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Dunn

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(54) **ADJUSTABLE WINDAGE TRAY AND METHOD FOR OPERATION OF THE ADJUSTABLE WINDAGE TRAY**

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F01M 11/00 (2006.01)
F01M 1/02 (2006.01)

(52) **U.S. Cl.**

CPC ***F01M 13/0011*** (2013.01); ***F01M 1/02*** (2013.01); ***F01M 11/0004*** (2013.01); *F01M 2011/005* (2013.01); *F01M 2013/0088* (2013.01)

(58) **Field of Classification Search**

CPC .. F01M 13/0011; F01M 1/02; F01M 11/0004; F01M 2011/005; F01M 2013/0088
See application file for complete search history.

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(57) **ABSTRACT**

Methods and systems are provided for adjusting a flow profile of a windage tray. In one example, a method for operation an engine system is provided that includes operating an engine to perform combustion, determining an engine speed, and adjusting a flow profile of a plurality of deflectors in a windage tray positioned in a crankcase based on the engine speed.

20 Claims, 6 Drawing Sheets

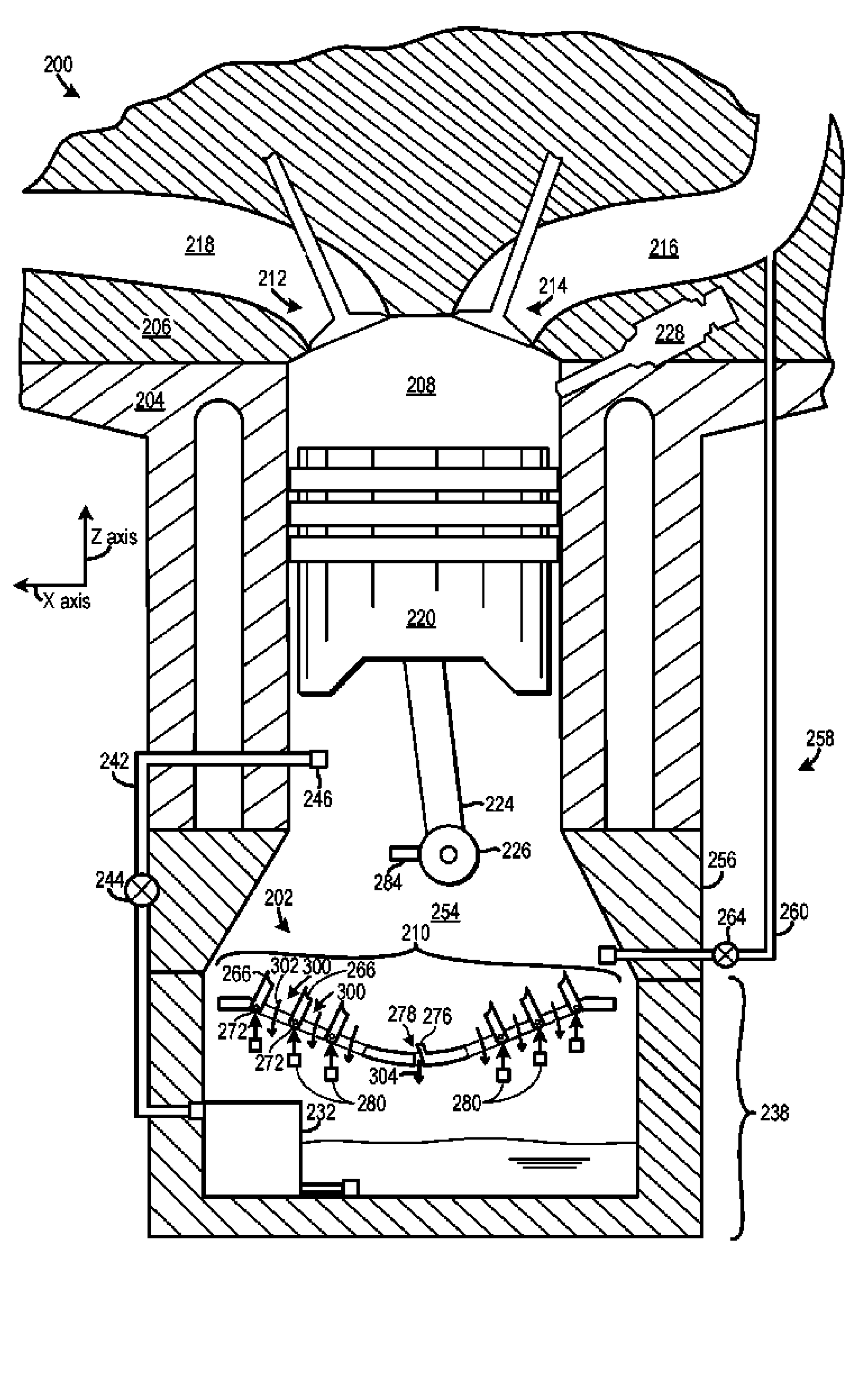
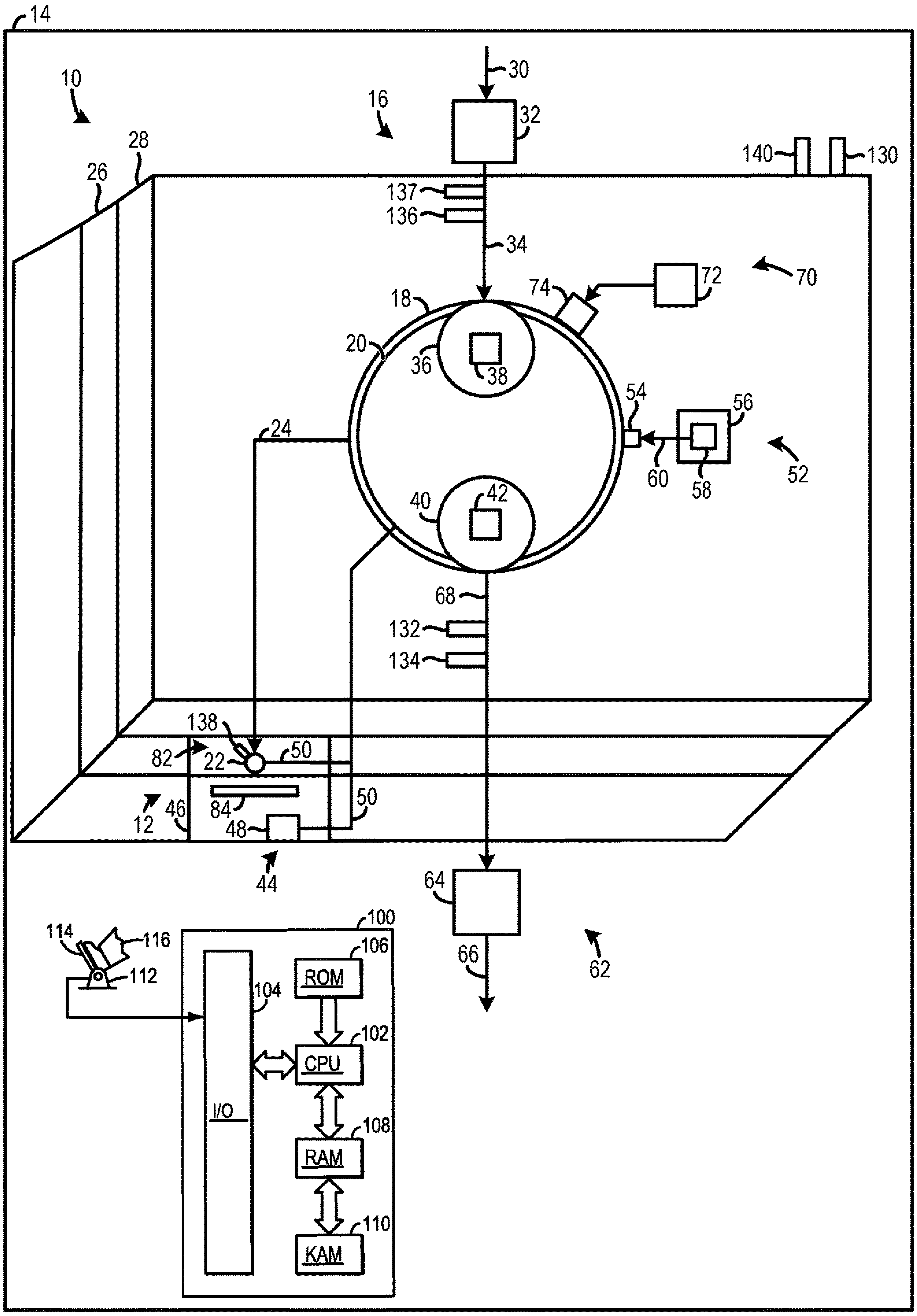


FIG. 1



14
10
16
30
32
28
26
140
130
137
136
34
72
70
74
18
20
36
38
54
56
24
60
58
52
40
42
68
132
134
138
82
22
50
46
84
50
12
48
44
64
62
66
100
114
116
106
112
ROM
104
102
CPU
I/O
108
RAM
110
KAM

