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(54) **OIL FILTERING AND COOLING SYSTEM FOR COMPRESSION IGNITION ENGINES**

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(21) Appl. No.: **14/627,160**

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Related U.S. Patent Documents

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Appl. No.: **13/427,778**
Filed: **Mar. 22, 2012**

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F01M 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***F01M 5/00*** (2013.01)

(58) **Field of Classification Search**
CPC F01M 5/00
USPC .... 123/196 R, 41.33; 184/104.3; 29/888.01
See application file for complete search history.

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(57) **ABSTRACT**

An oil distribution and cooling system for diesel engines of the design represented by the 6.4L POWER STROKE® engine. The stock oil cooler and cover are removed and a manifold is positioned in place of the removed stock oil cooler and cover. The block has oil in, oil out, coolant in and coolant out ports which align with those on the engine. Coolant is directed to an adapter plate and a relocated oil cooler which may be the removed cooler or a replacement, preferably of the oil-to-air type. Oil to be filtered and cooled is directed through the manifold to a filter and then to the cooler. Cool, clean oil is returned to the manifold for distribution to various engine locations.

12 Claims, 9 Drawing Sheets

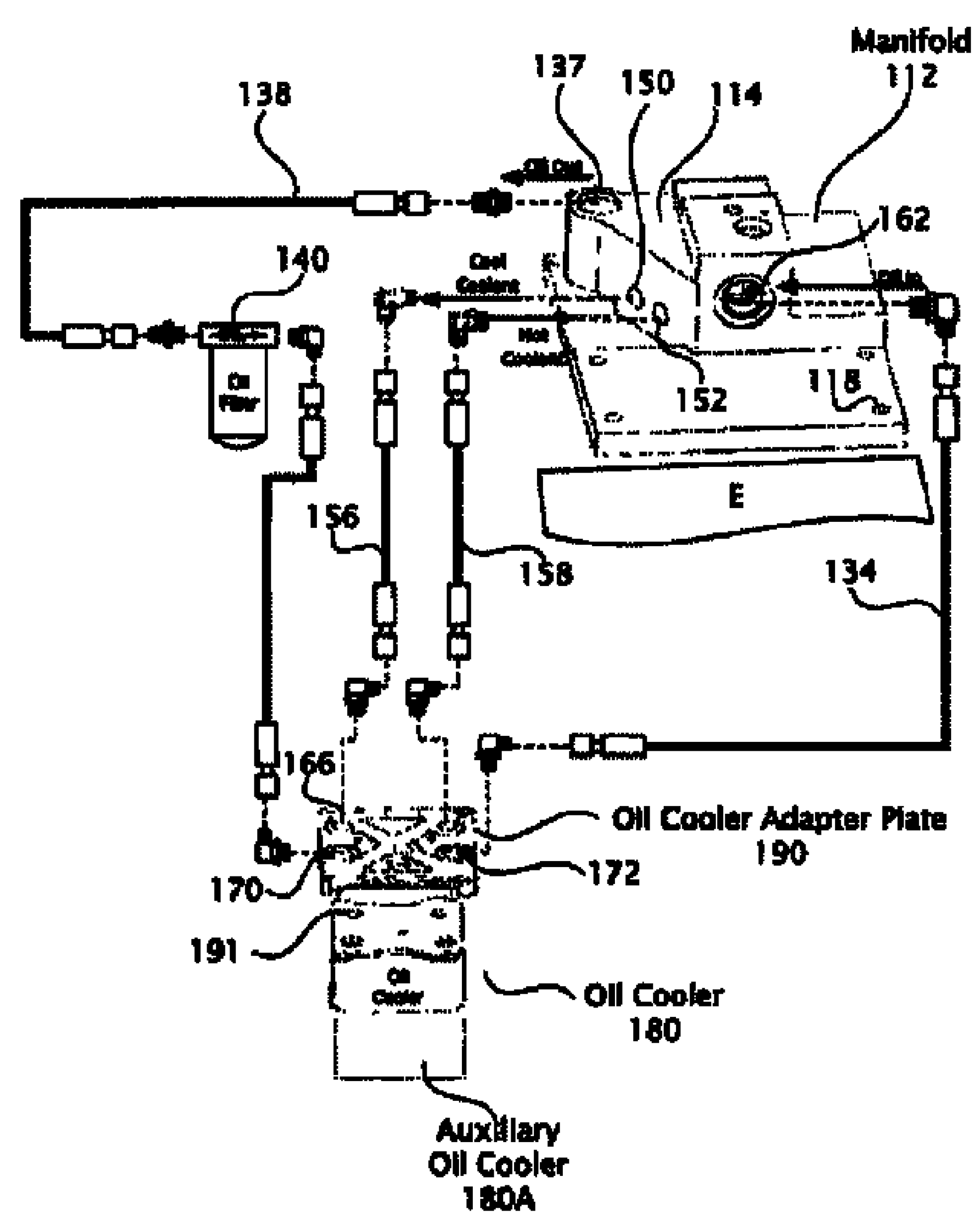

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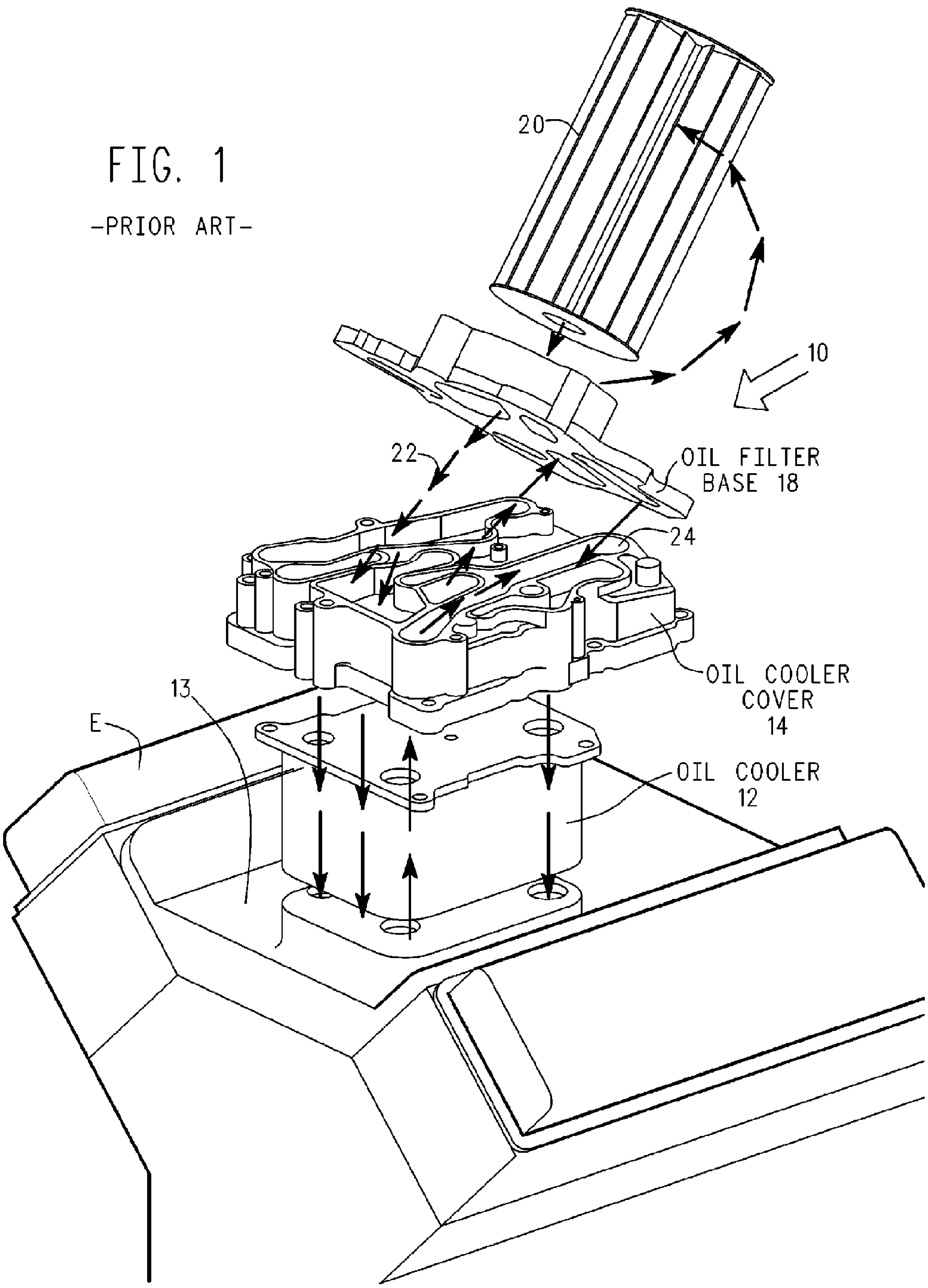
FIG. 1

