



- (51) International Patent Classification:
F02G 5/02 (2006.01)
- (21) International Application Number:
PCT/US2012/024622
- (22) International Filing Date:
10 February 2012 (10.02.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/444,818 21 February 2011 (21.02.2011) US
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

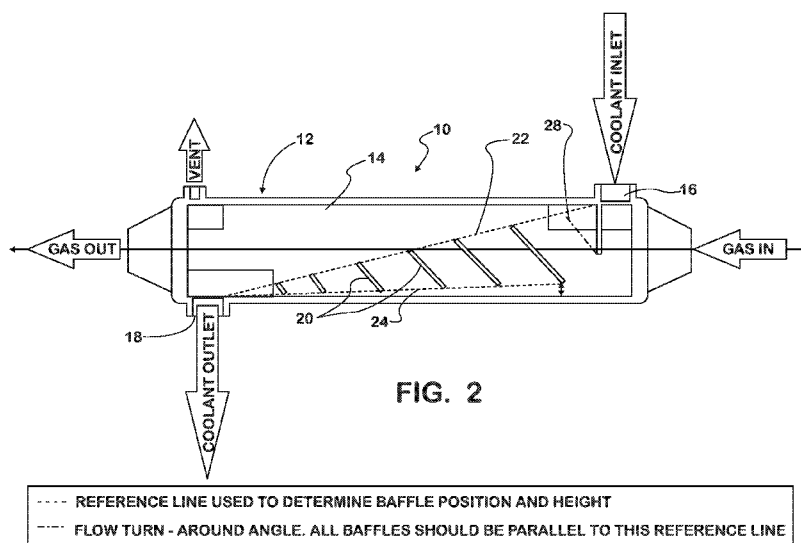
Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:

- with international search report (Art. 21(3))
- with amended claims (Art. 19(1))

(54) Title: EGR COOLER AND METHOD



(57) Abstract: A device and method for enhancing the flow of coolant through an EGR cooler, are described. The device includes a housing or tank having an interior space with a fluid inlet for receiving coolant and a fluid outlet for releasing coolant from the interior space. A series of angled baffles in a parallel arrangement are positioned within the interior of the housing from the fluid inlet to the fluid outlet. The baffles extend into a flow path of the coolant redirecting a portion of the flow path above and below the baffles as the coolant passes through the housing. A plurality of tubes or conduit are positioned adjacent the baffles, defining an exhaust gas flow pathway through the housing.



EGR COOLER AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of United States Patent Application Serial No. 61/444,818 filed on February 21, 2011.

TECHNICAL FIELD

[0002] The present device and method relates to a heat exchanger for use in internal combustion engines. Particularly, the present device and method relates to an exhaust gas recirculation (EGR) cooler having a fluid flow baffle arrangement for use in enhancing the coolant flow through the EGR cooler for more effective reduction of the exhaust gas temperature and reducing the production of NO_x in the exhaust stream.

BACKGROUND

[0003] Diesel engines are efficient, durable and economical. Diesel exhaust, however, can harm both the environment and people. To reduce this harm, governments, such as the United States and the European Union, have proposed stricter diesel exhaust emission regulations. These environmental regulations require diesel engines to meet the same pollution emission standards as gasoline engines. Typically, to meet such regulations and standards, diesel engine systems require equipment additions and modifications.

[0004] For example, a lean burning engine provides improved fuel efficiency by operating with an amount of oxygen in excess of the amount necessary for complete combustion of the fuel. Such engines are said to run “lean” or on a “lean mixture.” However, the increase in fuel efficiency is offset by the creation of undesirable pollution emissions in the form of nitrogen oxides (NO_x). Nitrogen oxide emissions are regulated through regular emission testing requirements.

[0005] Many internal combustion engines use an exhaust gas recirculation (EGR) system to reduce the production of NO_x during the combustion process in the cylinders. EGR systems typically divert a portion of the exhaust gases exiting the cylinders for mixing with intake air. The exhaust gas generally lowers the combustion temperature of the fuel below the temperature where nitrogen combines with oxygen to form NO_x. EGR systems have an EGR

cooler or heat exchanger that reduces the temperature of the exhaust gases. Generally, more exhaust gas can be mixed with the intake air when the exhaust gas temperature is lower.

Additional exhaust gases in the intake air may further reduce the amount of NO_x produced by the engine.

[0006] EGR coolers typically use coolant from the engine's cooling system to reduce the temperature of the exhaust gases. The coolant may be water, an antifreeze fluid such as ethylene glycol, a combination thereof, or the like. The EGR cooler is connected to another engine component in series so that the same coolant flows through the other component and then the EGR cooler in sequence. In some internal combustion engines, the coolant flows sequentially from the coolant pump through the crankcase, through an oil cooler prior, and then through the EGR cooler. The coolant usually flows from the EGR cooler into the cylinder head, where it combines with coolant from the crankcase for return to the coolant pump.

[0007] Coolant circulating in the engine cooling loop has already absorbed combustion heat from the engine when it arrives at the EGR cooler. In the EGR cooler, additional heat is transferred to the coolant from the exhaust gas. Therefore, it is important that the coolant flow through the EGR cooler effectively. Typically, a plurality of vertical baffles are positioned within the interior of the EGR cooler (FIG. 1 – prior art). The baffles direct the flow of the coolant, which enhances thermal performance. However, this baffling approach, while enhancing the thermal performance, does so at the cost of higher coolant flow pressure drop across the cooler, and leaves small flow recirculation behind each baffle.