FIG. 2

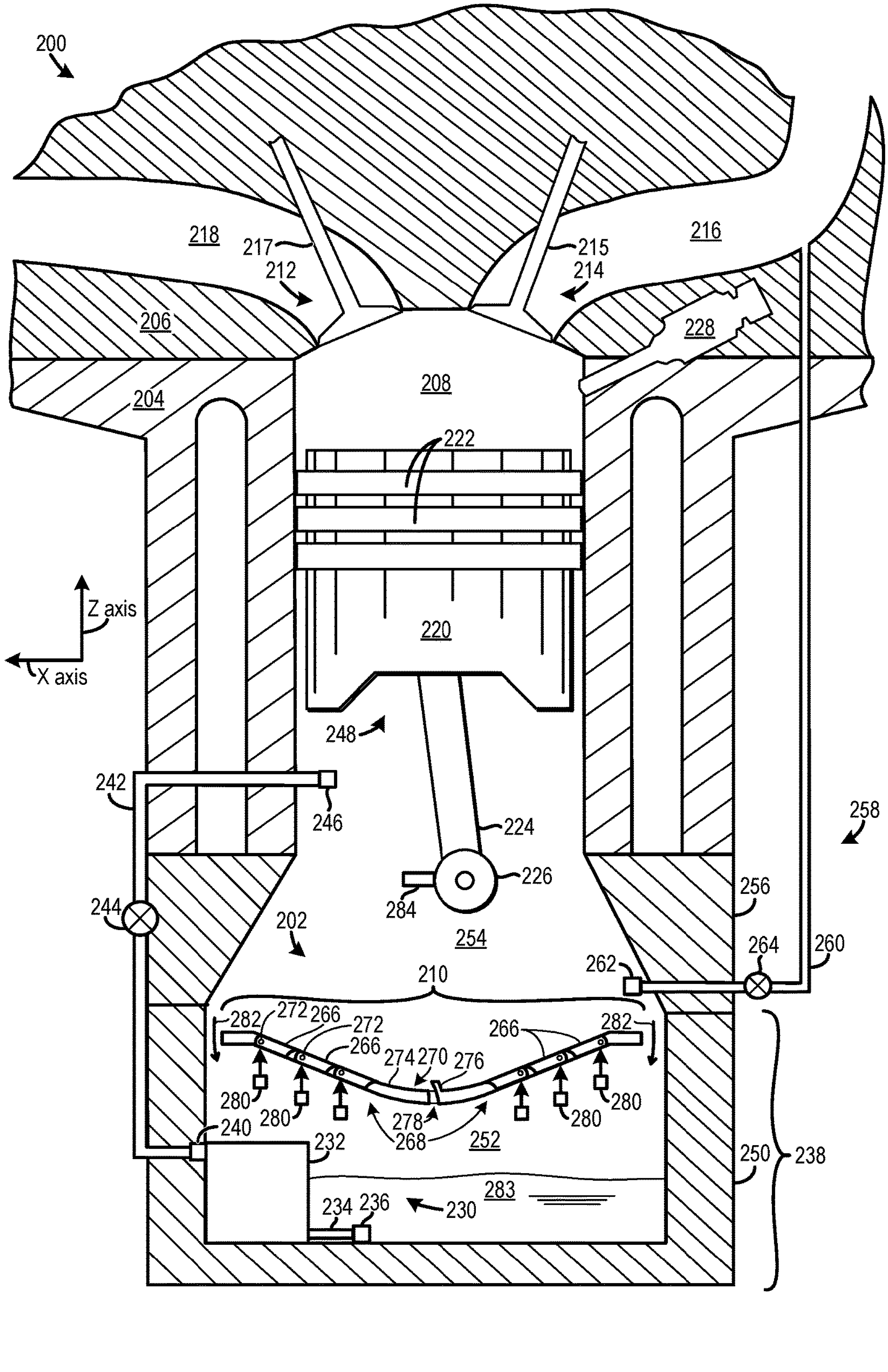

200
218
217
212
206
204
208
215
214
216
228
222
220
Z axis
X axis
248
242
246
224
226
284
244
202
254
258
256
264
260
262
210
282
272
266
272
266
274
270
276
266
282
280
280
280
280
278
268
252
240
232
250
238
283
234
236
230

FIG. 3

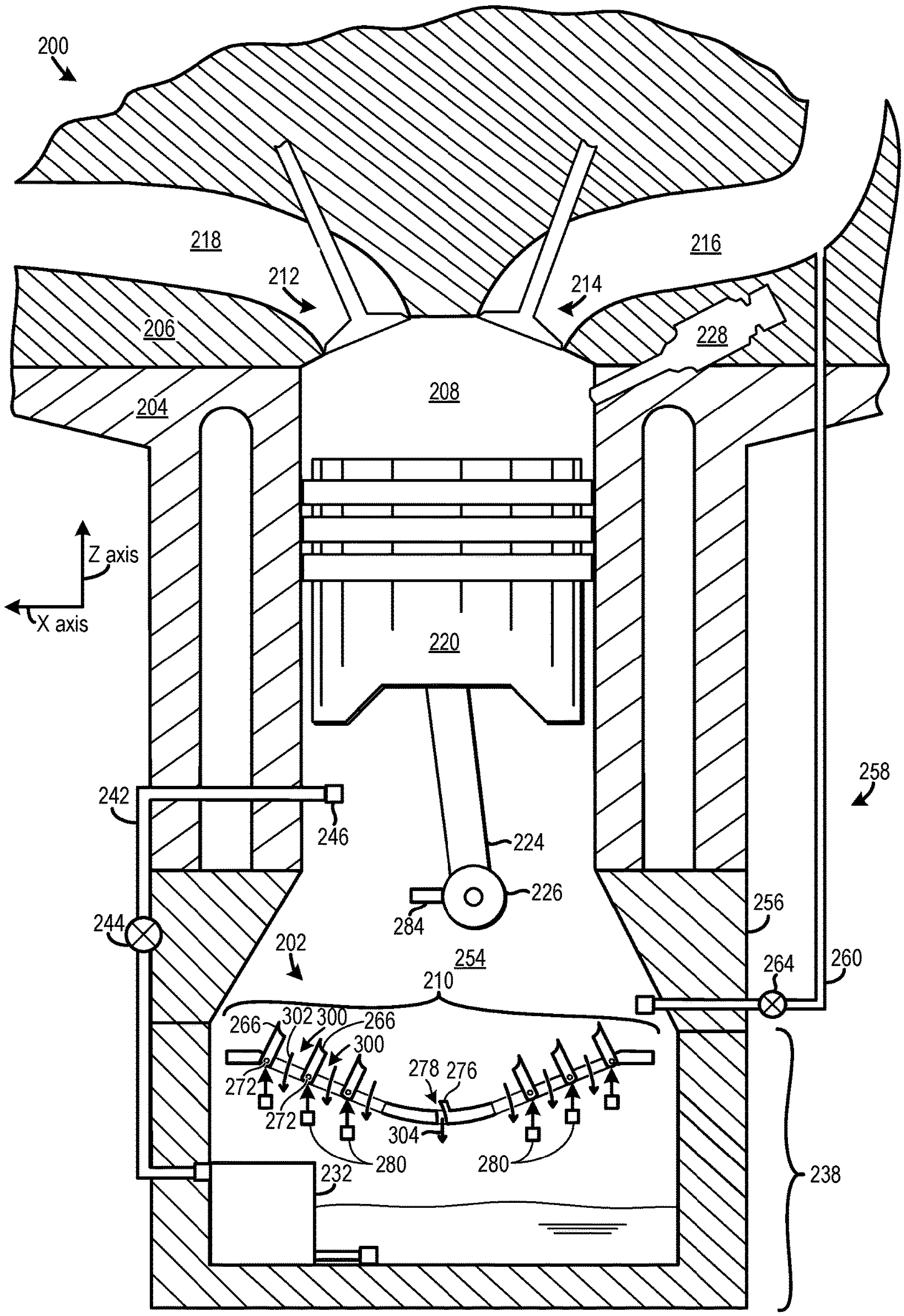

200
218
216
212
214
206
228
204
208
Z axis
X axis
220
258
242
246
224
226
284
244
256
202
254
264
260
210
266
302
300
266
300
278
276
272
272
304
280
280
232
238

