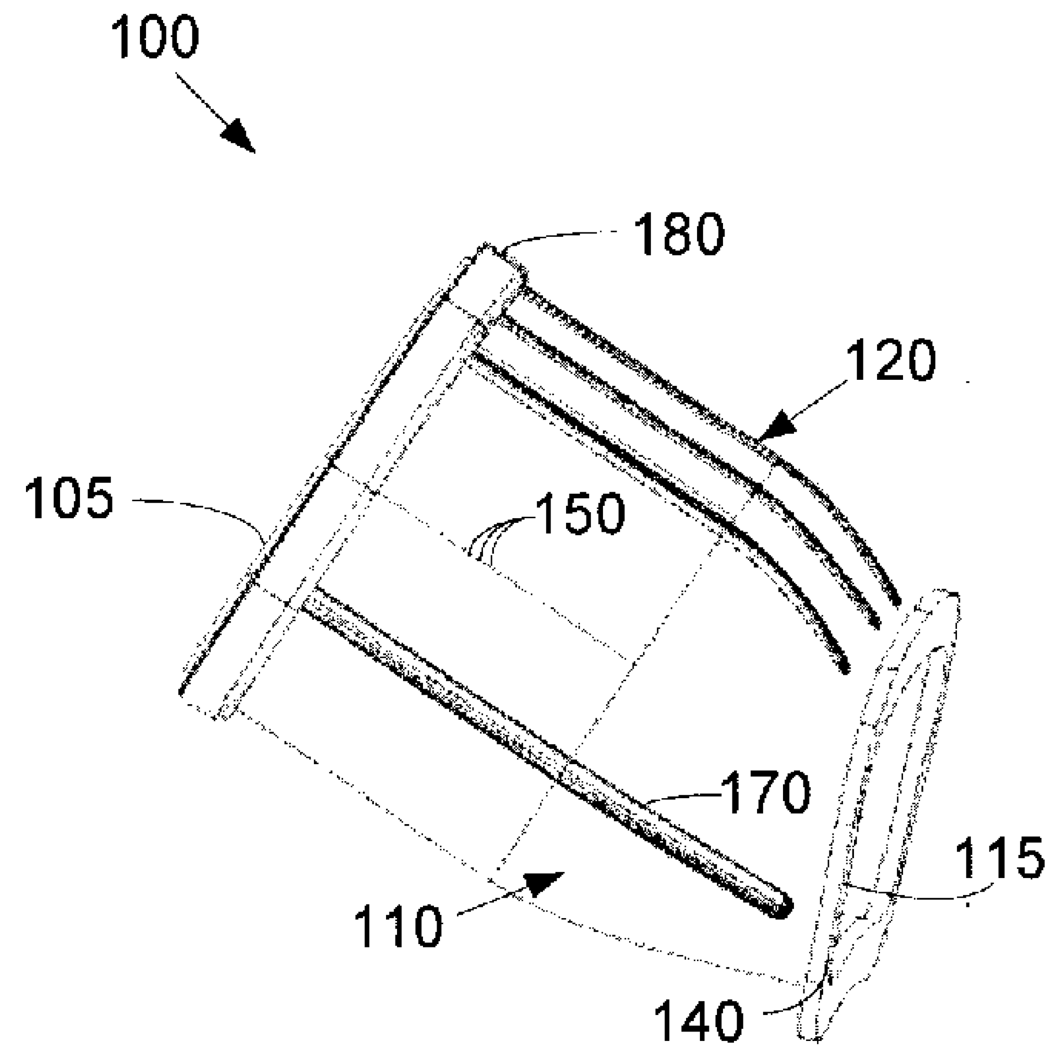

Fig. 3

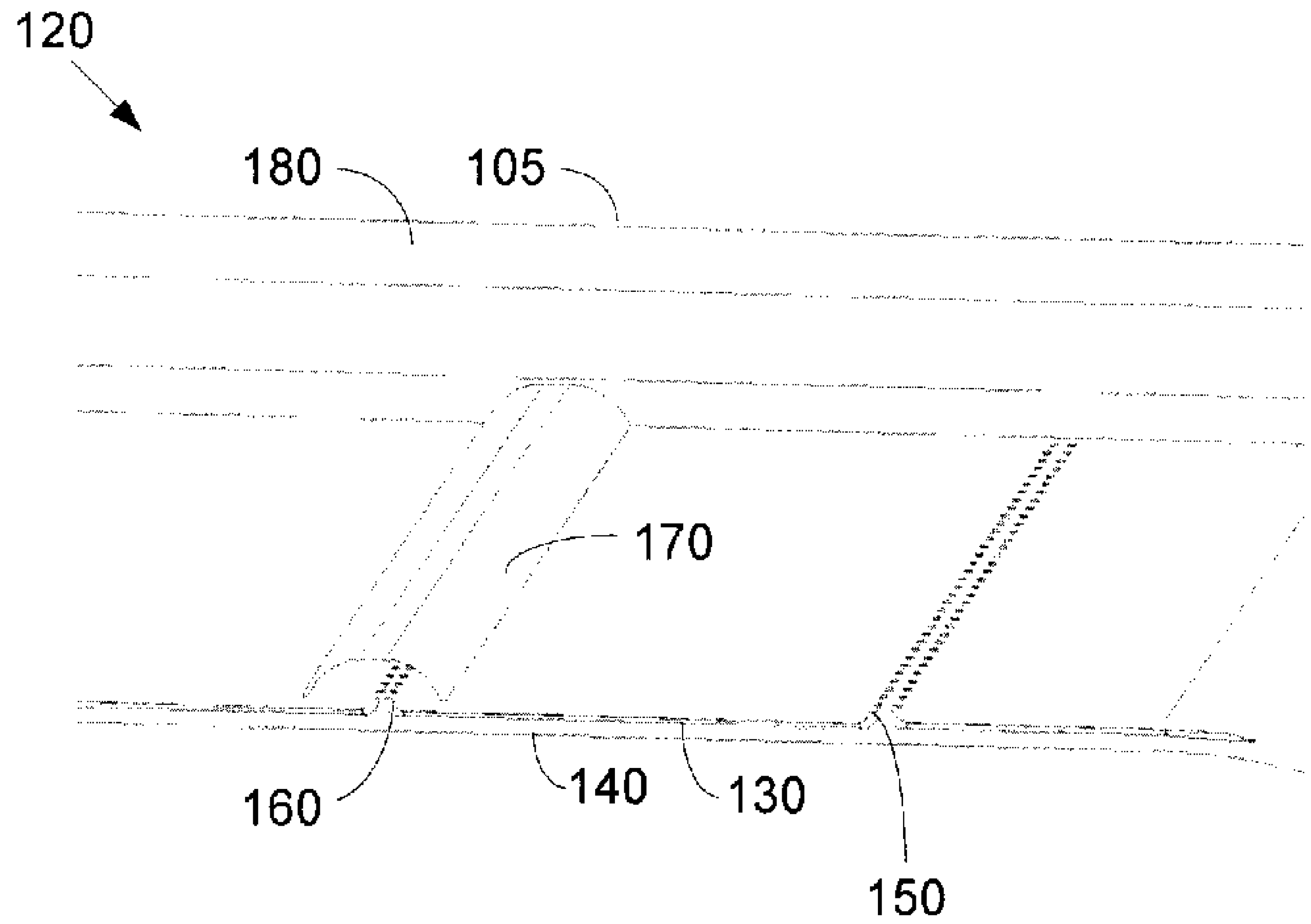

Fig. 4

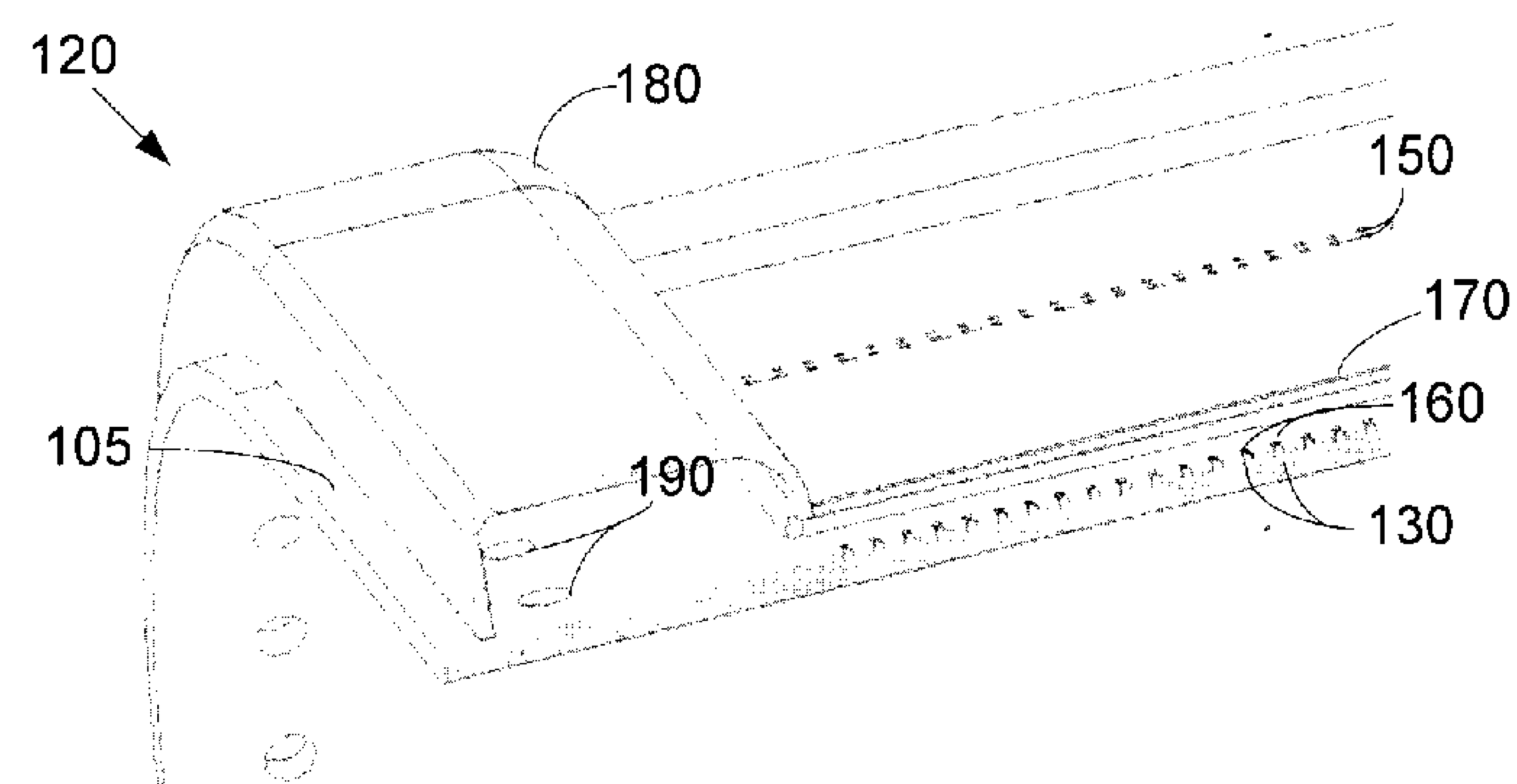

Fig. 5

COMBUSTOR WALL CHANNEL COOLING SYSTEM

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0001] This invention was made with U.S. Government support under contract No. DE-FE0023965 awarded by the U.S. Department of Energy. The Government has certain rights in this invention.

TECHNICAL FIELD

[0002] The present application and the resultant patent relate generally to gas turbine engines and more particularly relate to a combustor wall channel cooling system having liner wall cooling channels positioned about a liner wall of a combustor so as to provide wall cooling as well as purge or film cooling flows.

BACKGROUND OF THE INVENTION

[0003] In a gas turbine engine, hot combustion gases generally flow from a combustor through a transition piece and into a turbine along a hot gas path to produce useful work. Because higher temperature combustion flows generally result in an increase in the performance, the efficiency, and the overall power output of the gas turbine engine, the components that are subject to the higher temperature combustion flows must be cooled to allow the gas turbine engine to operate at such increased temperatures without damage or a reduced lifespan.

[0004] One example of a hot gas path component that should be cooled is the combustor liner. Specifically, the hot temperature flows caused by combustion of the fuel-air mixture within the combustor are directed through the combustor liner. Current methods to cool the liner include different types of film cooling techniques and the like. These cooling flows may be driven into the liner or the hot gas path via the overall system pressure drop. Specifically, the air may be driven to the combustor from the compressor or elsewhere via a somewhat complex series of heat exchangers and piping. Such film cooling techniques may be effective but the cooling flow cannot then be used to reduce undesirable emissions. Moreover, such cooling flows may be expensive in that external cooling may be required before use.