[0008] Therefore, it would be advantageous to provide a baffle arrangement within the EGR cooler that offers improved flow distribution for efficient thermal performance while maintaining relatively low pressure drop through the cooler.

SUMMARY

[0009] There is disclosed herein a device and method, each of which avoids the disadvantages of prior devices and methods while affording additional operating advantages.

[0010] An EGR cooler having a baffle arrangement resulting in an improved coolant flow pattern for use in reducing the production of NO_x in an exhaust stream, is described and claimed.

[0011] In an embodiment, a heat exchanger for use in reducing the production of NO_x in an exhaust stream, is described. The heat exchanger comprises a tank having an interior space, an

inlet for receiving a cooling fluid into the interior space, an outlet for releasing the cooling fluid from the interior space, a plurality of angled baffles having a parallel arrangement and disposed in a longitudinal direction within the interior space from the inlet to the outlet; and, a conduit for directing the flow of the exhaust stream through the interior space, wherein the conduit is positioned in close proximity to the baffles.

[0012] In an embodiment, the baffles in a series of graduated heights, are positioned within the fluid flow path from the inlet to the outlet for directing the fluid flow path around and between the baffles.

[0013] A method for directing coolant fluid flow distribution through an EGR cooler apparatus, is disclosed. The method comprises the steps of providing a housing having an interior space with a fluid inlet and an opposing fluid outlet, positioning in a parallel arrangement a plurality of angled baffles within the interior space of the housing from the inlet to the outlet, creating an exhaust flow path within the interior of the housing and in close proximity to the baffles, and, flowing a coolant through the interior of the housing from the inlet to the outlet, wherein the coolant cools the exhaust flow through the exhaust flow path.

[0014] These and other aspects of the present device and method may be understood more readily from the following description and the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a side view of an EGR cooler showing a prior art embodiment of a coolant flow baffle arrangement;

[0016] FIG. 2 is a side view of an EGR cooler having an embodiment of the present coolant flow baffle arrangement;

[0017] FIG. 3 is a side view of an EGR cooler having an embodiment of the present coolant flow baffle arrangement illustrating a proposed coolant flow geometry;

[0018] FIG. 4 is a side view of an EGR cooler having an embodiment of the present coolant flow baffle arrangement with lines A-A; and,

[0019] FIG. 5 is a top view of the EGR cooler of FIG. 4 along lines A-A;

[0020] FIG. 6 is a side view of an EGR cooler showing a another embodiment of the present coolant flow baffle arrangement; and,

[0021] FIG. 7 is a side view of an EGR cooler having the embodiment of the present coolant flow baffle arrangement of FIG. 6, illustrating a proposed coolant flow geometry.

DETAILED DESCRIPTION

[0022] Referring to FIGS. 2-7, there is illustrated an EGR cooler or heat exchanger, generally designated 10, having an angled baffle arrangement 20 for directing the flow of a cooling fluid through the EGR cooler. As generally known, exhaust flow enters into the EGR cooler from the exhaust manifold (not shown) near the turbocharger (not shown) of an engine (not shown). The EGR cooler 10 cools the hot exhaust gases to a temperature that will not adversely impact combustion efficiency. The cooled gases are returned to the intake manifold (not shown) through an EGR valve (not shown), which opens and closes based on operating conditions. The EGR cooler 10 diminishes the amount of NO_x in the exhaust stream.

[0023] As shown in FIG. 2, the cooler comprises a housing or tank 12 having an interior space 14, an inlet 16 for receiving a cooling fluid into the interior space, an outlet 18 for releasing the cooling fluid from the interior space. The tank 12 can have any suitable shape depending on vehicle requirements, but is typically elongated, having a length sufficient for adequate fluid flow and heat dissipation from the exhaust stream.

[0024] Positioned within the interior space 14 of the tank 12 is a plurality of baffles 20. As noted in FIG. 1, EGR coolers 10 are usually equipped with baffles that whip the coolant flow back and forth as the coolant flows through the tank 12 from the inlet 16 to the outlet 18. As shown in FIG. 2, the baffle arrangement 20 useful in the present application is positioned angled and parallel. While the baffles 20 can be positioned anywhere within the interior space 14 of the tank 12, the arrangement of the present disclosure is to have the baffles disposed in a longitudinal direction within the interior space from the inlet 16 to the outlet 18. In this manner, the flow of coolant comes in contact with an influence of the baffles through the entire length of the tank 12.

[0025] Prior baffle arrangements provided the baffles in a vertical configuration (FIG. 1). However, this arrangement resulted in a high coolant flow pressure drop across the cooler 10. In the present baffle arrangement, the baffles 20 are positioned at an angle, and specifically, the baffles angle in the direction of the coolant flow. As shown in FIG. 3, the angled positioning of the baffles 20 results in enhanced flow above and below the baffles, thereby avoiding the high

flow pressure drop and flow recirculation left behind in the prior art vertical baffle arrangement (FIG. 1).

[0026] As shown in FIG. 2, determining the height and positioning of the baffles 20 is based on the distance from the coolant inlet 16 to the coolant outlet 18. FIG. 2 shows a top reference line 22 and a bottom reference line 24, both of which are used to determine the proper position and height of the baffles. The reference line 22 extends from the coolant inlet 16 to the coolant outlet 18. It is the slope of the top reference line 22 and bottom reference line 24 that determines the height and position of the baffles 20. In addition, the height of the baffles can vary. For example, in one embodiment, the height of the baffles 20 decreases from the coolant inlet 16 to the coolant outlet 18. The positioning of the baffles and change in height through the cooler 10 provides a desired coolant flow geometry (FIG. 3), which results in both good flow distribution while maintaining relatively low pressure drop across the tank. Optimization of the height and angle of the baffles 20 can be determined using computational fluid dynamics (CFD).