-PRIOR ART-



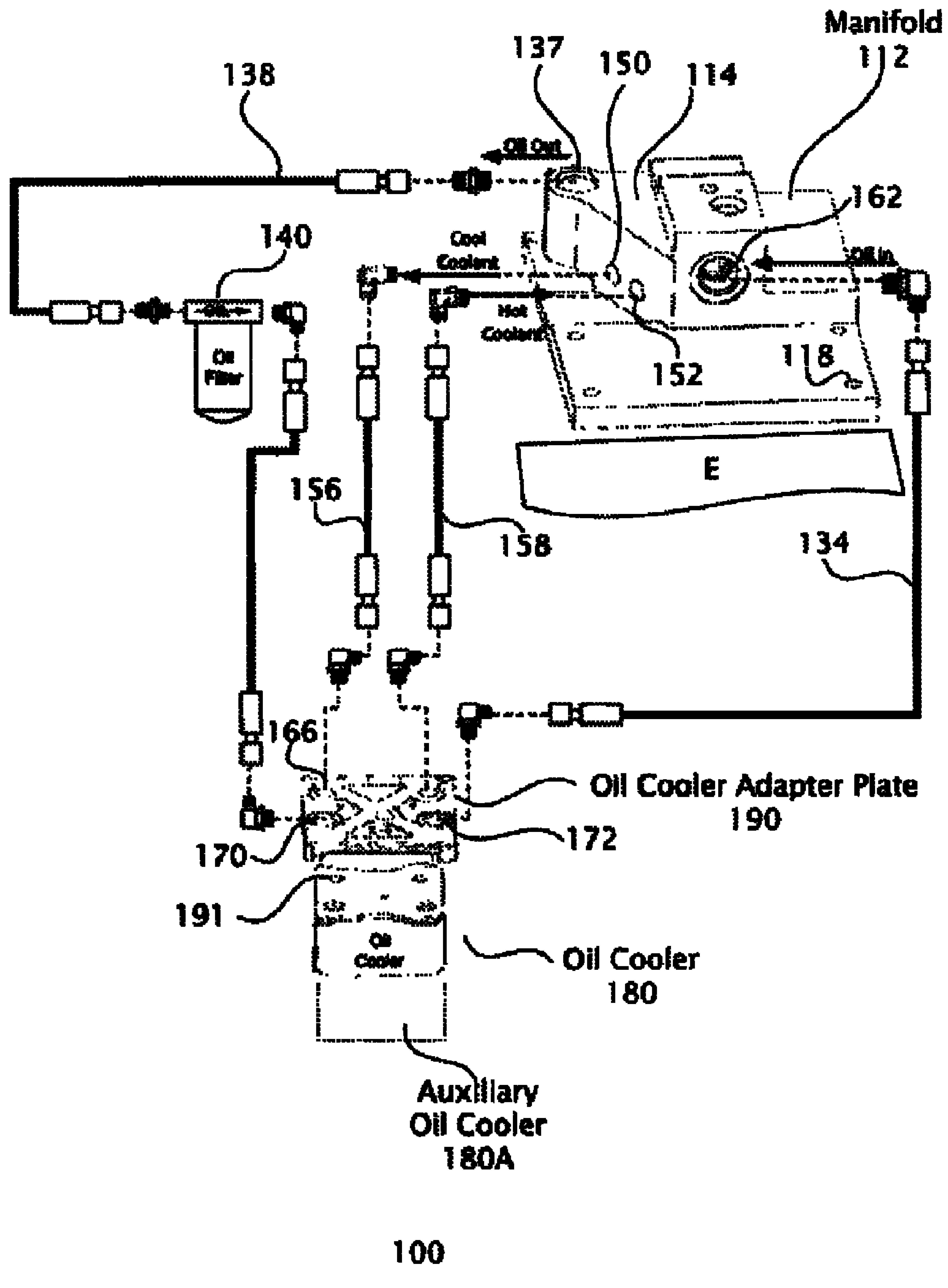
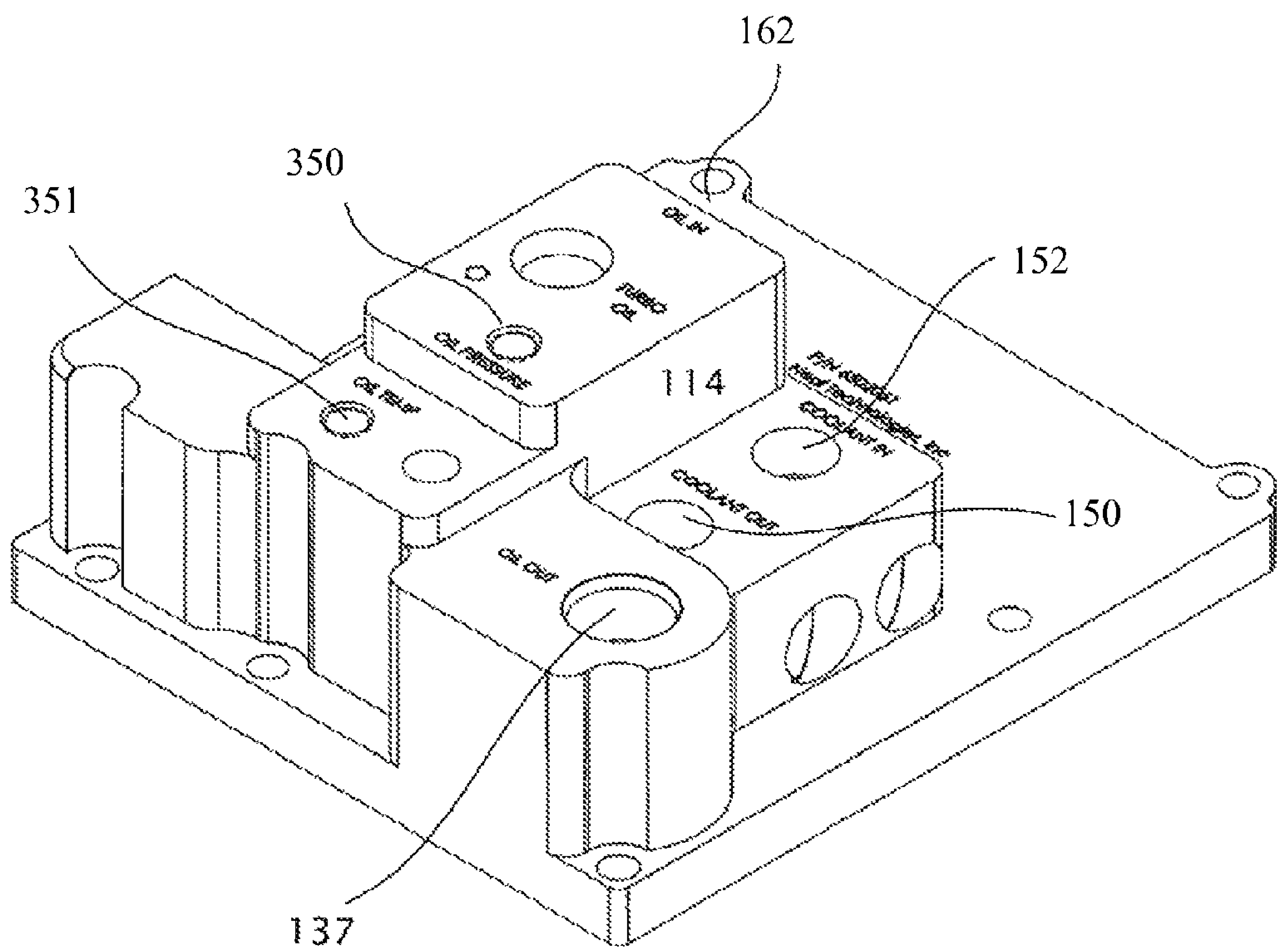
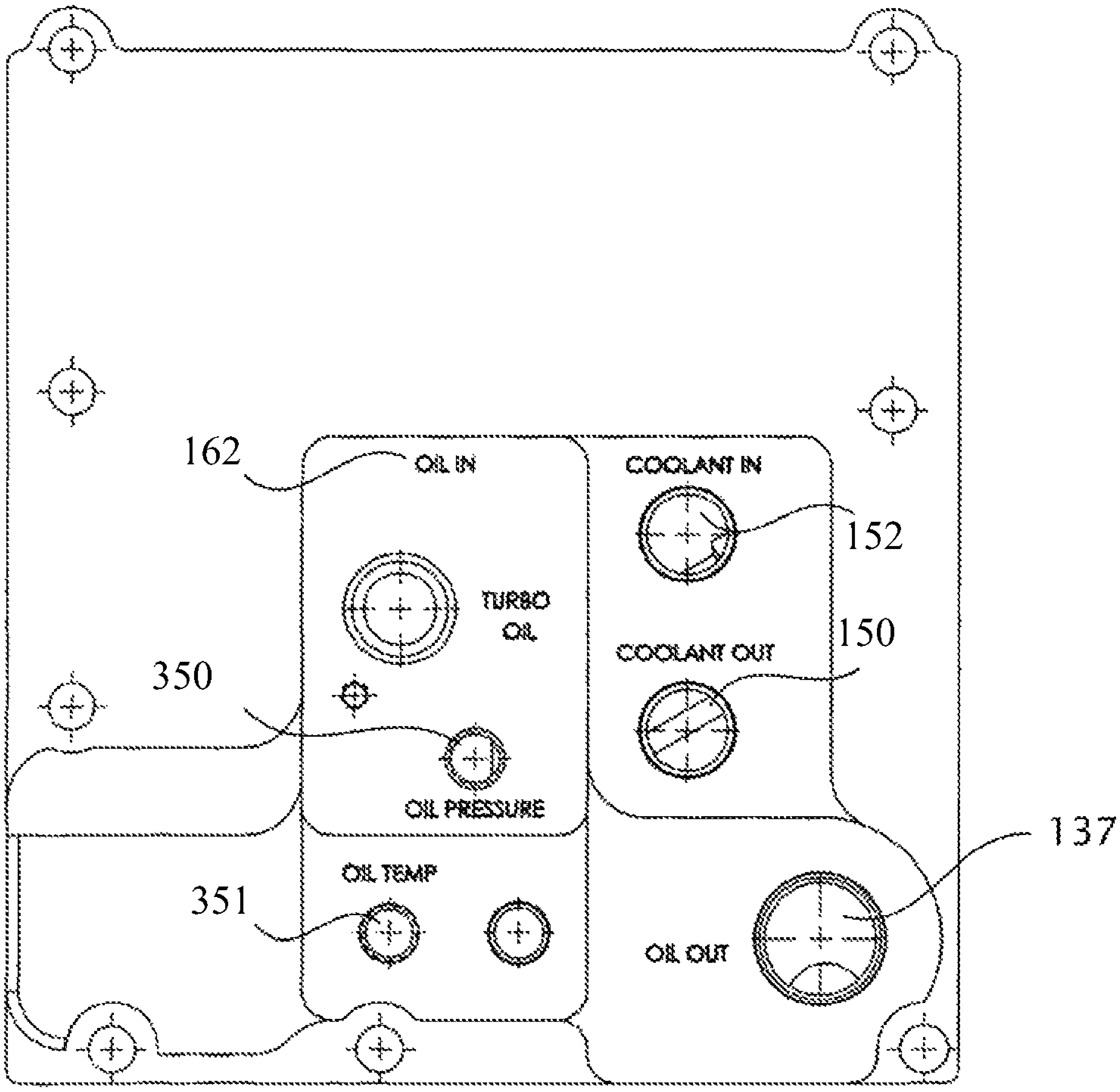