[0005] There is thus a desire for improved cooling systems and methods of cooling a combustor liner and/or other types of hot gas path components. Such improved cooling systems and methods may provide adequate cooling with an overall increase in system output and efficiency.

SUMMARY OF THE INVENTION

[0006] The present application and the resultant patent thus provide a combustor liner for use with a gas turbine engine. The combustor liner may include a liner wall extending from a head end to an aft end in whole or in part, a number of liner wall cooling channels positioned within the liner wall and extending from an inlet to an outlet, and a number of liner return ducts. The outlets of the liner wall cooling channels may be positioned about the liner return ducts.

[0007] The present application and the resultant patent further provide a method of cooling a component of a combustor in a gas turbine engine. The method may include the steps of providing a flow of air to a wall of the component, flowing the air through a number of cooling channels in the wall of the component, flowing the air from the cooling channels in the wall of the component into a return duct, and flowing the air in the return duct to a further component.

[0008] The present application and the resultant patent further provide a component for use with a gas turbine engine. The component may include a component wall extending from a head end to an aft end in whole or in part, a number of component wall cooling channels positioned within the component wall and extending from an inlet to an outlet, and a number of component return ducts. The outlets of the component wall cooling channels may be positioned about the component return ducts.

[0009] These and other features and improvements of the present application and the resultant patent will become apparent to one of ordinary skill in the art upon review of the following detailed description when taken in conjunction with the several drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a schematic diagram of a gas turbine engine showing a compressor, a combustor, a turbine, and a load.

[0011] FIG. **2** is a schematic diagram of a combustor that may be used with the gas turbine engine of FIG. **1**.

[0012] FIG. **3** is a perspective view of a combustor liner with a wall channel cooling system as may be described herein.

[0013] FIG. **4** is a partial perspective view of the wall channel cooling system of FIG. **3**.

[0014] FIG. **5** is a partial section view of the wall channel cooling system of FIG. **3**.

DETAILED DESCRIPTION

[0015] Referring now to the drawings, in which like numerals refer to like elements throughout the several views, FIG. **1** shows a schematic view of gas turbine engine **10** as may be used herein. The gas turbine engine **10** may include a compressor **15**. The compressor **15** compresses an incoming flow of air **20**. The compressor **15** delivers the compressed flow of air **20** to a combustor **25**. The combustor **25** mixes the compressed flow of air **20** with a pressurized flow of fuel **30** and ignites the mixture to create a flow of combustion gases **35**. Although only a single combustor **25** is shown, the gas turbine engine **10** may include any number of combustors **25**. The flow of combustion gases **35** is in turn delivered to a turbine **40**. The flow of combustion gases **35** drives the turbine **40** so as to produce mechanical work. The mechanical work produced in the turbine **40** drives the compressor **15** via a shaft **45** and an external load **50** such as an electrical generator and the like.

[0016] The gas turbine engine **10** may use natural gas, various types of syngas liquid fuels, and/or other types of fuels and blends thereof. The gas turbine engine **10** may be any one of a number of different gas turbine engines offered by General Electric Company of Schenectady, N.Y., including, but not limited to, those such as a 7 or a 9 series heavy duty gas turbine engine and the like. The gas turbine engine **10** may have many different configurations and may use other types of components. Other types of gas turbine engines also may be used herein. Multiple gas turbine engines, other types of turbines, and other types of power generation equipment also may be used herein together.

[0017] FIG. **2** shows an example of the combustor **25** that may be used with the gas turbine engine **10** and the like. Generally described, the combustor **25** may include a cover plate **55** at an upstream end thereof. The cover plate **55** may at least partially support a number of fuel nozzles **60** therein. Any number or type of the fuel nozzles **60** may be used herein. The cover plate **55** provides a pathway for the flow of air **20** and the flow of fuel **30** to the fuel nozzles **60**.

[0018] The combustor **25** may include a combustor liner **65** disposed within a flow sleeve **70**. The arrangement of the liner **65** and the flow sleeve **70** may be substantially concentric and may define an annular flow path **75** therebetween. The flow sleeve **70** may include a number of flow sleeve inlets **80** extending therethrough. The flow sleeve inlets **80** may provide a pathway for at least a portion of the flow air **20** from the compressor **15** or elsewhere. The flow sleeve **70** may be perforated with a pattern of the inlets **80** or otherwise. The combustion liner **65** may define a combustion chamber **85** for the combustion of the flow of air **20** and the flow of fuel **30** downstream of the fuel nozzles **60**. The aft end of the combustor **25** may include a transition piece **90**. The transition piece **90** may be positioned adjacent to the turbine **40** and may direct the flow of combustion gases **35** thereto. The combustor **25** and the combustor components described herein are for the purpose of example only. Many other types of combustors and combustor components may be known.