[0027] In addition to the plurality of angled baffles positioned longitudinally across the interior of the tank 12, there is at least one vertically positioned entry baffle 26 located at the coolant inlet 16. This entry baffle 26 directs the initial flow of the coolant entering the tank 12 in a downward path (waterfall-like effect) toward the bottom surface of the tank. In this manner, the coolant flow can be directed to paths (F) both above and below the angled baffles 20. In addition, the entry baffle 26 is located in such a manner as to permit a small "leak path" (L) around the top of the baffle from the inlet 16 (FIG. 3). This is to eliminate stagnant flow region behind the entry baffle 26. In this alternate flow pattern, the coolant flows throughout the majority of the interior space 14 of the tank resulting in the desired coolant flow geometry providing enhanced heat exchange between the exhaust flow and the coolant. As shown in FIG. 2, the entry baffle 26 also provides a reference point 28, which is used for positioning the angled baffles 20. In order to provide the desired flow geometry, all of the angled baffles 20 should be positioned parallel to this reference point 28.

[0028] Turning to FIGS. 4 and 5, FIG. 4 illustrates a side view of an embodiment of the present baffling arrangement, while FIG. 5 shows a top view along lines A-A of FIG. 4, illustrating the conduits or tubes 30 for directing the flow of the exhaust stream through the interior space 14 of the tank (FIG. 5). The conduit or tubes 30 are generally positioned in close proximity to the baffles 20, so as to enhance the heat transfer between the exhaust gases flowing

through the tubes resulting from the enhanced flow geometry of the described baffling arrangement. Alternatively, the baffles 20 can be brazed directly onto the tubes 30. It should be understood that there can be any number of tubes 30, disposed in any suitable location within the tank 12. In addition the tubes 30 may be straight, curved or angled, depending on specific requirements of the system.

[0029] FIGS. 6 and 7 represent yet another embodiment of the present baffling arrangement within a heat exchanger apparatus 100. In this embodiment, there is an additional vertical baffle 102, which is positioned opposed from the entry baffle 26. The entry baffle 26, and the second vertical baffle 102 are in addition to the plurality of angled baffles 20 disposed longitudinally across the interior of the tank 12, as previously described. As shown in FIG. 7, the entry baffle 26 and second vertical baffle 102 direct the initial flow of the coolant entering the tank 12 in a substantially U-shaped path (U) prior to the flow entering the angled baffles 20. The coolant efficiently flows throughout the majority of the interior space 14 of the tank resulting in the desired coolant flow geometry providing enhanced heat exchange between the exhaust flow and the coolant.

[0030] The present baffling arrangement provides a method for directing coolant fluid flow distribution through an EGR cooler apparatus. The method includes providing an EGR cooler 10, 100, having a tank 12 with an interior space 14 with a fluid inlet 16 and an opposing fluid outlet 18. A plurality of angled baffles 20 having a parallel arrangement are positioned within the interior space 14 of the housing 10 from the inlet to the outlet. The angled baffles 20 creating an exhaust flow path having a desired flow geometry of coolant within the interior of the housing. The method also includes creating an exhaust flow path by providing a plurality of conduits 30 for receiving the exhaust gas. The exhaust gas is cooled as it flows through the tubes within the housing by the flow geometry of the coolant.

CLAIMS

What is claimed is:

1. A heat exchanger for use in reducing the production of NO_x in an exhaust stream, the exchanger comprising:
 - a tank having an interior space;
 - an inlet for receiving a cooling fluid into the interior space;
 - an outlet for releasing the cooling fluid from the interior space;
 - a plurality of angled baffles having a parallel arrangement and disposed in a longitudinal direction within the interior space from the inlet to the outlet; and,
 - a conduit for directing the flow of the exhaust stream through the interior space, wherein the conduit is positioned in close proximity to the baffles.
2. The heat exchanger of claim 1, wherein the cooling fluid creates a fluid flow path through the interior space from the inlet to the outlet.
3. The heat exchanger of claim 2, wherein the baffles are positioned within the fluid flow path for directing the fluid flow path around and between the baffles.
4. The heat exchanger of claim 3, wherein the baffles have a series of graduated heights.
5. The heat exchanger of claim 4, wherein baffles decrease in height from the inlet to the outlet.
6. The heat exchanger of claim 3, wherein the baffles angle in the direction of the fluid flow path.
7. The heat exchanger of claim 3, wherein the fluid flow path travels above and below the baffles.

8. The heat exchanger of claim 1, wherein at least one vertical baffle is positioned in the interior space near the inlet and separate and apart from the angled baffles.

9. An EGR cooler apparatus comprising;

a housing having an interior space, the housing further including a fluid inlet for receiving a coolant into the interior space and a fluid outlet for releasing the coolant from the interior space;

a series of angled baffles having a parallel arrangement within the interior of the housing from the fluid inlet to the fluid outlet, wherein the baffles extend into a flow path of the cooling fluid redirecting a portion of the flow path above and below the baffles as the cooling fluid passes through the housing from the fluid inlet to the fluid outlet; and,

a plurality of tubes positioned adjacent the baffles and defining a exhaust gas flow pathway through the housing.