Manifold
112
137
150
114
138
Oil Out
162
140
Cool
Coolant
Oil In
Hot
Coolant
Oil
Filter
152
118
E
156
158
134
166
Oil Cooler Adapter Plate
190
170
172
191
Oil
Cooler
Oil Cooler
180
Auxiliary
Oil Cooler
180A
100

FIG. 2



Manifold
112

FIG. 3



Manifold
112

FIG. 4

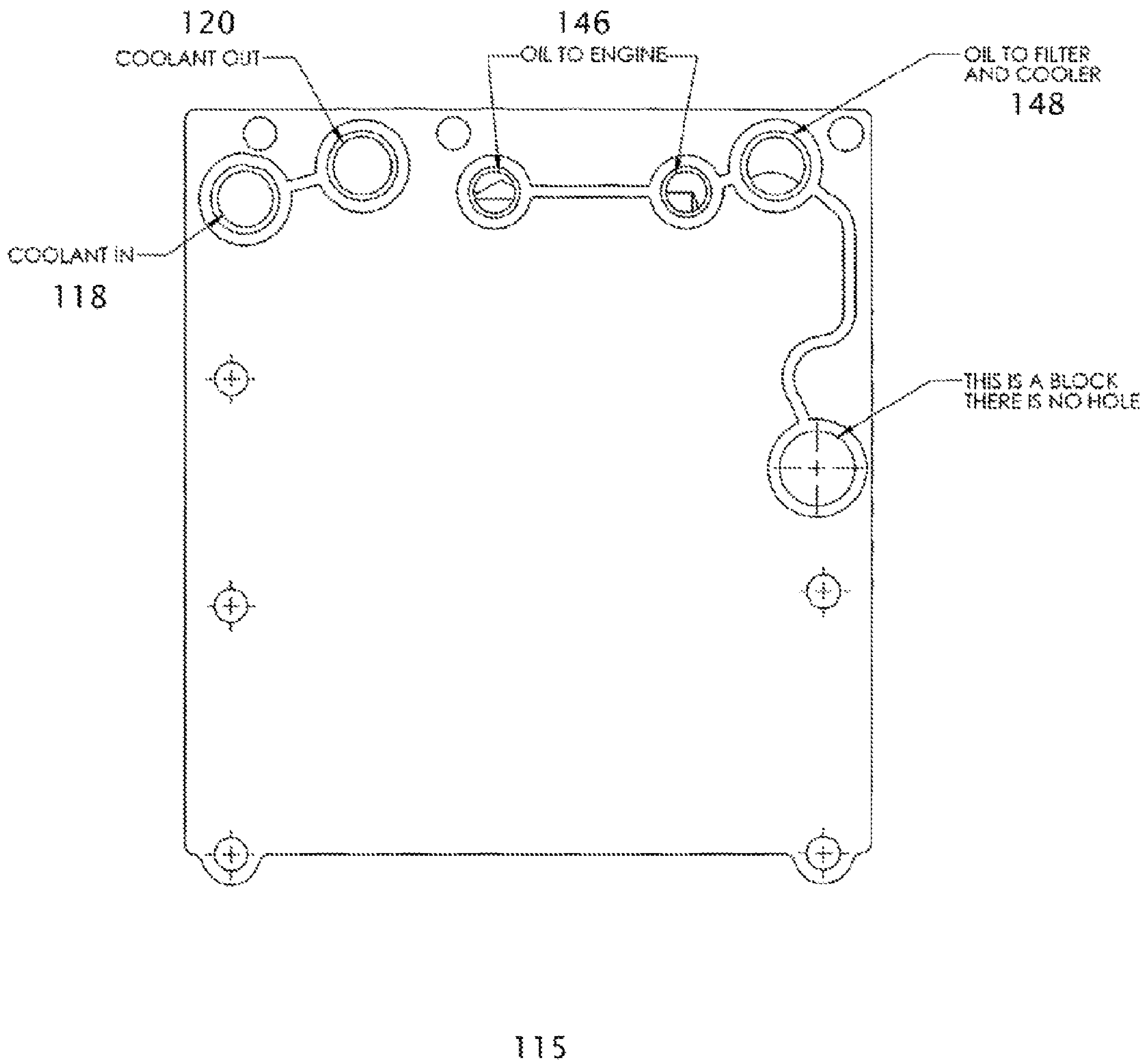
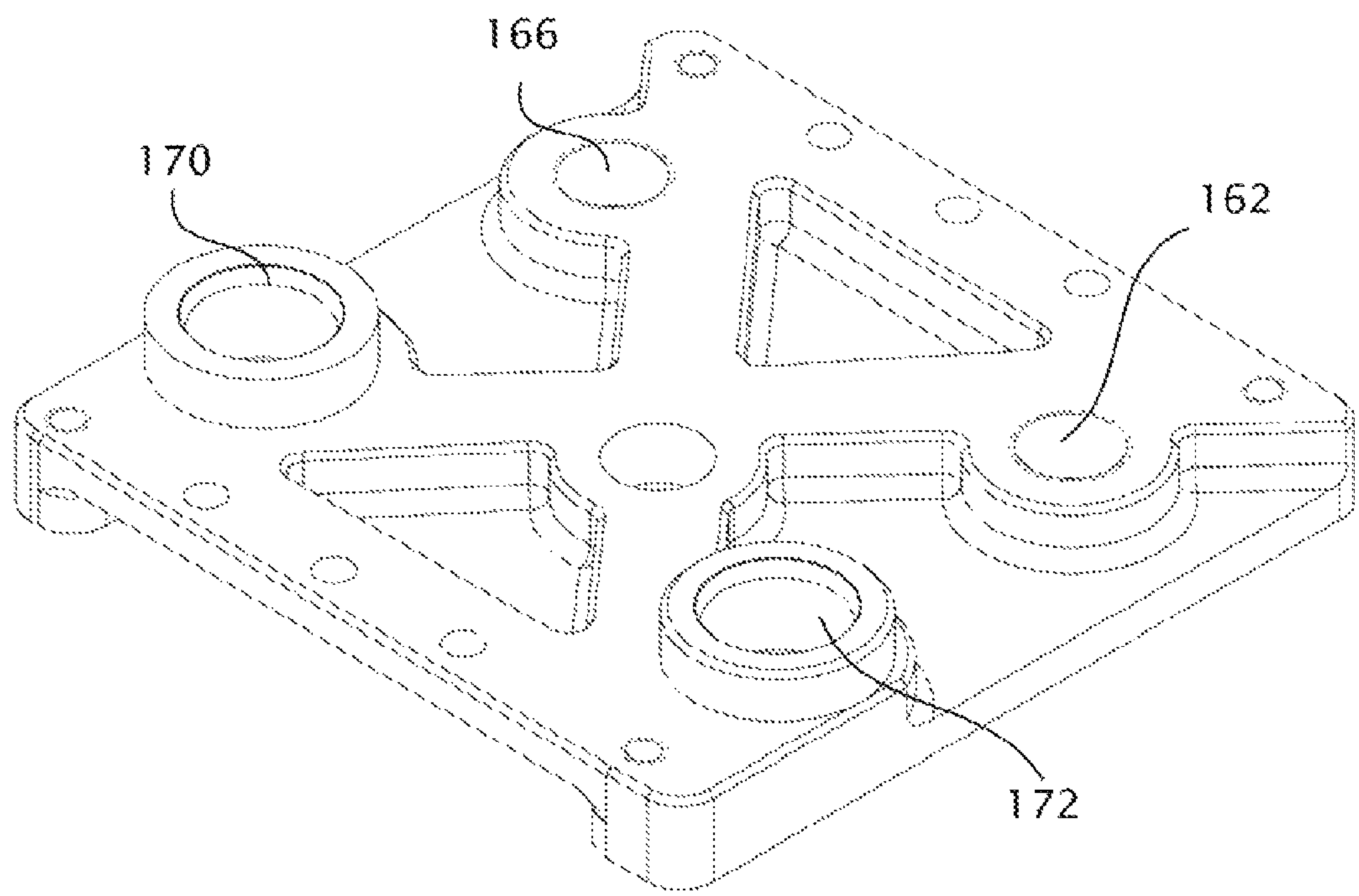
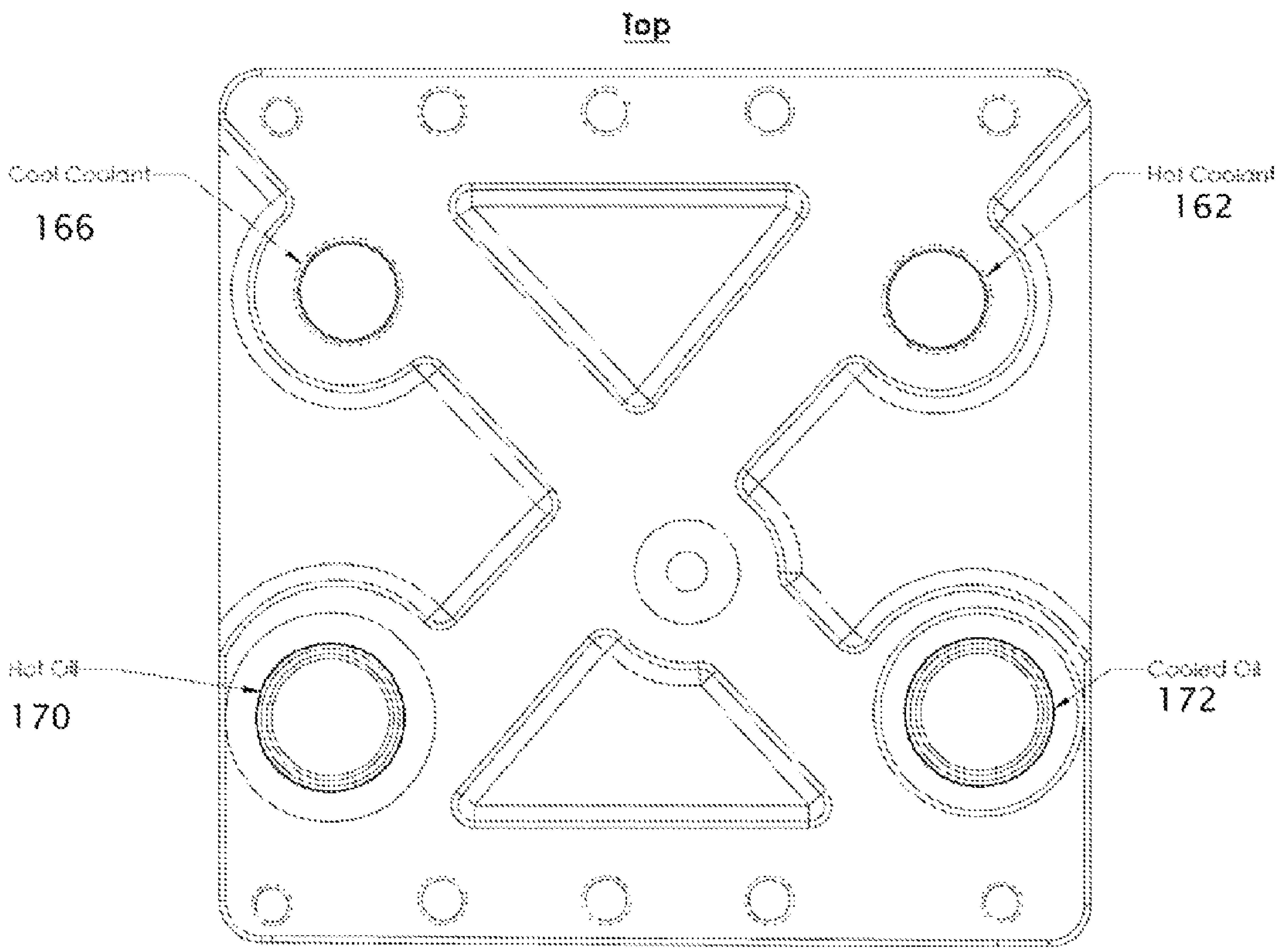