FIG. 4

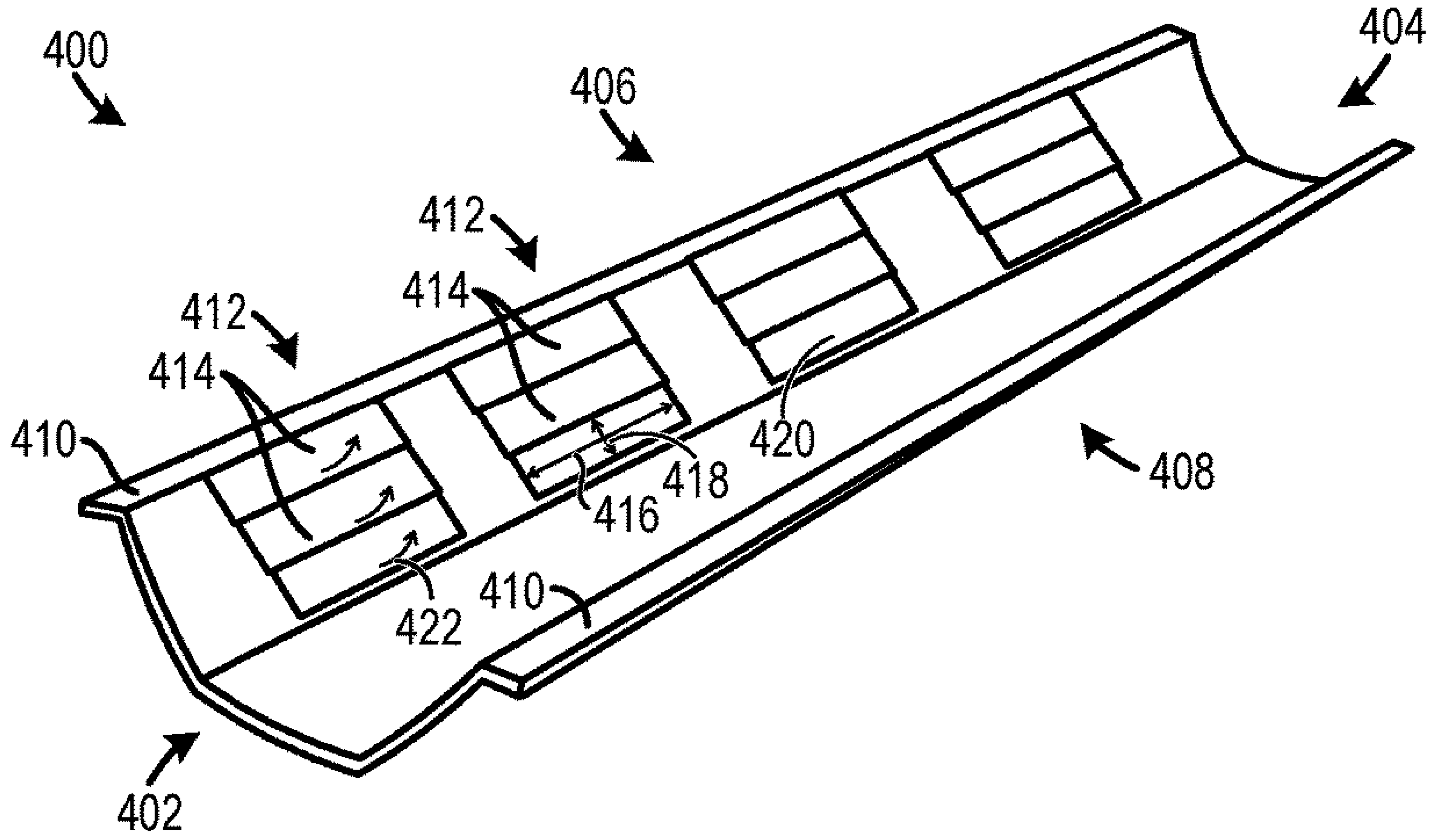

400
406
404
412
412
414
414
410
420
418
416
408
422
410
402

FIG. 5

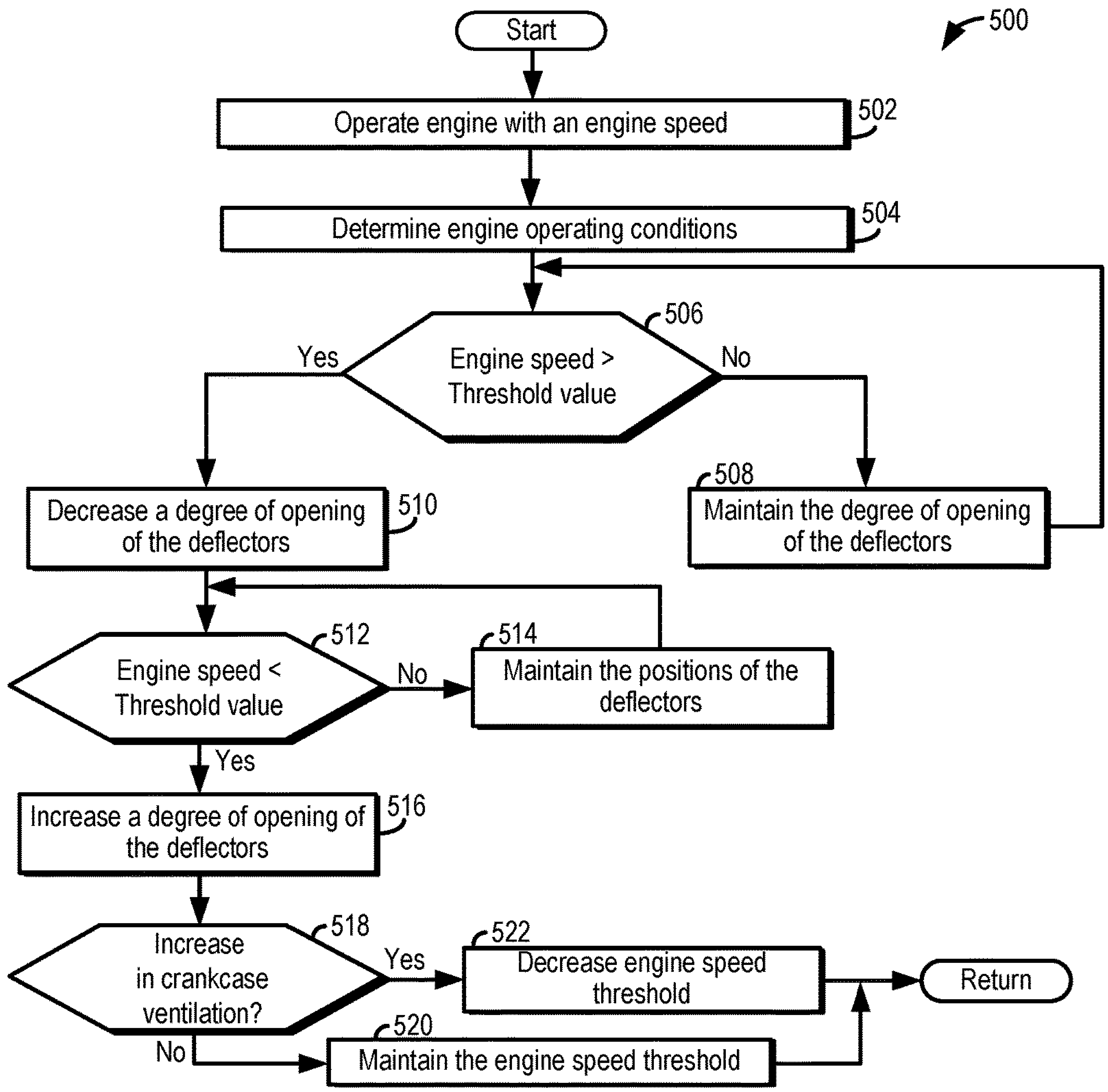

Start
500
Operate engine with an engine speed
502
Determine engine operating conditions
504
506
Engine speed > Threshold value
Yes
No
508
Decrease a degree of opening of the deflectors
510
Maintain the degree of opening of the deflectors
512
514
Engine speed < Threshold value
No
Maintain the positions of the deflectors
Yes
Increase a degree of opening of the deflectors
516
Increase in crankcase ventilation?
518
Yes
522
Decrease engine speed threshold
Return
No
520
Maintain the engine speed threshold

FIG. 6

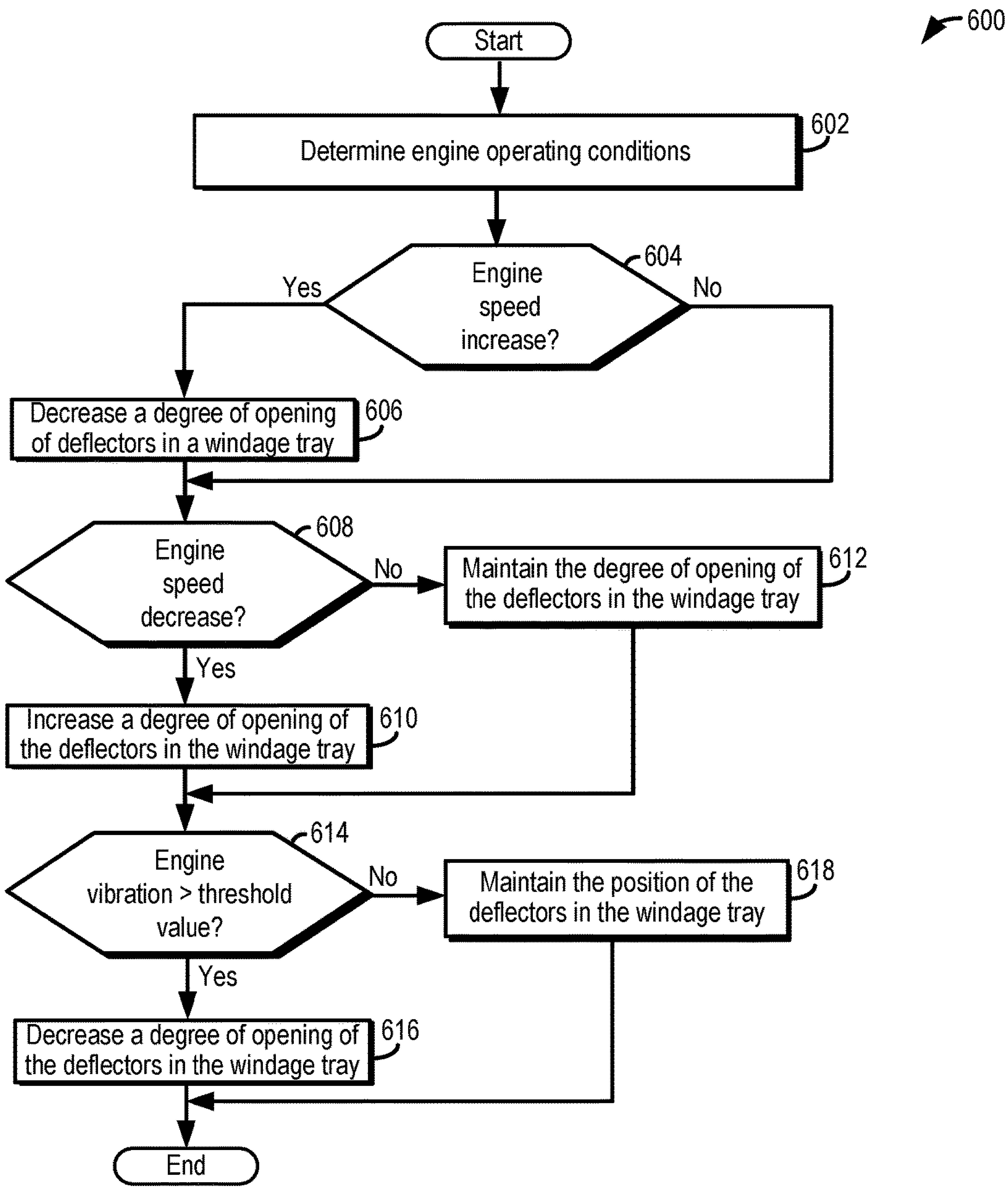
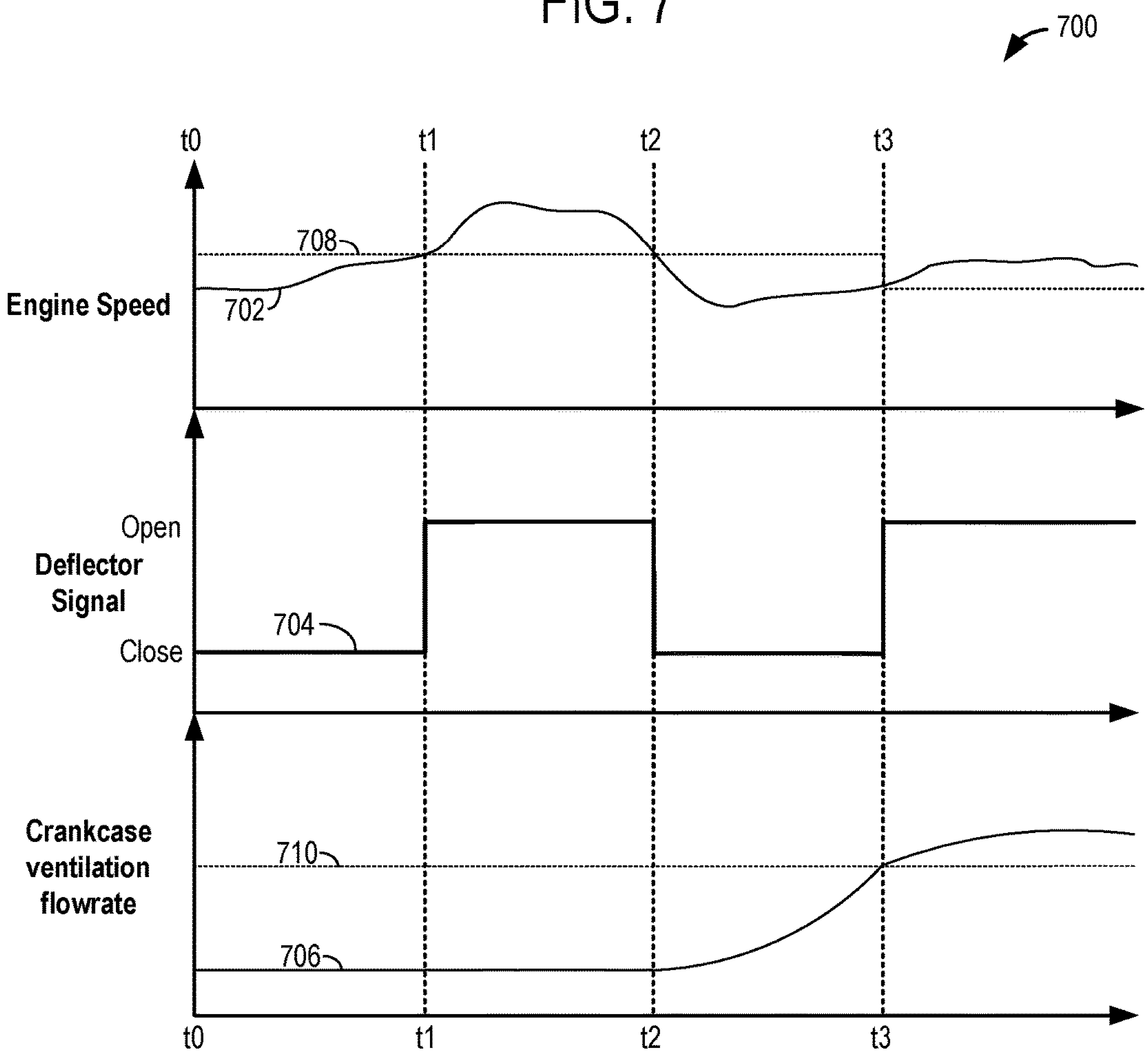