10. The apparatus of claim 9, wherein the baffles graduate downward in height from the fluid inlet to the fluid outlet.

11. The apparatus of claim 9, wherein the baffles include a deflecting surface which angles in the direction of the flow path of the cooling fluid.

12. The apparatus of claim 11, wherein the deflecting surfaces of the baffles direct the flow path of the coolant around and between the baffles.

13. A method for directing coolant fluid flow distribution through an EGR cooler apparatus, the method comprising the steps of:

providing a housing having an interior space with a fluid inlet and an opposing fluid outlet;

positioning in a parallel arrangement a plurality of angled baffles within the interior space of the housing from the inlet to the outlet;

creating an exhaust flow path within the interior of the housing and in close proximity to the baffles; and,

flowing a coolant through the interior of the housing from the inlet to the outlet, wherein the coolant cools the exhaust flow through the exhaust flow path.

14. The method of claim 13, wherein the step of positioning the angled baffles further includes placing the baffles longitudinally within the interior space in decreasing height from the inlet to the outlet.

15. The method of claim 13, wherein the step of flowing the coolant further includes creating a flow pattern around and over the angled baffles.

AMENDED CLAIMS

received by the International Bureau on 04 June 2012 (04.06.2012)

What is claimed is:

1. A heat exchanger for use in reducing the production of NO_x in an exhaust stream, the exchanger comprising:
 - a tank having an interior space;
 - an inlet for receiving a cooling fluid into the interior space;
 - an outlet for releasing the cooling fluid from the interior space;
 - a plurality of angled baffles having a parallel arrangement and disposed in a longitudinal direction within the interior space from the inlet to the outlet; and,
 - a conduit for directing the flow of the exhaust stream through the interior space, wherein the conduit is positioned in close proximity to the baffles, wherein at least one vertical baffle is positioned in the interior space near the inlet and separate and apart from the angled baffles.
2. The heat exchanger of claim 1, wherein the cooling fluid creates a fluid flow path through the interior space from the inlet to the outlet.
3. The heat exchanger of claim 2, wherein the baffles are positioned within the fluid flow path for directing the fluid flow path around and between the baffles.
4. The heat exchanger of claim 3, wherein the baffles have a series of graduated heights.
5. The heat exchanger of claim 4, wherein baffles decrease in height from the inlet to the outlet.
6. The heat exchanger of claim 3, wherein the baffles angle in the direction of the fluid flow path.