120
COOLANT OUT
146
OIL TO ENGINE
OIL TO FILTER AND COOLER
148
COOLANT IN
118
THIS IS A BLOCK THERE IS NO HOLE
115

FIG. 5



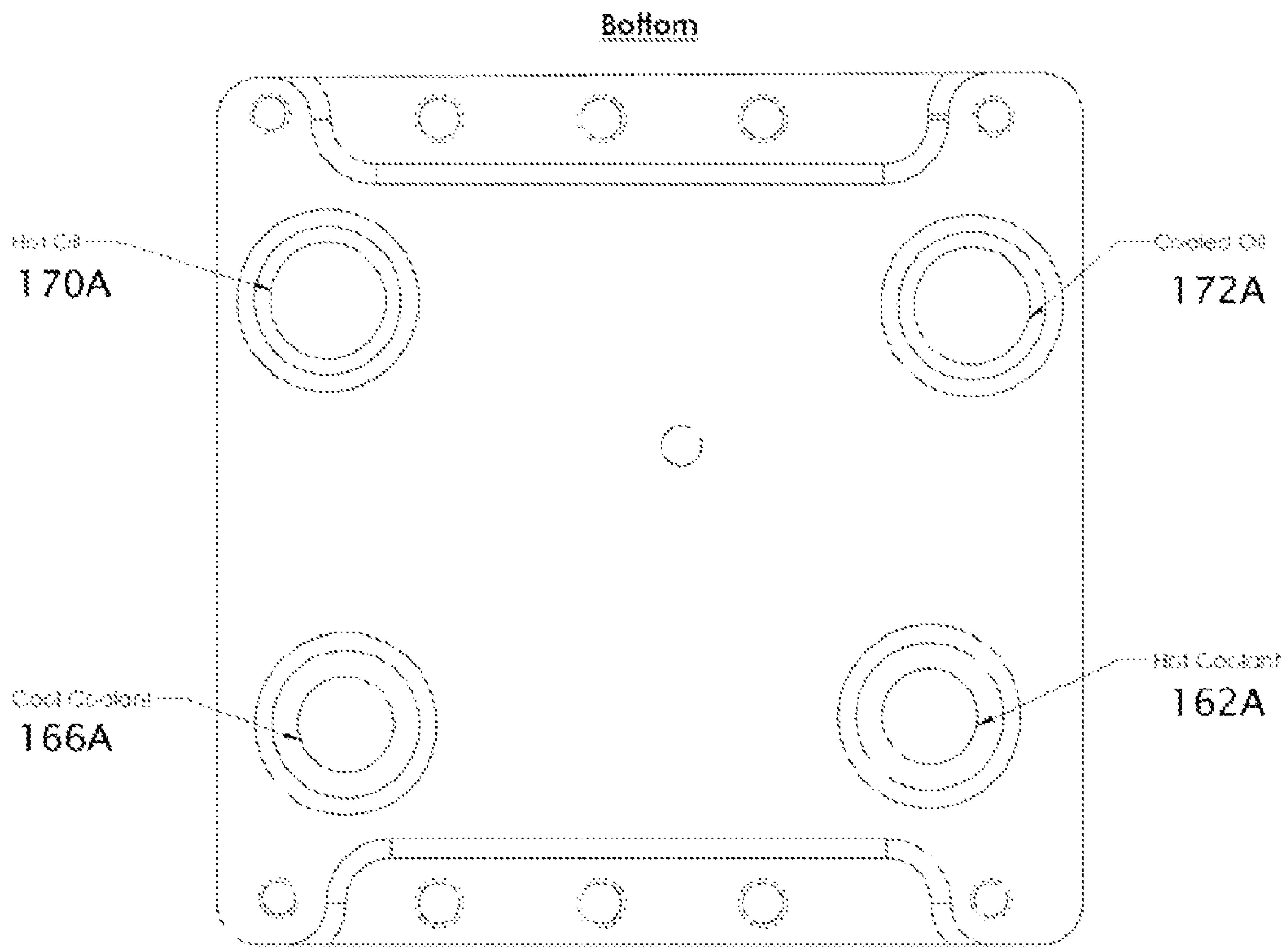
Oil Cooler Adapter Plate
190

FIG. 6



Oil Cooler Adapter Plate
190

FIG. 7



Oil Cooler Adapter Plate
190

FIG. 8

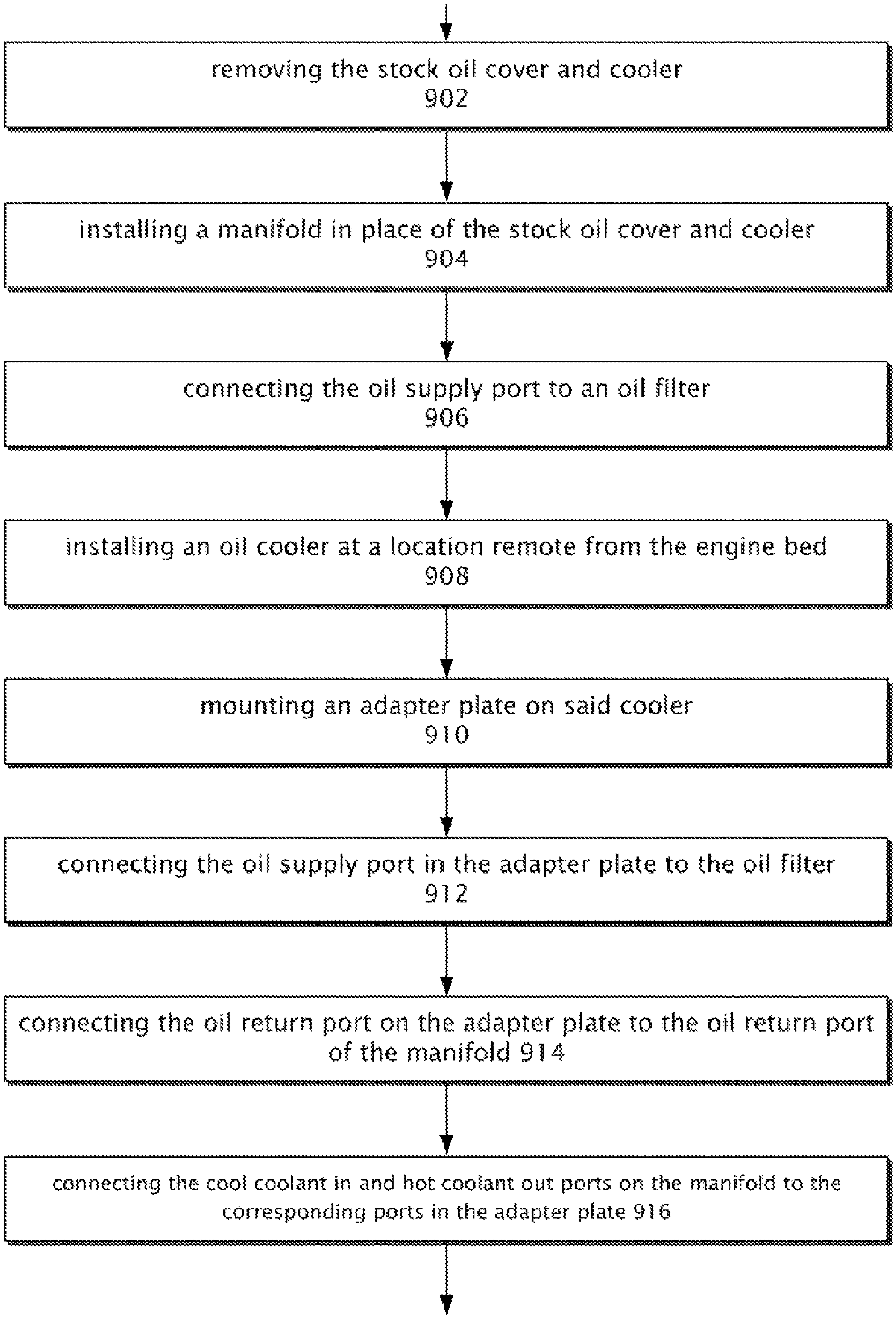

removing the stock oil cover and cooler
902
installing a manifold in place of the stock oil cover and cooler
904
connecting the oil supply port to an oil filter
906
installing an oil cooler at a location remote from the engine bed
908
mounting an adapter plate on said cooler
910
connecting the oil supply port in the adapter plate to the oil filter
912
connecting the oil return port on the adapter plate to the oil return port of the manifold 914
connecting the cool coolant in and hot coolant out ports on the manifold to the corresponding ports in the adapter plate 916

FIG. 9

OIL FILTERING AND COOLING SYSTEM FOR COMPRESSION IGNITION ENGINES

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

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application claims the benefit of U.S. Provisional Patent Application No. 61/465,706 filed Mar. 22, 2011, the contents of which are hereby incorporated by reference.

TECHNICAL FIELD

The present example relates generally to lubrication systems and more specifically relates to oil cooling and filtration systems for diesel engines that may be provided as an original equipment manufacturer ("OEM") system. The present example also more specifically relates to a method of aftermarket modification to existing engines to enhance the lubrication system.

BACKGROUND

Diesel or compression ignition engines are widely used in both light and heavy duty trucks. The well known FORD® F Series and E Series vehicles may utilize diesel engines, such as the 6.0 L and 6.4 L POWER STROKE® engines. These type diesel engine designs may have an oil cooler that is mounted in the bed, or valley, on the top of the engine, beneath an oil filter which is typically a canister-style filter.

Oil is drawn from the oil pan or reservoir through a pick up tube and directed by an oil generated rotor ("gerotor") pump, or its equivalent, to the top mounted oil cooler and then to the oil filter. Oil to be cooled is routed to the oil cooler by passageways in the oil filter base. The stock oil cooler is a plate-style, liquid-to-liquid heat exchanger or cooler in which the oil to be cooled is in heat exchange relationship with engine coolant. The coolant from the engine cooling system passes through the oil cooler to extract heat from the oil. After exiting the cooler, the cooled and filtered oil is directed to various engine locations requiring lubrication and other locations such as the oil reservoir for the high pressure pump, the injection galleries, EOT and EOP sensors and to the turbo charger, if the engine is so equipped.