600
Start
Determine engine operating conditions
602
Engine speed increase?
604
Yes
No
Decrease a degree of opening of deflectors in a windage tray
606
Engine speed decrease?
608
No
Maintain the degree of opening of the deflectors in the windage tray
612
Yes
Increase a degree of opening of the deflectors in the windage tray
610
Engine vibration > threshold value?
614
No
Maintain the position of the deflectors in the windage tray
618
Yes
Decrease a degree of opening of the deflectors in the windage tray
616
End

FIG. 7


700
t0
t1
t2
t3
708
702
Engine Speed
Open
Deflector
Signal
704
Close
Crankcase
ventilation
flowrate
710
706
t0
t1
t2
t3

ADJUSTABLE WINDAGE TRAY AND METHOD FOR OPERATION OF THE ADJUSTABLE WINDAGE TRAY

FIELD

The present description relates generally to an engine with an engine system including an adjustable windage tray and a method for operation of said engine system.

BACKGROUND/SUMMARY

Engines have utilized windage trays positioned in crankcases to modify flow dynamics in the crankcase. The use of windage trays is particularly prevalent in high performance engines, due to the propensity of high performance engines to be operated at high speeds for extended periods. However, the necessity of the windage tray varies based on engine operating conditions. During lower engine speeds the turbulence in the crankcase may not cause the oil aeration issues that are so prevalent at the high engine speeds. However, as the engine speed increases, the momentum of the crankcase flowfield and oil leakage via component bearings, perturb and impinge with high velocity on the free surface of the oil within the oil reservoir. Aeration is an inherent consequence of the oil interacting with the highly turbulent flowfield within the crankcase. A more quiescent oil free surface is one of the design goals of previous windage trays. However, during lower engine speeds oil aeration considerably decreases and may not pose a significant problem. Therefore, during lower engine speeds flow interruption created by the windage tray may not be needed. Furthermore, during low engine speeds the windage tray may interfere with oil draining. For instance, oil may impinge on surfaces of windage trays, thereby interfering with oil draining operation. Specifically, the amount and/or speed of oil returning to the oil pan may be reduced due to windage tray interference. Furthermore, some windage trays may also create losses in crankcase ventilation systems.

U.S. Pat. No. 6,019,071 discloses a windage tray with an oil flow path provided in the windage tray with integrated oil squirters directing oil towards the undersides of the engine pistons. However, the windage tray discloses in U.S. Pat. No. 6,019,071 suffers from the abovementioned problems of slow oil draining and crankcase ventilation losses.

Recognizing the problems described above and in an attempt to address at least some of the problems the inventors developed a method for operating an engine system. The method includes operating an engine to perform combustion, determining an engine speed and adjusting a flow profile of a plurality of deflectors in a windage tray positioned in a crankcase based on the engine speed. In this way, the flow profile of the windage tray may be dynamically adjusted to alter flow characteristics in the crankcase over a wide range of engine speeds. Consequently, the functionality of the windage tray can be varied to suit engine operating conditions, enabling the windage tray to reduce oil aeration during selected operating conditions while reducing windage tray flow interference during other operating conditions to increase oil draining, for instance.

In one example, the deflectors in the windage tray may be opened when the engine is operated below a threshold speed and closed when the engine is operated above the threshold speed. In this way, the windage tray acts to decrease crankcase turbulence around the lubricant reservoir, thereby decreasing oil aeration during high speed operation. Conversely, during lower speed engine operation the lubricant drainage interference is mitigated by opening the deflectors in the windage tray, thereby increasing the lubrication system efficiency.

It should be understood that the summary above is provided to introduce in simplified form a selection of concepts that are further described in the detailed description. It is not meant to identify key or essential features of the claimed subject matter, the scope of which is defined uniquely by the claims that follow the detailed description. Furthermore, the claimed subject matter is not limited to implementations that solve any disadvantages noted above or in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a schematic depiction of an internal combustion engine including a windage tray with adjustable deflectors.

FIG. **2** shows an illustration of a cross-section of a first example of a windage tray with adjustable deflectors in a closed configuration.

FIG. **3** shows an illustration of a cross-section of the first example of the windage tray with the adjustable deflectors in an open configuration.

FIG. **4** shows a perspective view of another exemplary windage tray with adjustable deflectors.

FIG. **5** shows a method for operation of an engine system with an adjustable windage tray.

FIG. **6** shows another method for operation of an engine system with an adjustable windage tray.

FIG. **7** shows a timing diagram of an exemplary windage tray control strategy.

DETAILED DESCRIPTION

The following description relates to an engine system and method for varying the flow profile of a windage tray based on engine speed, enabling the windage tray to act to interrupt crankcase turbulence during targeted conditions. The engine system includes a windage tray with adjustable deflectors (e.g., louvers) to achieve flow interference adaptability. The deflectors may be pivoted or otherwise moved to increase and decrease the amount of crankcase gas passing through the windage tray. In one example, the deflectors may be moved into open positions during lower speed operation to increase lubricant draining. Continuing with such an example, during higher speed operation the deflectors may be closed to reduce the likelihood of crankcase turbulence causing lubricant aeration. As a result, engine lubrication is enhanced during both high and low speed engine operation, thereby increasing engine reliability and longevity.

FIG. **1** shows a schematic depiction of an engine system with a windage tray. FIG. **2** shows an example of the engine system with the windage tray with deflectors in the windage tray in a closed position. FIG. **3** shows the engine system and windage tray shown in FIG. **2** with the deflectors in an open position. FIG. **4** shows a perspective view of another exemplary windage tray. FIGS. **5** and **6** show methods for operation of engine systems with windage trays to vary flow patterns in the crankcase and lubricant reservoir based on engine operating conditions. FIG. **7** shows a timing diagram associated with a windage tray control strategy which decreases lubricant aeration and increases lubricant draining in a lubricant system.

Turning to FIG. **1**, an engine **10** with an engine system **12** in a vehicle **14** is schematically illustrated. Although, FIG. **1** provides a schematic depiction of various engine and engine system, it will be appreciated that at least some of the components may have a different spatial positions and greater structural complexity than the components shown in FIG. **1**. The structural details of the components are discussed in greater detail herein with regard to FIGS. **2-4**.

An intake system **16** providing intake air to a combustion chamber **18**, is also depicted in FIG. **1**. A piston **20** is positioned in the combustion chamber **18**. The piston **20** is coupled to a crankshaft **22** via a mechanical component **24** (e.g., piston rod). The combustion chamber **18** is formed by a cylinder block **26** coupled to a cylinder head **28**. Although, FIG. **1** depicts the engine **10** with one combustion chamber. The engine **10** may have additional combustion chambers, in other examples. For instance, the engine **10** may include a plurality of combustion chambers which may in some instances be positioned in banks.

The intake system **16** includes an intake conduit **30** and a throttle **32** coupled to the intake conduit. The throttle **32** is configured to regulate the amount of airflow provided to the combustion chamber **18**. In the depicted example, the intake conduit **30** feeds air to an intake manifold **34**. In turn, the intake manifold **34** directs air to an intake valve **36**. However, in other examples, such as in a multi-cylinder engine intake runners may branch off of the intake manifold and feed intake air to other intake valves.

The intake valve **36** may be actuated by an intake valve actuator **38**. Likewise, an exhaust valve **40** may be actuated by an exhaust valve actuator **42**. In one example, the intake valve actuator **38** and the exhaust valve actuator **42** may employ cams coupled to intake and exhaust camshafts (not shown), respectively, to open/close the valves. Continuing with the cam driven valve actuator example, the intake and exhaust camshafts may be rotationally coupled to the crankshaft **22**. Further in such an example, the valve actuators may utilize one or more of cam profile switching (CPS), variable cam timing (VCT), variable valve timing (VVT), and/or variable valve lift (VVL) systems to vary valve operation. Thus, cam timing devices may be used to vary the valve timing, if desired. It will therefore be appreciated that valve overlap may occur. In another example, the intake and/or exhaust valve actuators, **38** and **42**, may be controlled by electronic valve actuation. For example, the valve actuators, **38** and **42**, may be electronic valve actuators controlled via electronic actuation. In yet another example, the engine **10** may alternatively include exhaust valves controlled via electric valve actuation and intake valves controlled via cam actuation including CPS and/or VCT systems or vice versa. In still other embodiments, the intake and exhaust valves may be controlled by a common valve actuator or actuation system.