7. The heat exchanger of claim 3, wherein the fluid flow path travels above and below the baffles.

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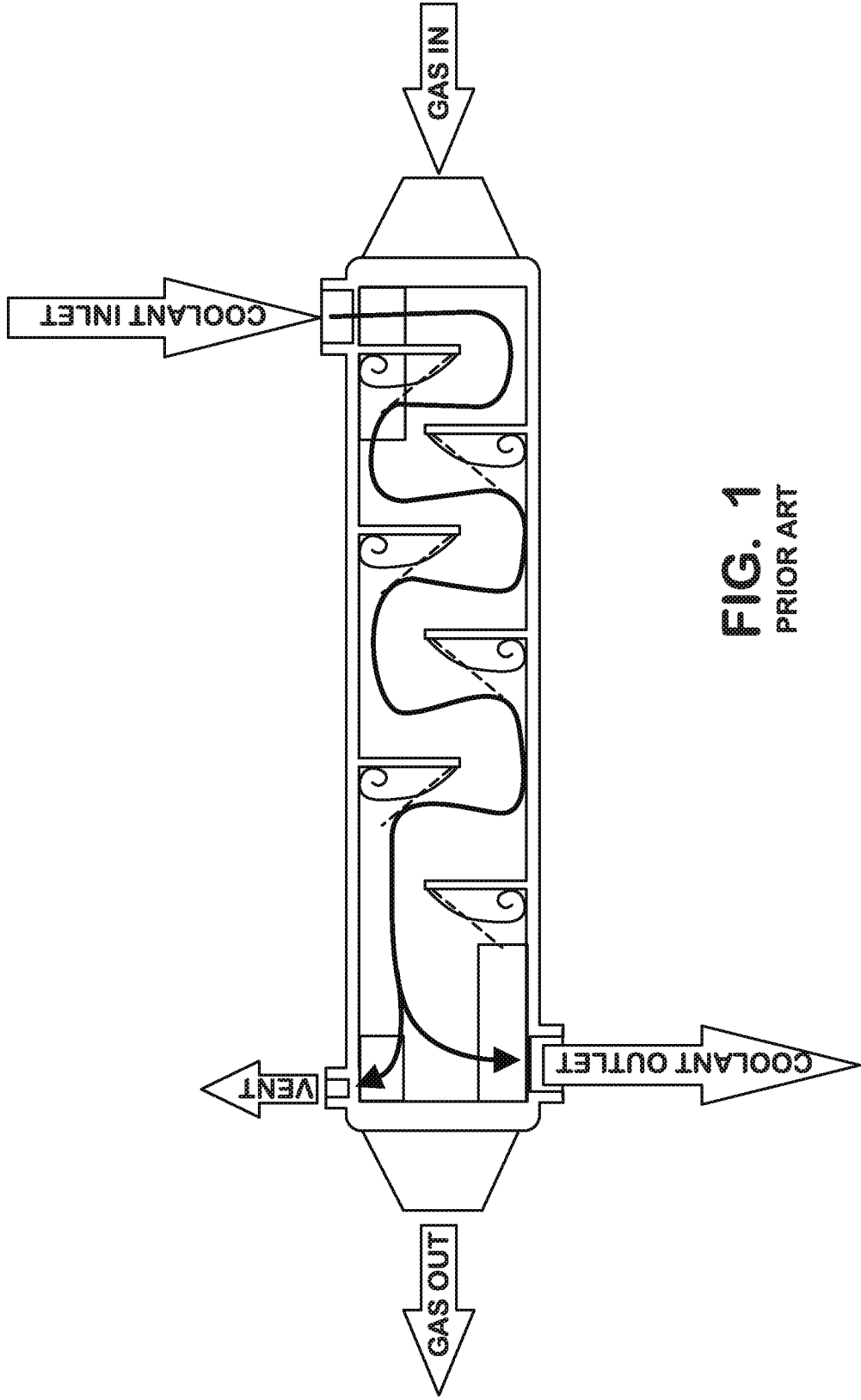
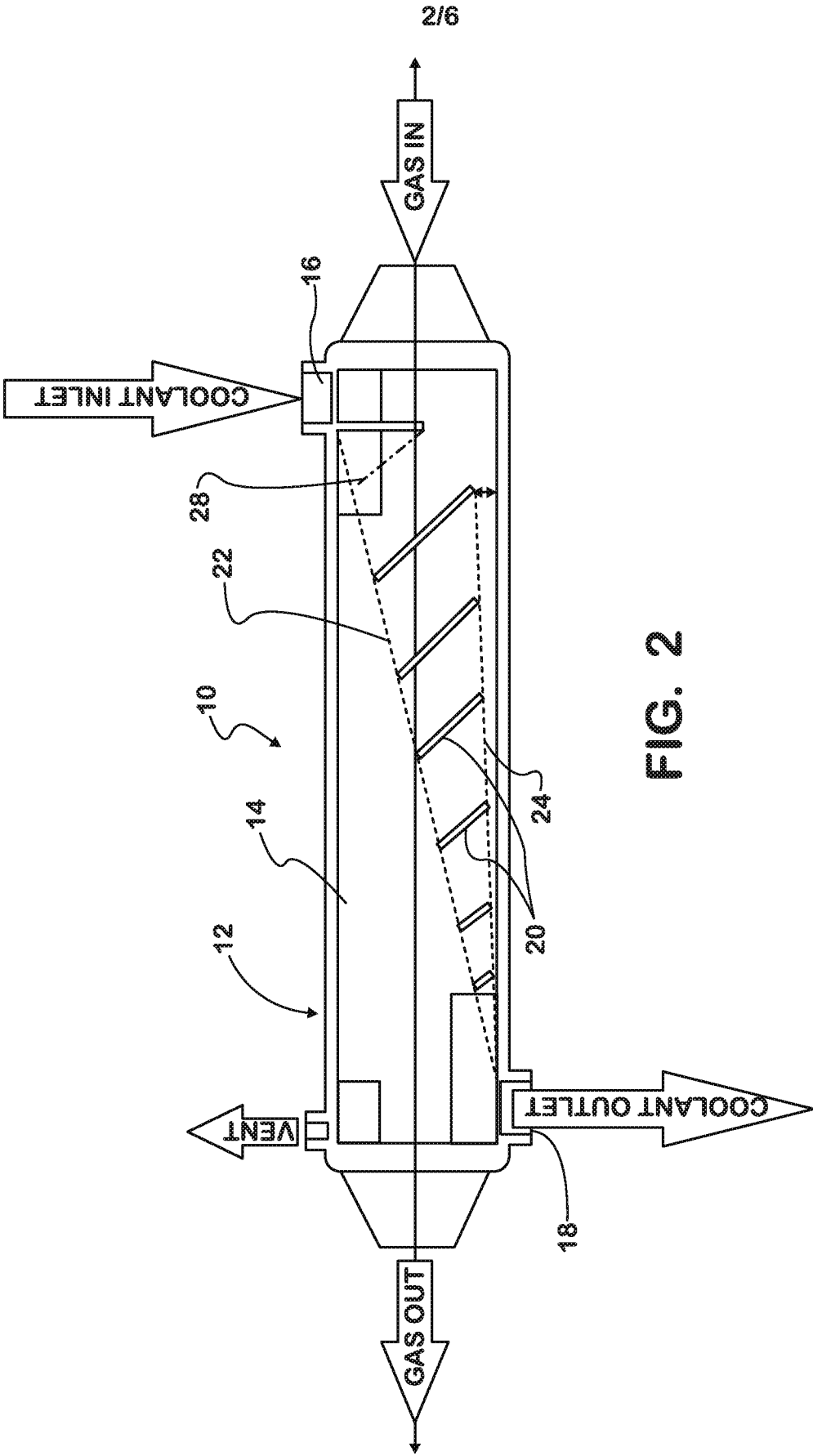


FIG. 1
PRIOR ART



----- REFERENCE LINE USED TO DETERMINE BAFFLE POSITION AND HEIGHT
-.-.- FLOW TURN - AROUND ANGLE. ALL BAFFLES SHOULD BE PARALLEL TO THIS REFERENCE LINE