The oil distribution and cooling and filtration systems of conventional automotive diesel engines often present problems, as the oil cooler is top mounted in the engine valley on an oil filter base. The oil filter base includes an oil drain, to drain oil from the filter base during an oil change. If the oil drain becomes clogged, the result may be oil spillage during an oil change once the filter is removed. A faulty drain valve can also result in a critical and potentially damaging loss of lubricating oil.

Another problem with conventional oil cooler and filter systems is that these systems are expensive to repair and service. Space limitations present difficulty and obstruction to modifying the oil and cooling systems to enhance performance and engine durability.

As mentioned, diesel engines similar in construction to those described above, are widely used in automotive or highway applications. Diesel engines also have broad application and are used for marine, industrial, power generation and other mobile and fixed applications. These types of diesel engines often encounter the same or similar problems with lubrication systems as described with reference to automotive applications.

SUMMARY

The following presents a simplified summary of the disclosure in order to provide a basic understanding to the reader. This summary is not an extensive overview of the disclosure and it does not identify key/critical elements of the invention or delineate the scope of the invention. Its sole purpose is to present some concepts disclosed herein in a simplified form as a prelude to the more detailed description that is presented later.

The present example provides an improved oil distribution, filtering and cooling system which is particularly adapted to automotive diesel engines of the general type described above. The improved oil cooling and filtering system of the present example may be an OEM installation or may be retrofitted to an existing diesel engine, and includes a uniquely constructed manifold which, in one example, replaces the stock oil cooler and oil cooler cover. The manifold is mounted in place of the stock engine oil cooler which is removed. The configuration of the replacement manifold allows utilization of OEM gaskets and mounting hardware to facilitate installation.

Filtered oil is routed by the replacement manifold to an adapter plate having inlet and outlet ports for oil and inlet and outlet ports for engine coolant. The adapter plate mounts on an oil cooler. The oil and coolant ports in the adapter plate align with the corresponding ports in an oil cooler. The cooler may be the stock cooler which has been relocated from another engine location such as on the bed of the engine or may be a replacement cooler, preferably of the air-to-oil type. The adapter plate attaches to the cooler to direct oil and coolant through the cooler and returns these fluids to the manifold and to the engine. Multiple oil coolers of either the liquid-to-liquid or liquid-to-air type may be utilized depending on system requirements and space restrictions.