The engine **10** further includes a lubrication system **44** providing lubricant to engine components such as the piston **20**, crankshaft **22**, mechanical component **24**, etc. The lubrication system **44** includes a lubricant reservoir **46** that receiving lubricant from the lubricated components (e.g., pistons, crankshaft, piston rods, etc.). Thus, the lubricant reservoir **46** in the lubrication system **44** may be designed to receive lubricant draining from the lubricated components such as the pistons **20**, crankshaft **22**, mechanical component **24**, etc. For instance, the lubricant reservoir **46** may be positioned below the lubricated components to receive oil that has been sprayed or otherwise delivered to the lubricated components. A lubricant pump **48** is positioned in the lubricant reservoir **46** in the illustrated example. However, in other examples, the lubricant pump **48** may be positioned external to the lubricant reservoir with a pick-up line extending into the reservoir. The lubricant pump **48** is configured to flow pressurized lubricant to a plurality of lubrication lines **50**. The plurality of lubrication lines **50** are schematically illustrated. However it will be appreciated that the lubrication lines may extend through different sections of the cylinder block **26** and/or cylinder head **28** to provide lubricant to the piston **20**, the crankshaft **22**, the mechanical component **24**, etc. The lubrication system **44** may further include nozzles designed to spray or otherwise direct lubricant to the piston, crankshaft, etc., and are discussed in greater detail herein with regard to FIGS. **2** and **3**. The lubrication system **44** also includes valves that are designed to regulate the flowrate of the lubricant provided to the lubricated components, discussed in greater detail herein with regard to FIGS. **2** and **3**.

The engine **10** may also include an engine cooling system (not shown). The engine cooling system may include coolant jackets circulating coolant through the cylinder head and/or cylinder block as well as a heat exchanger (e.g., radiator) removing heat from the coolant.

A fuel delivery system **52** is also shown in FIG. **1**. The fuel delivery system **52** provides pressurized fuel to a fuel injector **54**. In the illustrated example, the fuel injector **54** is a direct fuel injector coupled to combustion chamber **18**. Additionally or alternatively, the fuel delivery system **52** may also include a port fuel injector designed to inject fuel upstream of the combustion chamber **18** into the intake system **16**. The fuel delivery system **52** includes a fuel tank **56** and a fuel pump **58** designed flow pressurized fuel to downstream components. A fuel line **60** provides fluidic communication between the fuel pump **58** and the fuel injector **54**. The fuel delivery system **52** may include conventional components such as a high pressure fuel pump, check valves, return lines, etc., to enable fuel to be provided to the injectors at desired pressures.

An exhaust system **62** configured to manage exhaust gas from the combustion chamber **18** is also included in the vehicle **14** depicted in FIG. **1**. The exhaust system **62** includes the exhaust valve **40** designed to open and close to allow and inhibit exhaust gas flow to downstream components from the combustion chamber. The exhaust system **62** also includes an emission control device **64** coupled to an exhaust conduit **66** downstream of an exhaust manifold **68**. The emission control device **64** may include filters, catalysts, absorbers, etc., for reducing tailpipe emissions. The engine **10** also includes an ignition system **70** including an energy storage device **72** designed to provide energy to an ignition device **74**. Additionally or alternatively, the engine **10** may perform compression ignition.

The engine system **12** is designed to vary the flow pattern in the lubricant reservoir **46** and a crankcase **82**. The engine system **12** includes a windage tray **84**. The windage tray **84** includes adjustable deflectors that may be actively controlled to alter the amount of crankcase gas flowing through the windage tray. For instance, the deflectors may be opened to allow crankcase gas to flow through the windage tray during low engine speeds. Continuing with such an example, the deflectors may be closed to inhibit crankcase gas from flowing through the windage tray during high engine speeds. The deflectors are described in greater detail herein with regard to FIGS. **2-4**. Further in one example, the engine system **12** may also include the lubricant reservoir **46**, the lubricant pump **48**, and/or the crankshaft **22**.

During engine operation, the combustion chamber **18** typically undergoes a four stroke cycle including an intake stroke, compression stroke, expansion stroke, and exhaust stroke. During the intake stroke, generally, the exhaust valve closes and intake valve opens. Air is introduced into the combustion chamber via the corresponding intake conduit, and the piston moves to the bottom of the combustion chamber so as to increase the volume within the combustion chamber. The position at which the piston is near the bottom of the combustion chamber and at the end of its stroke (e.g., when the combustion chamber is at its largest volume) is typically referred to by those of skill in the art as bottom dead center (BDC). During the compression stroke, the intake valve and the exhaust valve are closed. The piston moves toward the cylinder head so as to compress the air within combustion chamber. The point at which the piston is at the end of its stroke and closest to the cylinder head (e.g., when the combustion chamber is at its smallest volume) is typically referred to by those of skill in the art as top dead center (TDC). In a process herein referred to as injection, fuel is introduced into the combustion chamber. In a process herein referred to as ignition, the injected fuel in the combustion chamber is ignited via compression, resulting in combustion. However, in other examples, additionally or alternatively, spark from an ignition device may be used to ignite the air fuel mixture in the combustion chamber. During the expansion stroke, the expanding gases push the piston back to BDC. A crankshaft converts this piston movement into a rotational torque of the rotary shaft. During the exhaust stroke, in a traditional design, exhaust valve is opened to release the residual combusted air-fuel mixture to the corresponding exhaust passages and the piston returns to TDC.

FIG. **1** also shows a controller **100** in the vehicle **14**. Specifically, controller **100** is shown in FIG. **1** as a conventional microcomputer including: microprocessor unit **102**, input/output ports **104**, read-only memory **106**, random access memory **108**, keep alive memory **110**, and a conventional data bus. Controller **100** is configured to receive various signals from sensors coupled to the engine **10**. The sensors may include engine coolant temperature sensor **130**, exhaust gas composition sensor **132**, exhaust gas airflow sensor **134**, an intake airflow sensor **136**, manifold pressure sensor **137**, engine speed sensor **138**, vibration sensor **140**, etc. Additionally, the controller **100** is also configured to receive throttle position (TP) from a throttle position sensor **112** coupled to a pedal **114** actuated by an operator **116**.

Additionally, the controller **100** may be configured to trigger one or more actuators and/or send commands to components. For instance, the controller **100** may trigger adjustment of the throttle **32**, lubrication system **44**, intake valve actuator **38**, exhaust valve actuator **42**, engine system **12**, fuel delivery system **52**, and/or the ignition system **70**. Specifically, the controller **100** may be configured to send signals to the windage tray **84** to adjust the position of deflectors (e.g., louvers) in the windage tray. The controller **100** may also be configured to send control signals to the lubrication system **44** to control the amount of lubricant delivered to targeted lubricated components. Furthermore, the controller **100** may be configured to send control signals to the fuel pump **58** and the fuel injector **54** to control the amount and timing of fuel injection provided to the combustion chamber **18**. The controller **100** may also send control signals to the throttle **32** to vary engine speed.

Therefore, the controller **100** receives signals from the various sensors and employs the various actuators to adjust engine operation based on the received signals and instructions stored in memory (e.g., non-transitory memory) of the controller. Thus, it will be appreciated that the controller **100** may send and receive signals from the engine system **12**. For example, adjusting deflectors in the windage tray may include adjusting deflector actuators to adjust the deflectors in the windage tray. In yet another example, adjusting the degree of opening of deflectors in the windage tray, may be empirically determined and stored in predetermined lookup tables and/or functions. For example, one table may correspond to determining an amount of deflector opening in the windage tray when the engine is operating within a first speed range and another table may correspond to determining an amount deflector opening in the windage tray when the engine is operating within a second speed range that is less than the first speed range. The tables may be indexed to engine operating conditions such as engine speed, engine load, among other engine operating conditions. Furthermore, the tables may output an amount of fuel to inject via the fuel injectors to the combustion chamber at each cylinder cycle. Thus, it will be appreciated that the controller **100** may be configured to implement the methods, control strategies, etc., described herein with regard to an engine system including a windage tray.

FIG. **2** shows a first example of an internal combustion engine **200** and engine system **202** in cross-section. A z-axis and x-axis are provided in FIG. **2** as well as FIG. **3**, for reference. FIG. **4** also shows a y-axis along with the z-axis and the x-axis for reference. In one example, the z-axis may be parallel to a gravitational axis. The x-axis may be a lateral axis, in one example. Furthermore, the y-axis may be a longitudinal axis, in one instance. However in other examples, other, x-axis, y-axis, and z-axis orientations have been contemplated. It will be appreciated that the engine **200** and the engine system **202**, shown in FIG. **2**, are examples of the engine **10** and the engine system **12**, shown in FIG. **1**. Therefore, features in the engine **10** and engine system **12** shown in FIG. **1** may be included in the engine **200** and engine system **202**, shown in FIG. **2**, or vice versa.

FIG. **2** shows the engine **200** including a cylinder block **204** coupled to a cylinder head **206** forming a combustion chamber **208**. Although only one cylinder is depicted in FIG. **2**, it will be appreciated that the engine **200** may include additional combustion chambers. In such an example, a windage tray **210** included in the engine system **202** may extend underneath pistons and associated piston rods, for instance.

Additionally, an exhaust valve **212** and an intake valve **214** are shown coupled to the combustion chamber **208**. The intake valve **214** includes an intake valve stem **215** and the exhaust valve **212** includes an exhaust valve stem **217**. Correspondingly, intake conduit **216** and exhaust conduit **218** providing fluidic communication between upstream intake system components and downstream exhaust system components, are also depicted in FIG. **2**.

A piston **220** is positioned within the combustion chamber **208**. The piston **220** include piston rings **222** designed to seal the combustion chamber **208**. A piston rod **224** is attached to the piston **220** and a crankshaft **226**.

A direct fuel injector **228** is also shown coupled to the combustion chamber **208**. However, a port fuel injector may additionally or alternatively be included in the engine. A lubrication system **230** is also shown in FIG. **2**. The lubrication system **230** includes a lubricant pump **232** designed to circulate lubricant through lubricant lines in the lubrication system. Furthermore, the lubricant pump **232** may be driven via rotational energy extracted from the crankshaft, in one example. However, in other examples, the lubricant pump **232**, may be an electrical pump. Suitable pumps such as a gear pump, trochoid pump, vane pump, etc., have been contemplated. The lubricant pump **232** includes a pick-up line **234** with an inlet **236** directing lubricant **283** from a lubricant reservoir **238** into the pump. The lubricant pump

232 also includes an outlet **240** in fluidic communication with a lubricant line **242**. A lubricant valve **244** coupled to the lubricant line **242**. The lubricant valve **244** is configured to vary the amount of lubricant flowing through the lubricant line **242**. For instance, the lubricant valve **244** may be fully opened, fully closed, and/or may have varying degrees of opening and closure. The lubricant valve **244** as well as other lubricant valves described herein may be an on/off electrically actuated solenoid valve, an on/off pneumatically actuated solenoid valve, an on/off electrically actuated piezo-electric stack valve, an electrically actuated proportioning valve, or a pneumatically actuated proportioning valve. A nozzle **246** is coupled to an end of the lubricant line **242**. The nozzle **246** is designed to direct lubricant spray towards an underside **248** of the piston **220** to lubricate said piston. It will be appreciated that the lubrication system **230** may also include additional lubricant lines directing lubricant towards other lubricated components such as the crankshaft **226**, the intake valve stem **217**, the exhaust valve stem **215**, etc.