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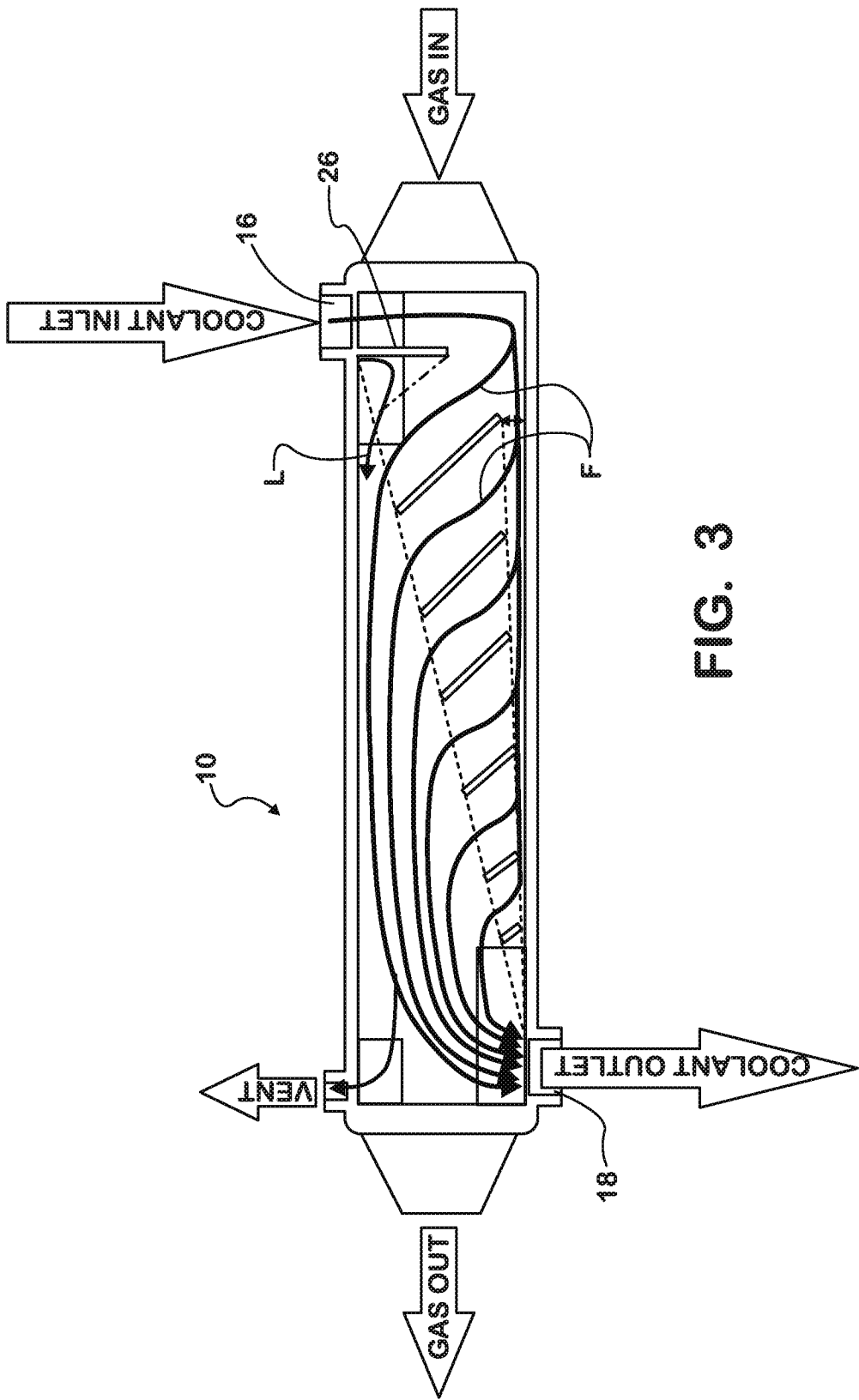