Many of the attendant features will be more readily appreciated as the same becomes better understood by reference to the following detailed description considered in connection with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

The present description will be better understood from the following detailed description read in light of the accompanying drawings, wherein:

FIG. **1** is a perspective view showing a standard or stock top-mounted oil cover, cooler and filter as provided by the automotive manufacturer and found on engines such as the FORD® 6.4 L F Series POWER STROKE DIESEL®.

FIG. **2** is a schematic of an example of the improved oil filtering and cooling system of the present example.

FIG. **3** is a perspective view of the oil and coolant manifold utilized in the present example replacing the stock cooler and cover.

FIG. **4** is a top view of the manifold shown in FIG. **3**.

FIG. **5** is a bottom plan view of the manifold shown in FIG. **3**.

FIG. **6** is a top perspective view of the oil cooler adapter plate which mounts on and is compatible with existing oil cooler engine mountings.

FIG. 7 is a plan view showing the top side of the adapter plate utilized in the system of the present example.

FIG. 8 is a bottom plan view of the adaptor plate shown in FIG. 6.

FIG. 9 is a flow diagram showing a process of modifying an oil distribution and cooling system for a stock diesel engine having an oil cover and cooler mounted in the bed of the engine.

Like reference numerals are used to designate like parts in the accompanying drawings.

DETAILED DESCRIPTION

The detailed description provided below in connection with the appended drawings is intended as a description of the present examples and is not intended to represent the only forms in which the present example may be constructed or utilized. The description sets forth the functions of the example and the sequence of steps for constructing and operating the example. However, the same or equivalent functions and sequences may be accomplished by different examples.

The examples below describe an oil cooling and filtration system. Although the present examples are described and illustrated herein as being implemented in a diesel engine system, the system described is provided as an example and not a limitation. As those skilled in the art will appreciate, the present examples are suitable for application in a variety of different types of engine systems.

FIG. **1** is a perspective view showing a standard or stock top-mounted oil cover, cooler and filter which forms a standard oil filtration and cooling system as typically provided by the automotive manufacturer. FIG. **1** is representative of parts that might be found on a FORD® F Series POWER STROKE® 6.4 L diesel engine, but is representative of other oil distribution and lubrication systems to which the present example may be applied.

The stock system **10** utilizes a liquid-to-liquid stacked plate heat exchanger or cooler **12** mounted in the valley (**13**) of the engine E. The engine oil is pumped by an oil pump (not shown) to the oil cooler cover **14** where it is directed to the cooler **12**. A coolant pump (not shown), directs coolant to the heat exchanger **12**, where it flows through the aluminum fins and divider plates separating the oil and coolant in the cooler **12** to cool the oil circulating through the cooler. The cooled oil is then directed to the oil filter base **18** where it next enters the oil filter **20**. After filtration, the cool and clean oil is directed at **22** to various engine lubrication circuits for lubrication or for actuation of electro-hydraulic fuel injectors and to engine oil temperature ("EOT") and engine oil pressure ("EOP") sensors.

There are several problems that many vehicle owners and operators can experience with stock lubrication systems of this type. The stock oil-to-coolant oil cooler **12**, is typically a stacked plate and fin design which inherently defines numerous small fluid passageways which are susceptible to easily becoming blocked or obstructed over a period of use.

Another problem with the standard design is that the top mounted cooler does not afford convenient service access and its construction does not facilitate servicing or system modification which may be desirable to enhance oil cooling. The stock system has a cartridge-type filter **20** located on the top of the engine with a drain back valve (not shown) and passage **24** to drain the filter housing. In the event the drain **24** becomes clogged, oil spillage can occur during servicing or repair. The drain back valve can also become damaged or stuck "open," causing loss of oil to the engine.

FIG. **2** is a schematic diagram showing the unique oil filtering and cooling system **100** of the present example, which may replace a stock oil filtration and cooling system on a representative engine E, such as an exemplary a 6.4 L POWER STROKE® diesel. The Applicants' system **100** may be provided as a stock system, or a modification or replacement of a stock system including that of the type previously described in FIG. **1**. The fittings and hoses shown are exemplary and may be changed, altered or otherwise equivalently changed to couple the components in a desired application. The unique oil filtration and cooling system of the present example is generally designated by the numeral **100** and includes a specially designed manifold **112**, an oil cooler adapter plate **190** coupled to a remotely mounted oil cooler **180**, and a remotely mounted oil filter **140**. Remote mounting of the oil filter **140**, and oil cooler **180**, can allow for the alleviation of the before mentioned problems with a stock system, including accessibility, improved cooling and spill prevention.

Specially designed manifold **112**, which mounts in the valley of the engine E replacing the conventional oil cooler and cover normally in this location. The specially designed manifold **112** couples to existing bolt patterns on an engine block, Manifold **112** also couples to engine coolant passageways and oil passageways disposed in engine E. Engine oil may be routed to an externally disposed filtration device, and then to an externally mounted oil cooler **180**. Also, coolant may be routed to an externally mounted oil cooler **170**. A plurality of mounting bores, such as the exemplary mounting hole **118** are provided to align with the existing mounting location on the engine E to match those of the stock cooler.

The manifold **112** may include, an oil out port **137** which receives oil from the crankcase. Crank case oil is routed away from the engine through port **137** via oil line **138** coupled to the oil filter **140**.

Oil filter **140** may be conventionally constructed and include a suitable mounting fixture, if of the "spin on" type. Alternatively the filter may be a cartridge type filter, with an external cover. Oil filter assembly **140** includes an oil out port where filtered oil may be coupled via supply line **139** to an oil cooler input port **170** provided on the oil cooler adapter plate **190**.

The oil cooler **180**, may be a stock oil cooler **180**, or its equivalent, remotely mounted. The oil cooler **180**, may be coupled to an oil cooler adapter plate **190**, that, in the case of a stock oil cooler, reproduces the mounting configuration of the engine E. Filtered and cooled oil exits the oil cooler **180** at port **172** and is routed back to the specially designed manifold plate **112**, via supply hose **134**. Supply hose **134** couples to the oil input port **162**.

Coolant is also routed by specially designed manifold **112**. Coolant from the engine cooling system is received by the manifold **115** at a port **162** which aligns with the coolant port at the mounting location of the removed stock oil cooler.

Cool coolant is directed by the manifold through port **150** through coolant line **156**. Line **156** connects to port **166** in the adaptor plate **190** which is mounted to cooler **180**. Port **166** aligns with the coolant in port **191** on the cooler. Similarly, hot coolant returning to the engine E after passage through the cooler **180** returns via line **158** to manifold port **152**.

The cooler **180** is mounted to adapter plate **190**, as described and seen in FIGS. **6**, **7** and **8**, having hot oil inlet **170** and cool oil outlet ports **172**.

The cooler **180** can be mounted or relocated in a suitable location such as on the vehicle bumper or other location in the engine compartment, such as on the condenser, to provide maximum heat transfer and serviceability. The cooler **180** may be the stock oil-to-coolant cooler removed from the top of the engine E and relocated or may be a replacement cooler preferably of the air-to-oil type.

If the cooler **180** is a replacement air-to-liquid cooler, preferably it is a tube and fin style with the oil passing through the tubes and cooled by the passage of air through the cooler. The engine fan operates to move air through the oil cooler if the cooler **180** is properly placed rearward of the condenser so that even under extended idle conditions, the engine fan will provide an adequate airflow through the cooler across the heat exchange tubes.