The lubricant reservoir **238** is also included in the lubrication system **230** shown in FIG. **2**. The lubricant reservoir **238** includes a housing **250** defining an interior section **252** of the lubricant reservoir **238** storing lubricant (e.g., oil).

A crankcase **254** is also shown in FIG. **2**. The crankcase **254** houses the crankshaft **226**. A crankcase housing **256** may for at least a portion of the boundary of the crankcase **254**. Further in one example, the cylinder block **204** may also form a boundary of the crankcase **254**.

FIG. **2** also shows a crankcase ventilation system **258**. The crankcase ventilation system **258** includes a ventilation conduit **260** extending through the crankcase housing **256** into the crankcase **254**. Thus, a first end **262** of the ventilation conduit **260** opens into the crankcase. The ventilation conduit **260** extend between the crankcase **254** and the intake conduit **216**. A crankcase ventilation valve **264** is also coupled to the ventilation conduit **260**. The crankcase ventilation valve **264** may be opened when there is a sufficient vacuum generated in the intake conduit **216** and crankcase ventilation flow is desired. The crankcase ventilation valve **264** may be controlled via pressure gradients between the intake system and crankcase. The crankcase ventilation valve and oil separator pressure drop requirements may be determined based on engine architecture and operating regimes, in one example. It will be appreciated that the controller **100** may send and receive signals from the valves, sensors, etc., shown in FIGS. **2** and **3**. For instance, the controller **100** may adjust operation of the crankcase ventilation valve **264**, the lubricant pump **232**, windage tray **210**, lubricant valve **244**, etc.

The engine system **202** includes the windage tray **210**. The engine system **202** may also include the lubricant reservoir **238**, the lubricant pump **232**, and/or the crankshaft **226**. The windage tray **210** is positioned below (e.g., vertically below) the crankshaft and above (e.g., vertically above) the lubricant pump **232**. The windage tray **210** also shown positioned in the lubricant reservoir **238**. It will be appreciated that in other examples the windage tray **210** may extend into the crankcase **254**. Thus, in some examples, the windage tray **210** may be attached (e.g., fixedly attached) to the lubricant reservoir housing **250** and/or the crankcase housing **256**.

The windage tray **210** is shown including deflectors **266**. The deflectors **266** are positioned in inclined sections **268** of the base **270** of the tray. However, other deflector positions have been contemplated. In the closed positioned the deflectors **266** may be aligned with upper surfaces **274** of the inclined sections **268**, to substantially reduce (e.g., inhibit) crankcase gas flow through the windage tray. The deflectors **266** are moveably coupled (e.g., pivotally coupled) to the base **270**. Specifically, the deflectors **266** are designed to pivot about deflector pivots **272**. However, deflectors with alternate adjustment mechanisms have been contemplated.

FIG. **2** also shows a fixed deflector **276** and an opening **278** in the windage tray **210**. The opening **278** enables lubricant to drain and pass through the windage tray and into the lubricant reservoir **238**. In this way, lubricant build up on the windage tray may be avoided, thereby reducing interference between the lubrication system **230** and the windage tray **210**. Consequently, lubrication system **230** efficiency may be increased.

Actuators **280** configured to adjust the positions of the deflectors are shown coupled to the deflectors. It will be appreciated that in other examples, a single actuator may actuate all of the deflectors or the actuators may actuate more than one deflector. In one example, the actuators **280** may be hydraulic actuators controlling the position of the deflectors **266** (e.g., louvers) via hydraulics. However, other suitable actuators have been contemplated.

Arrows **282** indicate the general direction of crankcase gas flow around the windage tray **210**. Thus, when the deflectors **266** are in a closed position crankcase gas is substantially inhibited from flowing through the interior of the windage tray **210**. However, in other examples when the deflectors **266** are in the closed position crankcase gas flow through the windage tray may be substantially reduced. As illustrated in FIG. **2**, crankcase gas is direct towards the periphery of the windage tray near the lubricant reservoir housing **250**. As a result, crankcase gas interference with lubricant **283** (e.g., oil) in the lubricant reservoir **238** is reduced, thereby reducing lubricant aeration. It will be appreciated that the gas flow pattern in around the windage tray **210** has greater complexity than is illustrated in FIG. **2**.

It will be appreciated that the windage tray **210** (e.g., actuators **280**), lubricant valve **244**, crankcase ventilation valve **264**, lubricant pump **232**, and/or direct fuel injector **228** may receive control signals from the controller **100**, shown in FIG. **1**, and may also send signals to the controller. An engine speed sensor **284** coupled to the crankshaft **226** is also shown in FIG. **2**. It will be appreciated that the engine speed sensor **284** may send signals to the controller **100**, shown in FIG. **1**.

FIG. **2** shows the deflectors **266** in a closed position while FIG. **3** shows the engine system **202** with the windage tray **210** with the deflectors in an open position. It will be appreciated that the actuators **280** may be commanded to place the deflectors **266** in the open position. Specifically, as shown in FIG. **3** the deflectors **266** are pivoted about the deflector pivots **272** such that the deflectors extend away from the base **270** of the windage tray **210**. When the deflectors **266** are moved in this manner openings **300** in the windage tray **210** are uncovered. However, other deflector adjustment kinematics have been contemplated. When the openings **300** are uncovered crankcase gas can flow through the windage tray **210**. Thus, when the deflectors **266** are moved into the open position from the closed position the flowrate of crankcase gas through the windage tray is increased. Conversely, when the deflectors **266** are moved from the open position to the closed position the flowrate of crankcase gas through the windage tray is reduced. Arrows **302** depict the general direction of gas flow through the openings **300**. However, it will be appreciated that the gas flow pattern in the crankcase and through the openings has greater complexity than is illustrated.

In a fully open configuration the deflectors **266** may be arranged perpendicular to the base **270** of the windage tray **210**. However, other orientations between the fully opened deflectors and the base of the windage tray have been contemplated. Conversely, in the closed position the deflectors **266** may be parallel to the base **270** of the windage tray. However, other orientations between the closed deflectors and the base has been envisioned such as 2°, 5°, 10°, etc., angles formed between the deflectors and the base. In the open position the deflectors **266** allow gas to flow through the windage tray **210** from the crankcase **254** to the lubricant reservoir **238**.

Lubricant may also flow through the openings **300** when the deflectors **266** are opened to increase lubricant draining. Lubricant also drains through the opening **278** next to the fixed deflector **276**. Arrow **304** indicates the generate path of lubricant flow through the openings **278**. Consequently, lubricant can more efficiently drain into the lubricant reservoir **238**.

It will be appreciated that the deflectors **266** in the windage tray **210** may be placed in the open configuration shown in FIG. **3** when the engine is operating above a threshold speed (e.g., 5,000 RPM, 5,500 RPM, 6,000 RPM, etc.,) in one instance. Conversely, the deflectors **266** in the windage tray **210** may be placed in the closed configuration shown in FIG. **2** when the engine is operating below the threshold speed.

In another example, the deflectors **266** in the windage tray **210** may be placed in the open configuration, shown in FIG. **3**, when the engine speed is increasing. Thus, in such an example, the deflectors may be placed in the closed configuration, shown in FIG. **2**, when the engine speed is decreasing. Control strategies for the deflectors in the windage tray are discussed in greater detail herein with regard to FIGS. **5**, **6**, and **7**.

FIG. **3** again shows the engine **200**, engine system **202**, cylinder block **204**, cylinder head **206**, combustion chamber **208**, piston **220**, piston rod **224**, crankshaft **226**, crankcase housing **256**, and engine speed sensor **284**. The intake valve **214**, the exhaust valve **212**, intake conduit **216**, exhaust conduit **218**, direct fuel injector **228**, lubricant pump **232**, lubricant valve **244**, lubricant line **242**, nozzle **246**, lubricant reservoir **238**, crankcase ventilation system **258**, ventilation conduit **260**, and crankcase ventilation valve **264** are also shown in FIG. **3**.

FIG. **4** shows a perspective view of an exemplary windage tray **400**. The windage tray **400** shown in FIG. **4** is an example of the windage tray **210**, shown in FIGS. **2** and **3**. Therefore, the windage tray **400** may be included in the engine system **202**, shown in FIGS. **2** and **3**. Furthermore, the windage tray **400** shown in FIG. **4** may receive signals from the controller **100**, shown in FIG. **1**, to adjust operation thereof.

The windage tray **400** includes a first end **402**, a second end **404**, a first side **406**, and a second side **408**. The windage tray **400** also includes flanges **410** configured to attach to a section of a crankcase housing, cylinder block, lubricant reservoir housing, etc.

The windage tray **400** includes different sets **412** of deflectors, each set having a plurality of deflectors **414**. As shown, the plurality of deflectors included in each set overlap with one another, in the closed position shown in FIG. **4**. However, in other examples the deflectors in each set may be spaced away from one another. Each set of deflectors is positioned at different longitudinal positions along the windage tray **400**. However, in other examples, the windage tray may include deflectors extending longitudinally down the length of the tray. It will be appreciated that numerous deflector profiles that enable the flow profile of the windage tray to be actively adjusted have been contemplated. It will also be appreciated that the second side **408** of the windage tray **210** may include sets of deflectors similar to the first side **406** of the windage tray.

The deflectors **414** shown in FIG. **4** are depicted as louvers plates. Each of the louver plates have a similar geometry in the illustrated example. However, in other examples the profile of the louver plates may vary within the sets of the louver plates and/or from set to set, for example. Specifically, in the illustrated example, the louver plates have a length **416** that is greater than their width **418**. Additionally, a top surface **420** of the deflectors is also illustrated as substantially planar. However, other louver plate geometries have been contemplated. For instance, the louver plates may have a curved (e.g., convex or concave) upper surface and/or may taper in a longitudinal or a lateral direction.