[0019] FIGS. **3-5** show portions of an example of a combustor **100** as may be described herein. Specifically, a combustor liner **110** is shown. The combustor liner **110** may extend from a head end **105** to an aft end **115**. The combustor liner **110** may be substantially similar to that described above but with the addition of a wall channel cooling system **120**. The combustor liner **110** may have any suitable size, shape, or configuration.

[0020] The wall channel cooling system **120** may include a number of cooling channels **130**. The cooling channels **130** may extend through a liner wall **140**. Each of the cooling channels **130** may extend from an inlet **150** to an outlet **160**. Any number of the cooling channels **130** may be used herein. In one example, the cooling channels **130** may have a substantially square shape and may have a diameter of about 0.070 inches (about 1.778 millimeters). Alternatively, circular channels may be used with a diameter of about 0.075 inches (about 1.905 millimeters). The cooling channels **130** may have a diameter of about 0.060 inches (about 1.524 millimeters) to about 0.080 inches (about 2.0 millimeters). Other shapes and sizes may be used herein. The length of the cooling channels **130** may be limited to no more than about several inches, i.e., no more than about 2 to 5 inches (about 5.1 to 20.3 centimeters). Other lengths also may be used herein.

[0021] The wall channel cooling system **120** may position the cooling channels **130** in a number of adjacent rows. In one example, **168** rows of the cooling channels **130** may be used. Moreover, about eight to fifteen cooling channels **130** may be positioned each in a number of columns circumferentially arranged about the liner wall **140**. Alternatively, the cooling channels **130** may extend for any part of the length of the liner wall **140** in any position. Any number of the cooling channels **130** may be used herein in any suitable size, shape, or configuration. The cooling channels **130** may be cast within the liner wall **140** and/or manufactured in other types of conventional techniques including PSP, braze, machined, and the like. Alternatively, additive manufacturing processes and the like also may be used in whole or in part.

[0022] The inlets **150** of the cooling channels **130** may be open so as to be exposed to the flow of air **20**. (The flow sleeve **70** described above need riot be used herein.) The outlets **160** of the cooling channels **130** may be positioned within a return duct **170**. Any number of the return ducts **170** may be used herein in any suitable size, shape, or configuration. The return ducts **170** extend along the length of the cold side of the liner wall **140** and may be in communication with a head end duct **180**. The head end duct **180** may encircle the head end **105** of the liner wall **140** in whole or in part. The head end ducts **180** may be in communication with a number of purge holes **190** and the like through the liner wall **140**. In one example, eighty of the purge holes **190** may be used herein with a diameter of about 0.375 inches (about 9.525 milometers). Any number of the purge holes **190** may be used herein in any suitable size, shape, or configuration. The flow of air **20** from the return ducts **170** also may be directed elsewhere. For example, the flow of air **20** may be directed to the premixers, AFS system, purge holes, nozzles, or elsewhere. Further, different return ducts **170** may direct portions of the flow to different locations. Other components and other configurations may be used herein.

[0023] In use, a portion of the flow of air **20** from the compressor or elsewhere may be driven against the liner wall **140** of the combustion liner **110**. A portion of the pressure drop may be used to drive the flow into the inlets **150** of the cooling channels **130** where the flow cools the liner wall **140** as it passes therethrough. The cooling channels **130** increase the overall cooling surface area and the heat transfer coefficient so as to improve cooling effectiveness per unit volume of air. The cooling channels **130** may be limited in length because the flow of air **20** therein may pick up heat quickly from the hot side of the liner wall **140**. Once a given temperature differential has been reduced by the flow, the cooling effectiveness for a given channel **130** may be diminished such that the next cooling channel **130** with a different flow of air may continue to cool the liner wall **140**. The cooling channels **130** may change size (flow area) between the inlets **150** and the exits **160** so as to minimize flow losses within the cooling channels **130**. For example, the inlet diameter may be about 0.065 inches (about 1.65 millimeters) and the exit diameter may be about 0.075 inches (about 1.91 millimeters). Other sizes may be used herein. The heated air **20** then may exit the cooling channels **130** via the outlets **160** and may be collected within the return ducts **170**. The flow of air **20** flows through the return ducts **170** to the head end duct **180**. The flow of air **20** then may be used as a purge or a leakage flow about the head end **105** of the liner **110** via the purge holes **190**. Alternatively, the flow of air **20** may be used for other purposes in whole or in part after flowing through the cooling channels **130**.