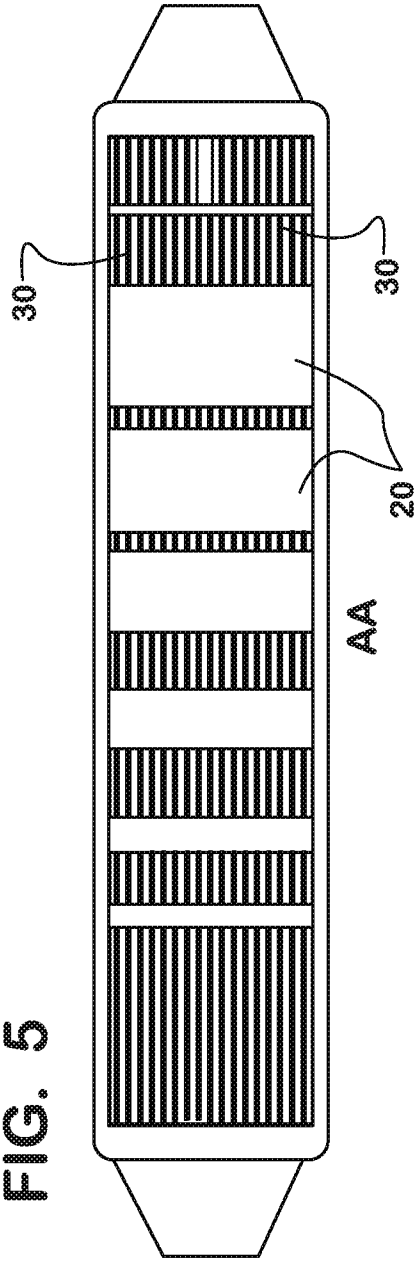
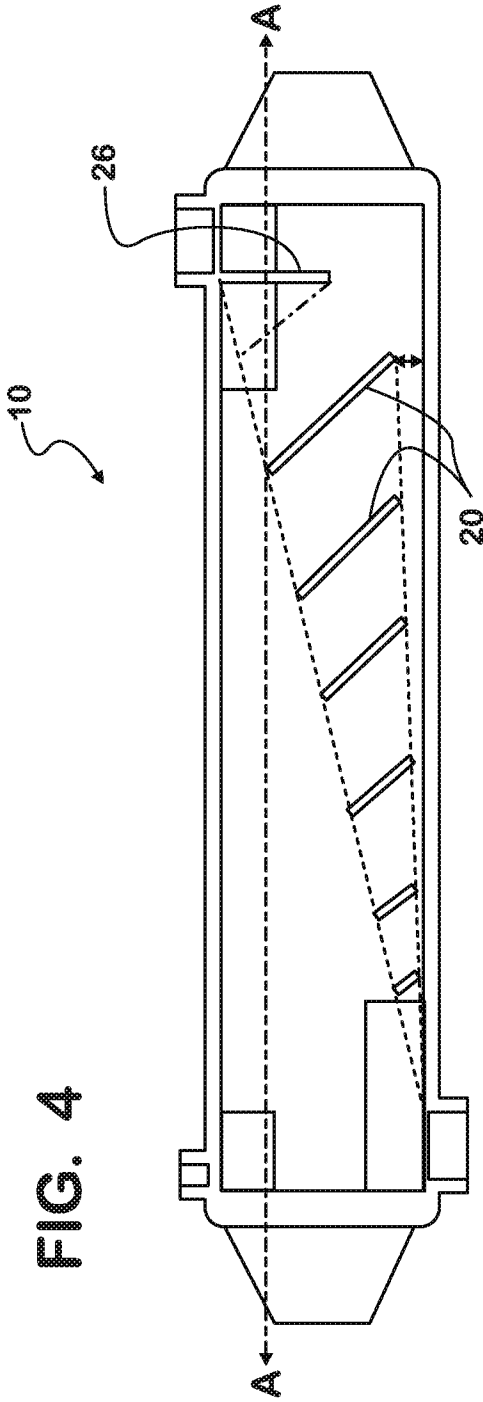
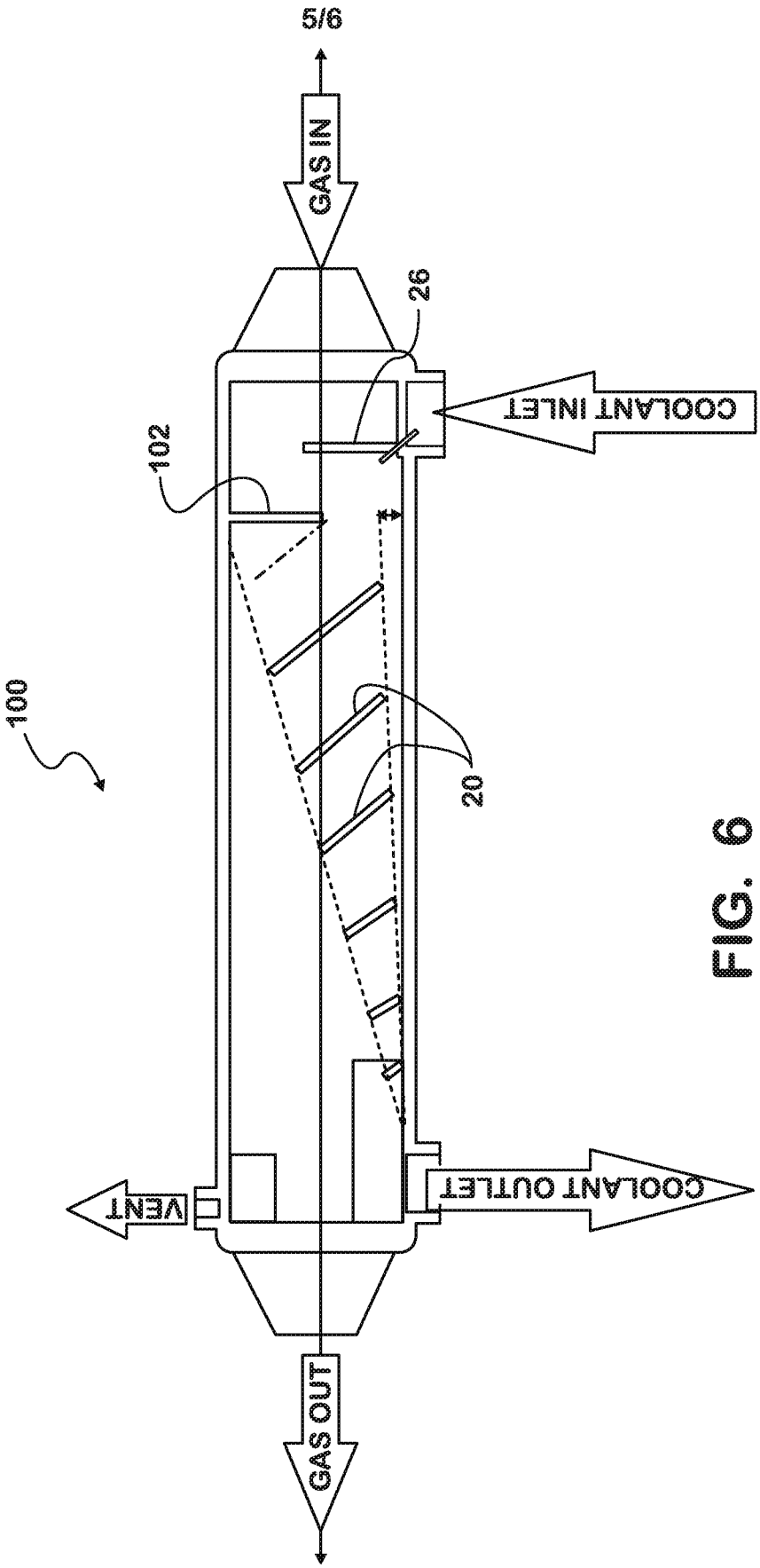