Arrows **422** indicate the direction of deflector movement when the deflectors **414** are shifted from the closed position shown in FIG. **4** to an open position. In one example, the sets **412** of the deflectors may be correspondingly adjusted. That is to say that each of the deflectors **414** may be opened/closed by corresponding amounts. However in other examples, the sets **412** of the deflectors may be independently adjusted. For instance, a first set of deflectors may be opened while another set of deflectors may be closed or the degree of opening or closure in different sets of deflectors may vary between the sets of deflector and/or within specific deflectors in the sets. For instance, a first set of deflectors may be opened while another set of deflectors may be closed. The variations in deflector opening may be determined based on engine operating conditions. For instance, the deflectors may be closed when the engine is operating above a threshold speed and may be opened when the engine is operating below the threshold speed. In other examples, the degree of opening of the deflectors may decrease as the engine speed increases. Correspondingly, the degree of opening of the deflectors may increase as the engine speed decreases.

FIGS. **2-4** show example configurations with relative positioning of the various components. If shown directly contacting each other, or directly coupled, then such elements may be referred to as directly contacting or directly coupled, respectively, at least in one example. Similarly, elements shown contiguous or adjacent to one another may be contiguous or adjacent to each other, respectively, at least in one example. As an example, components laying in face-sharing contact with each other may be referred to as in face-sharing contact. As another example, elements positioned apart from each other with only a space therebetween and no other components may be referred to as such, in at least one example. As yet another example, elements shown above/below one another, at opposite sides to one another, or to the left/right of one another may be referred to as such, relative to one another. Further, as shown in the figures, a topmost element or point of element may be referred to as a "top" of the component and a bottommost element or point of the element may be referred to as a "bottom" of the component, in at least one example. As used herein, top/bottom, upper/lower, above/below, may be relative to a vertical axis of the figures and used to describe positioning of elements of the figures relative to one another. As such, elements shown above other elements are positioned vertically above the other elements, in one example. As yet another example, shapes of the elements depicted within the figures may be referred to as having those shapes (e.g., such as being circular, straight, planar, curved, rounded, chamfered, angled, or the like). Further, elements shown intersecting one another may be referred to as intersecting elements or intersecting one another, in at least one example. Further still, an element shown within another element or shown outside of another element may be referred as such, in one example.

FIG. **5** shows a method **500** for operation of an engine system with a windage tray including adjustable deflectors. Method **500** as well as the other methods described herein may be implemented by engines and piston heating systems described above with regard to FIGS. **1-4** or may be implemented by other suitable engines and piston heating systems, in other examples. Instructions for carrying out the method **500** and the other methods described herein may be executed by a controller based on instructions stored in memory (e.g., non-transitory) executable by the controller and in conjunction with signals received from sensors of in the engine and corresponding systems, such as the sensors described above with reference to FIGS. **1-4**. The controller may employ engine actuators of the engine systems to adjust engine operation, according to the methods described below.

At **502** the method includes operating the engine with an engine speed. It will be appreciated that the engine speed may be adjusted based on signals from a pedal position sensor or other suitable acceleration request sensor. Moreover, it will be appreciated that operating the engine with an engine speed including operating the engine to perform combustion.

At **504** the method includes determining engine operating conditions. The engine operating conditions may include engine speed, engine load, intake flowrate, engine temperature, exhaust gas flowrate, exhaust gas composition, engine vibration, crankcase ventilation flowrate, etc. The engine operating conditions may be ascertained from signals sent from various sensors in the engine and/or determined (e.g., calculated) based on signals from the sensors.

At **506** the method includes determining if the engine is operating above a threshold speed. The threshold speed may be 4,000 RPM, 4,500 RPM, or 5,000 RPM, in some examples. In another example, oil pressure may be a criterion that could be used to determine the flow return rate to the oil pump and windage tray operating regime.

If it is determined that the engine is not operating above the threshold speed (NO at **506**) the method proceeds to **508**. At **508** the method includes maintaining the degree of opening of deflectors in the windage tray. For instance, the deflectors may be maintained in a fully opened or a partially opened position. Thus, the windage tray may be operated with deflectors in an open position. In this way, crankcase gas may flow through the windage tray and lubricant draining through the windage tray may be increased. In other examples, the deflectors may be moved into a fully opened or a partially opened position or the degree of opening of the deflectors may be increased at **508**.

On the other hand, if it is determined that the engine is operating above the threshold speed (YES at **506**) the method advances to **510**. At **510** the method includes decreasing a degree of opening of the deflectors. In this way, a flowrate of crankcase gas through the windage tray is decreased. In one example, decreasing a degree of opening of the deflectors may include placing the deflectors in a closed position. Thus, the windage tray may be operated with the deflectors in a closed position. As previously discussed, in the closed position crankcase gas through openings in the windage tray may be substantially inhibited. However in other examples, decreasing a degree of opening of the deflectors may include placing the deflectors in a partially closed position. Furthermore, as previously discussed adjusting a degree of opening or closing of the deflectors may include pivoting the deflectors at one end about a pivot.

At **512** the method includes determining if the engine is operating below the threshold speed. It will be appreciated that the operating conditions may be again determined prior to or during step **512**. If it is determined that the engine is not operating below the threshold speed (NO at **512**) the method proceeds to **514**. At **514** the method includes maintaining the positions of the deflectors. For instance, the deflectors may be maintained in a closed position.

However, if it is determined that the engine is operating below the threshold speed (YES at **512**) the method advances to **516**. At **516** the method includes increasing a degree of opening of the deflectors. Increasing a degree of opening of the deflectors may include moving the deflectors into a partially opened or fully opened position, in one example.

It will be appreciated that steps **506**, **510**, **512**, and **516** may be included in a more general step of adjusting a flow profile of the plurality of deflectors in the windage tray based on engine speed. In this way, the windage tray may be adapted to suit the current engine operating conditions.

At **518** the method includes determining if there is an increase in crankcase ventilation. The position of a crankcase ventilation valve and/or intake manifold pressure may be used to determine if there is an increase in crankcase ventilation. In other examples, it may be determined if the flowrate of crankcase ventilation gas surpasses a threshold value.

If it is determined that there is not an increase in crankcase ventilation (NO at **518**) the method proceeds to **520**. At **520** the method includes maintaining the current engine speed threshold. However, if it is determined that there is an increase in crankcase ventilation (YES at **518**) the method proceeds to **522** where the method includes decreasing the engine speed threshold. In this way, the engine speed threshold may be decreased when the crankcase ventilation system causes increased turbulence in the crankcase and lubricant reservoir. Consequently, the deflectors in the windage tray may be closed at lower engine speeds to decrease lubricant aeration.

FIG. **6** shows another method **600** for operation of an engine system with a windage tray having adjustable deflectors. As discussed above, the method may be implemented by the engines and engine systems described above with regard to FIGS. **1-4** or may be implemented by other suitable engines and engine systems.

At **602** the method includes determining engine operating conditions. The operating conditions may include engine speed, engine load, intake flowrate, engine temperature, exhaust gas flowrate, exhaust gas composition, engine vibration, crankcase ventilation flowrate, etc. It will be appreciated that the engine may be operated according to the aforementioned operating conditions.

At **604** the method includes determining if there is an increase in engine speed. If there is an increase in engine speed (YES at **604**) the method advances to **606**. At **606** the method includes decreasing a degree of opening of deflectors in a windage tray. For instance, the deflectors in the windage tray may be placed in a closed position or a partially closed position. However, if there is not an increase in engine speed (NO at **604**) the method proceeds to **608**. At **608** the method includes determining if there is a decrease in engine speed. If there is a decrease in engine speed (YES at **608**) the method proceeds to **610**. At **610** the method includes increasing a degree of opening of the deflectors in the windage tray. On the other hand, if there is not a decrease in engine speed (NO at **608**) the method moves to **612**. At **612** the method includes maintaining the degree of opening of the deflectors in the windage tray. It will be appreciated that in other examples, steps **604** and **608** may include determining if the engine is operating above a threshold speed or below a threshold speed, respectively.

At **614** the method includes determining if engine vibration is greater than a threshold value. If the engine vibration is greater than the threshold value (YES at **614**) the method moves to **616** where the method includes decreasing a degree of opening of the deflectors in the windage tray. Therefore it will be appreciated that vibration may be a catalyst of lubricant aeration therefore the windage tray contour may be responsively adjusted based on changes in engine vibration. In this way, the deflectors in the windage tray may be closed during periods of elevated vibration to reduce lubricant aeration. If the engine vibration is not greater than the threshold value (NO at **614**) the method moves to **618** where the method includes maintaining the position of the deflectors in the windage tray. Method **600** enables the flow profile of the windage tray to be adjusted to decrease lubricant aeration as the engine speed increases and to increase lubricant draining as the engine speed decreases.

Now turning to FIG. **7**, graphs **700** depict example engine system control signals in conjunction with engine speed and crankcase ventilation flowrate plots, such as described in FIGS. **1-6**. The example of FIG. **7** is drawn substantially to scale, even though each and every point is not labeled with numerical values. As such, relative differences in timings can be estimated by the drawing dimensions. However, other relative timings may be used, if desired. Furthermore, each of the curves and plots time is represented on the x axis. It will also be appreciated that the plots in FIG. **7** are exemplary in nature and that, in other examples, the timing of the control signals, the threshold values, etc., may vary.

Continuing with FIG. **7**, curve **702** depicts the engine speed (along the y axis). Signal **704** indicates a control signal sent to the windage tray with the adjustable deflectors. Curve **706** depicts the flowrate of crankcase gas into the intake system. The control signal **704** sent to the windage tray is shows including two values (i.e., open and close). However, it will be appreciated that more finite adjustments are possible such as stepwise or continuous adjustment of the deflectors to place the deflectors in different partially opened positions. For example, the deflectors may have a plurality of position that have different degrees of opening. Thus, each of the different deflector positions allow a different amount of crankcase gas flow through the windage tray. In this way, the degree of deflector opening/closing may be fine-tuned based on engine operating conditions.

At t1, the engine speeds surpasses a threshold engine speed **708**. The threshold engine speed may be ascertained using the previously discussed techniques. Responsive to the engine speed surpassing the engine speed threshold the control signal **704** sent to the windage tray is changed to "open". Consequently, the deflectors in the windage tray are opened to allow crankcase gas to flow therethrough as well as allow lubricant to drain through the windage tray.

At t2, the engine speed falls below the threshold engine speed **708**. Responsive to the engine speed falling below the threshold engine speed **708** the control signal **704** sent to the windage tray is changed to "close" to reduce (e.g., prevent) crankcase gas from flowing through openings in the windage tray. Consequently, the windage tray reduces flow interference between crankcase gas and lubricant in the lubricant reservoir when in the closed configuration, thereby reducing lubricant aeration.