[0024] Only a portion of the overall pressure drop may be used such that the wall channel cooling system **120** directs more and higher pressure air to the fuel-air premixing regions. As such, the combustor **100** may operate at higher pressure ratios for improved operability, fuel flexibility, and a reduction in overall emissions. The wall channel cooling system **120** also eliminates the need for external compressors, heat exchangers, complex piping, and the like for a simplified and less expensive cooling system. Although the wall channel cooling system **120** has been described in the context of the combustor liner **110**, the wall channel cooling system **120** may be used with any type of turbine component or pairs of turbine components.

[0025] It should be apparent that the foregoing relates only to certain embodiments of the present application and the resultant patent. Numerous changes and modifications may be made herein by one of ordinary skill in the art without departing from the general spirit and scope of the invention as defined by the following claims and the equivalents thereof.

We claim:

1. A combustor liner for use with a gas turbine engine, comprising:
- a liner wall extending from a head end to an aft end in whole or in part;
- a plurality of liner wall cooling channels positioned within the liner wall;
- wherein the plurality of liner wall cooling channels extends from an inlet to an outlet; and
- a plurality of liner return ducts;
- wherein the outlets of the plurality of liner wall cooling channels are positioned about the plurality of liner return ducts.

2. The combustor liner of claim **1**, wherein the plurality of liner return ducts is in communication with a head end duct positioned about the head end of the liner wall.

3. The combustor liner of claim **2**, wherein the liner wall comprises a plurality of purge holes in communication with the head end duct.

4. The combustor liner of claim **1**, wherein the inlets of the plurality of liner wall cooling channels are positioned in communication with a flow of air in a flow path within a flow sleeve.

5. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels comprises a substantially square shape or a substantially round shape.

6. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels comprises a length of about 2 to 5 inches (about 5.1 to 20.3 centimeters).

7. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels comprises a diameter of about 0.060 inches (about 1.524 millimeters) to about 0.080 inches (about 2.0 millimeters).

8. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels comprise a inlet diameter of about 0.065 inches (about 1.65 millimeters) and an exit diameter of about 0.075 inches (about 1.91 millimeters).

9. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels may be positioned in a plurality of columns on the liner wall.

10. The combustor liner of claim **9**, wherein eight to fifteen of the plurality of liner wall cooling channels may be positioned in each of the plurality of columns on the liner wall.

11. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels is cast into the liner wall.

12. The combustor liner of claim **1**, wherein the plurality of liner wall cooling channels is formed in an additive manufacturing process.

13. The combustor liner of claim **1**, wherein the liner wall surrounds a combustion chamber.

14. A method of cooling a component in a gas turbine engine, comprising:
- providing a flow of air to a wall of the component;
- flowing the air through a plurality of cooling channels in the wall of the component;
- flowing the air from the plurality of cooling channels in the wall of the component into a return duct; and
- flowing the air in the return duct to a further component.

15. The method of cooling of claim **14**, wherein the step of flowing the air in the return duct to a further component comprises flowing the air in the return duct to a head end duct.

16. A component for use with a gas turbine engine, comprising:
- a component wall extending from a head end to an aft end in whole or in part;
- a plurality of component wall cooling channels positioned within the component wall;
- wherein the plurality of component wall cooling channels extends from an inlet to an outlet; and
- a plurality of component return ducts;
- wherein the outlets of the plurality of component wall cooling channels are positioned about the plurality of component return ducts.

17. The component of claim **16**, wherein the component comprises a combustor liner.

18. The component of claim **16**, wherein the plurality of component wall cooling channels comprises an inlet and an outlet and wherein the outlets of the plurality of component wall cooling channels are positioned about the plurality of component return ducts.

19. The component of claim **16**, wherein the plurality of component return ducts is in communication with a duct positioned about the component wall.

20. The component of claim **16**, wherein the plurality of component wall cooling channels comprises a length of about 2 to 5 inches (about 5.1 to 20.3 centimeters).

* * * * *