The enhanced cooling provided by the system tends to eliminate the problem of early system failure and engine wear due to overheated engine oil. Mixing of coolant and oil may also avoided as the cooler is an air-to-liquid cooler. Engine oil temperatures are independent of coolant temperatures and adequate coolant supply which, if not proper, would be harmful to a conventional coolant-based oil cooling system.

The oil filtering and cooling system of the present example is highly versatile. For example, additional oil coolers **180**A can be added to the system for increased cooling. This can be accomplished by installing multiple coolers **180**, **180**A in series, as shown in dotted lines in FIG. **2**, each would be located for optimum airflow across the heat exchange element. The additional coolers may be either oil-to-air, oil-to-coolant or a system utilizing both.

FIG. **3** is a perspective view of the oil and coolant manifold **112** utilized in the present example replacing the stock cooler and cover. The manifold **112** has a body **114** constructed of steel, aluminum or other suitable material. The body **114** of the manifold includes, an oil out port **137**, an oil in port **142** which receives filtered and cooled oil from the cooler.

The fully filtered and cool oil is returned to the manifold at port **142** and is then directed by the manifold **115** to the various engine oil circuits. A high pressure, stainless steel oil pump filter screen may be integrated internally in the body **114** of the manifold in one of the oil passages to provide additional protection.

Coolant exits the manifold from port **150**, and subsequently returns via port **152**. Provision is made to allow the mounting of one or more sensors including an oil temperature sensor at location **351** and an oil pressure sensor at location **350**.

FIG. **4** is a top view of the manifold **112** shown in FIG. **3** providing a better view of ports **137**, **162**, **150**, **152**, **350** and **351**. Typically these ports may be threaded for accepting sensor modules and mating threaded couplers. Alternatively other suitable connections may be provided. Ports **350**, **351** for EOP and EOT sensors are preferably located in the top of the manifold.

FIG. **5** is a bottom plan view of the manifold **112** shown in FIG. **3**. Coolant in **118** and coolant out **120** ports are shown in the bottom or base view **115**. The various port locations align with the corresponding ports located in the engine valley location (E of FIG. **2**), where the stock cooler and cover have been removed.

The manifold **112** also has oil ports **146** for supplying oil to the engine, which ports aligns with the existing clean and cooled oil ports on the engine block E for distribution to the various engine locations. The manifold **112** may include port **148** where oil passes out of the manifold **112**, and then into the oil filter (**140** of FIG. **1**).

FIG. **6** is a top perspective view of the oil cooler adapter plate **190** which mounts to a stock engine oil cooler (**180** of FIG. **2**) and is compatible with existing oil cooler engine mountings. FIG. **7** is a plan view showing the top side of the adapter plate utilized in the system of the present example showing the same connections. Hot oil flows into the cooler adapter plate **190** at port **170**. Low temperature coolant is coupled to adapter at port **166**, and leaves after flowing through the attached cooler via port **162** for hot coolant. Cooled oil leaves from the cooler via adapter plate port **172**, where it returns to the engine.

FIG. **8** is a bottom plan view of the oil cooler adaptor plate **190**. The bottom side of the plate, has coolant inlet and outlet ports **162**A, **166**A which may be disposed parallel to the corresponding ports in the cooler and oil ports **170**A and **172**A.

FIG. **9** is a flow diagram showing a process of modifying an oil distribution and cooling system for a stock diesel engine having an oil cover and cooler mounted in the bed of the engine. At block **902** the stock oil cover and cooler is removed. At block **904** a manifold in place of the stock oil cover and cooler, the manifold having oil supply and coolant supply ports aligning with existing passageways on the engine bed, said manifold having a coolant return port and an oil return port aligning with the corresponding ports in the engine bed is installed. At block **906** the oil supply port to an oil filter is connected. At block **908** an oil cooler may be installed at a location remote from the engine bed. At block **910** an adapter plate may be mounted on the cooler having oil supply and oil return ports and coolant supply and coolant supply ports. At block **912** the oil supply port in the adapter plate may be connected to the oil filter. At block **914** the oil return port on the adapter plate may be connected to the oil return port of the manifold. At block **916** the cool coolant in and hot coolant out ports on the manifold may be connected to the corresponding ports in the adapter plate.

Those skilled in the art will realize that the process sequences described above may be equivalently performed in any order to achieve a desired result. Also, sub-processes may typically be omitted as desired without taking away from the overall functionality of the processes described above.

The invention claimed is:

1. A method of modifying an oil distribution and cooling system for a liquid-cooled diesel engine, the engine having an original equipment oil cooler cover and an original equipment oil cooler mounted at an original location proximal the upper end of the engine in the engine valley, the engine further having an oil pump for circulating oil and a water pump for circulating coolant, the original equipment oil cooler comprising a liquid-to-liquid heat exchanger, said method comprising:

removing the original equipment oil cooler cover and oil cooler from the engine;

attaching a modified non-stock manifold to the engine in the engine valley, in the original location of the removed original equipment oil cooler, the manifold having oil supply and coolant supply ports aligning with existing passageways in the engine which supplied oil and coolant to the removed original equipment oil cooler, the oil supply port receiving a flow of oil from the engine oil pump, the coolant supply port receiving a flow of coolant from the engine water pump, the manifold further comprising coolant return and oil return ports aligning with existing passageways in the engine which returned oil and coolant from the removed original equipment oil cooler to the engine;

installing an oil cooler *with an adapter plate* at a location remote from the engine**[**; mounting an adapter plate to said oil cooler**]**, the adapter plate having a hot oil inlet port, a cool oil outlet port, a cool coolant inlet port and a hot coolant outlet port**[**;**]**, *the adapter plate further having:*

[attaching] (*a*) an external oil supply line *operatively attached* to the hot oil inlet port of the adapter plate to provide a flow of oil from the manifold to the oil cooler;

[attaching] (*b*) an external oil return line *operatively attached* to the cool oil outlet port of the adapter plate to provide a return flow of cooled, [filtered] oil from the oil cooler to the engine;

[attaching] (*c*) an external coolant supply line *operatively attached* to the cool coolant inlet port of the adapter plate to provide a flow of coolant from the manifold to the oil cooler; and

[attaching] (*d*) an external coolant return line *operatively attached* to the hot coolant outlet port of the adapter plate to provide a return flow of coolant from the oil cooler to the engine.

2. The method of claim **1**, further comprising:

installing an oil filter interconnected between the manifold and the oil cooler.

3. The method of claim **1**, wherein:

the engine is a Ford diesel engine.

4. The method of claim **1**, wherein:

the engine is a Ford 6.0 L Power Stroke diesel engine.

5. The method of claim **1**, wherein:

the engine is a Ford 6.4 L Power Stroke diesel engine.

6. The method of claim **1**, wherein:

the oil cooler is a plate-type oil cooler.

7. The method of claim **1**, wherein:

the oil cooler is a tube-and-fin type oil cooler.

8. The method of claim **1**, wherein:

the existing passageways in the engine which supplied oil to the removed original equipment oil cooler are in a common horizontal plane.

9. The method of claim **1**, wherein:

the existing passageways in the engine which supplied coolant to the removed original equipment oil cooler are in a common horizontal plane.

10. The method of claim **1** wherein the oil cooler is an original equipment oil cooler removed from the engine, which is reinstalled at a location that is distal from the original location on the engine.

11. The method of claim **1** wherein the oil cooler is an air-to-liquid cooler.

12. The method of claim **1** wherein multiple oil coolers are installed and interconnected.

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