FIG. 3





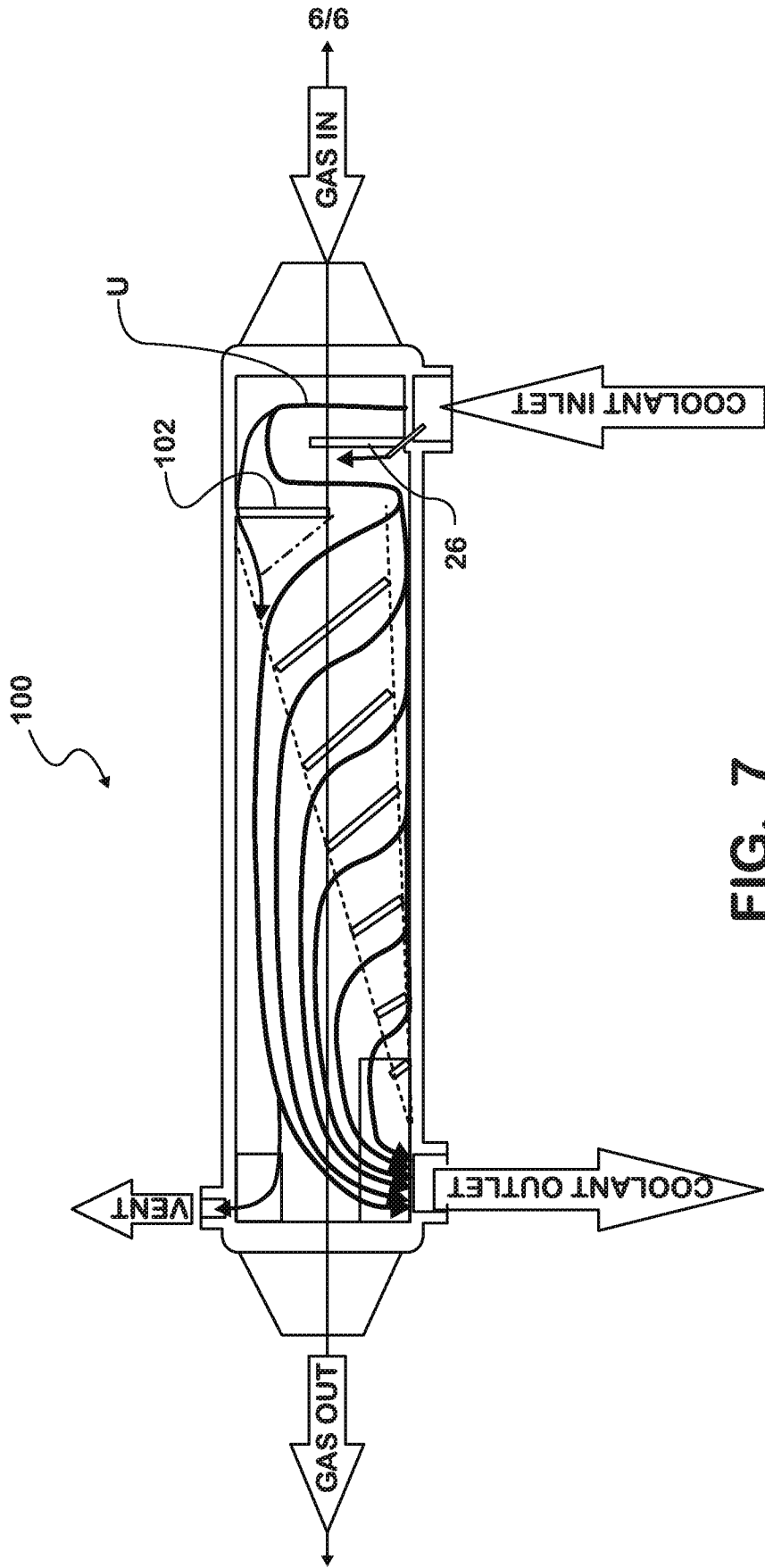


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/024622

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F02G 5/02 (2012.01)

USPC - 60/320

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - F01N 3/00, 3/02, 3/04; F02G 5/00, 5/02; F28D 1/02, 1/04, 1/047, 1/053 (2012.01)

USPC - 60/320; 123/568.12; 165/104.21, 159, 160, 161, 174

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/0022982 A1 (DILLEY et al) 03 February 2005 (03.02.2005) entire document	1-15
A	US 6,125,926 A (OKAMOTO et al) 03 October 2000 (03.10.2000) entire document	1-15
A	US 3,962,869 A (WOSSNER) 15 June 1976 (15.06.1976) entire document	1-15

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

09 May 2012

Date of mailing of the international search report

23 MAY 2012

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