At t3, the crankcase ventilation flowrate surpasses a threshold value **710**. When the crankcase ventilation flowrate surpasses the threshold value **710**, the threshold engine speed **708** is responsively decreased. The control signal **704** sent to the windage tray is changed to "open" responsive to the crankcase ventilation flowrate surpassing the threshold value. The control strategy shown in FIG. **7** enables the flow profile of the windage tray to be altered based on engine speed and crankcase ventilation flow to enable the windage tray to provide different functions (e.g., oil aeration reduction and increased oil draining) that suit different engine conditions. Consequently, the efficiency of the lubrication system is increased.

The engine systems and methods described herein have the technical effect of decreasing lubricant aeration during high engine speeds and increasing lubricant draining during lower engine speeds. As a results, lubrication system efficiency is increased across a wide range of engine operating conditions.

The invention will further be described in the following paragraphs. In one aspect, a method for operating an engine system is provided, the method including operating an engine to perform combustion operation, determining an engine speed, and adjusting a flow profile of a plurality of deflectors in a windage tray positioned in a crankcase based on the engine speed.

In another aspect an engine system is provided that includes a lubricant reservoir receiving lubricant from lubricated components, a lubricant pump positioned in the lubricant reservoir, a crankshaft positioned in a crankcase vertically above the lubricant reservoir and receiving rotational input from a piston rod, a windage tray positioned vertically between the lubricant pump and the crankshaft, the windage tray including a plurality of deflectors extending longitudinally along the windage tray, and code stored in memory executable by a processor to increase a degree of opening of the plurality of deflectors in response to a decrease in engine speed.

In another aspect, a method for operating an engine system is provided, the method includes operating an engine with an engine speed is greater than a threshold value, and in response to operating the engine with the engine speed greater than a threshold value, adjusting a position of flow deflectors in a windage tray to decrease the flowrate of crankcase gas through openings in the windage tray.

In any of the aspects herein or combinations of the aspects, adjusting a flow profile of deflectors in the windage tray may include increasing a degree of opening of the deflectors when an engine speed is less than a threshold value and decreasing a degree of opening of the deflectors when the engine speed is greater than the threshold value.

In any of the aspects herein or combinations of the aspects, the method may further include adjusting the threshold value based on a flowrate of crankcase gas into an intake system through a crankcase ventilation system.

In any of the aspects herein or combinations of the aspects, adjusting the threshold value may include decreasing the threshold value in response to an increase in a flowrate of crankcase gas into the intake system through the crankcase ventilation system.

In any of the aspects herein or combinations of the aspects, the method may further include adjusting a flow profile of the plurality of deflectors based on engine vibration.

In any of the aspects herein or combinations of the aspects, adjusting the deflectors may include for each of the deflectors, rotating the deflector at one end about a pivot.

In any of the aspects herein or combinations of the aspects, the plurality of deflectors may be louver plates.

In any of the aspects herein or combinations of the aspects, the louver plates may have a length greater than a width.

In any of the aspects herein or combinations of the aspects, the plurality of deflectors may pivot about pivots during the increase in the degree of opening of the plurality of deflectors.

In any of the aspects herein or combinations of the aspects, the engine system may further include code stored in memory executable by the processor to decrease a degree of opening of the plurality of deflectors in response to an increase in engine speed.

In any of the aspects herein or combinations of the aspects, the increase in engine speed may include an increase in engine speed above a threshold value.

In any of the aspects herein or combinations of the aspects, the engine system may further include code stored in memory executable by the processor to adjust the threshold value based on a flowrate of crankcase gas into the intake system through a crankcase ventilation system.

In any of the aspects herein or combinations of the aspects, adjusting the threshold value may include increasing the threshold value in response to a decrease in a flowrate of crankcase gas into the intake system through the crankcase ventilation system or decreasing the threshold value in response to an increase in the flowrate of crankcase gas into the intake system through the crankcase ventilation system.

In any of the aspects herein or combinations of the aspects, the engine system may further include code stored in memory executable by the processor to increase a degree of opening of the plurality of deflectors based on engine vibration.

In any of the aspects herein or combinations of the aspects, the method may include operating the engine with an engine speed less than the threshold value, and in response to operating the engine with the engine speed less than the threshold value, adjusting a position of a plurality of deflectors in a windage tray to increase the flowrate of crankcase gas through openings in the windage tray.

In any of the aspects herein or combinations of the aspects, the method may further include adjusting the threshold value based on a flowrate of crankcase gas into the intake system through a crankcase ventilation system.

In any of the aspects herein or combinations of the aspects, adjusting the threshold value may include at least one of increasing the threshold value in response to a decrease in a flowrate of crankcase gas into an intake system through the crankcase ventilation system and decreasing the threshold value in response to an increase in the flowrate of crankcase gas into the intake system through the crankcase ventilation system.

In any of the aspects herein or combinations of the aspects, adjusting the position of the plurality of deflectors may include for each of the deflectors, rotating the deflector at one end about a deflector pivot.

Note that the example control and estimation routines included herein can be used with various engine and/or vehicle system configurations. The control methods and routines disclosed herein may be stored as executable instructions in non-transitory memory and may be carried out by the control system including the controller in combination with the various sensors, actuators, and other engine hardware. The specific routines described herein may represent one or more of any number of processing strategies such as event-driven, interrupt-driven, multi-tasking, multi-threading, and the like. As such, various actions, operations, and/or functions illustrated may be performed in the sequence illustrated, in parallel, or in some cases omitted. Likewise, the order of processing is not necessarily required to achieve the features and advantages of the example embodiments described herein, but is provided for ease of illustration and description. One or more of the illustrated actions, operations and/or functions may be repeatedly performed depending on the particular strategy being used. Further, the described actions, operations and/or functions may graphically represent code to be programmed into non-transitory memory of the computer readable storage medium in the engine control system, where the described actions are carried out by executing the instructions in a system including the various engine hardware components in combination with the electronic controller.

It will be appreciated that the configurations and routines disclosed herein are exemplary in nature, and that these specific embodiments are not to be considered in a limiting sense, because numerous variations are possible. For example, the above technology can be applied to V-6, I-4, I-6, V-12, opposed 4, and other engine types. The subject matter of the present disclosure includes all novel and non-obvious combinations and sub-combinations of the various systems and configurations, and other features, functions, and/or properties disclosed herein.

The following claims particularly point out certain combinations and sub-combinations regarded as novel and non-obvious. These claims may refer to "an" element or "a first" element or the equivalent thereof. Such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements. Other combinations and sub-combinations of the disclosed features, functions, elements, and/or properties may be claimed through amendment of the present claims or through presentation of new claims in this or a related application. Such claims, whether broader, narrower, equal, or different in scope to the original claims, also are regarded as included within the subject matter of the present disclosure.

The invention claimed is:

1. A method for operating an engine system comprising:
operating an engine to perform combustion;
determining an engine speed; and
adjusting a flow profile of a plurality of deflectors in a windage tray positioned in a crankcase based on the engine speed.

2. The method of claim **1**, where adjusting a flow profile of deflectors in the windage tray includes increasing a degree of opening of the deflectors when an engine speed is less than a threshold value and decreasing a degree of opening of the deflectors when the engine speed is greater than the threshold value.

3. The method of claim **2**, further comprising adjusting the threshold value based on a flowrate of crankcase gas into an intake system through a crankcase ventilation system.

4. The method of claim **3**, where adjusting the threshold value includes decreasing the threshold value in response to an increase in a flowrate of crankcase gas into the intake system through the crankcase ventilation system.

5. The method of claim **1**, further comprising adjusting a flow profile of the plurality of deflectors based on engine vibration.

6. The method of claim **1**, where adjusting the deflectors includes for each of the deflectors, rotating the deflector at one end about a pivot.

7. An engine system comprising:

a lubricant reservoir receiving lubricant from lubricated components;

a lubricant pump positioned in the lubricant reservoir;

a crankshaft positioned in a crankcase vertically above the lubricant reservoir and receiving rotational input from a piston rod;

a windage tray positioned vertically between the lubricant pump and the crankshaft, the windage tray including a plurality of deflectors extending longitudinally along the windage tray; and

code stored in memory executable by a processor to:

increase a degree of opening of the plurality of deflectors in response to a decrease in engine speed.

8. The engine system of claim **7**, where the plurality of deflectors are louver plates.

9. The engine system of claim **8**, where the louver plates have a length greater than a width.

10. The engine system of claim **7**, where the plurality of deflectors pivot about pivots during the increase in the degree of opening of the plurality of deflectors.

11. The engine system of claim **7**, further comprising code stored in memory executable by the processor to decrease a degree of opening of the plurality of deflectors in response to an increase in engine speed.

12. The engine system of claim **11**, where the increase in engine speed includes an increase in engine speed above a threshold value.

13. The engine system of claim **7**, further comprising code stored in memory executable by the processor to adjust the threshold value based on a flowrate of crankcase gas into the intake system through a crankcase ventilation system.

14. The engine system of claim **7**, where adjusting the threshold value includes increasing the threshold value in response to a decrease in a flowrate of crankcase gas into the intake system through the crankcase ventilation system or decreasing the threshold value in response to an increase in the flowrate of crankcase gas into the intake system through the crankcase ventilation system.

15. The engine system of claim **7**, further comprising code stored in memory executable by the processor to increase a degree of opening of the plurality of deflectors based on engine vibration.

16. A method for operating an engine system comprising:

operating an engine with an engine speed is greater than a threshold value; and

in response to operating the engine with the engine speed greater than the threshold value, adjusting a position of flow deflectors in a windage tray to decrease the flowrate of crankcase gas through openings in the windage tray.

17. The method of claim **16**, further comprising:

operating the engine with an engine speed less than the threshold value; and

in response to operating the engine with the engine speed less than the threshold value, adjusting a position of the plurality of deflectors in the windage tray to increase the flowrate of crankcase gas through the openings in the windage tray.

18. The method of claim **16**, further comprising adjusting the threshold value based on a flowrate of crankcase gas into the intake system through a crankcase ventilation system.

19. The method of claim **18**, where adjusting the threshold value includes at least one of increasing the threshold value in response to a decrease in a flowrate of crankcase gas into an intake system through the crankcase ventilation system and decreasing the threshold value in response to an increase in the flowrate of crankcase gas into the intake system through the crankcase ventilation system.

20. The method of claim **16**, where adjusting the position of the plurality of deflectors includes for each of the deflectors, rotating the deflector at one end about a deflector pivot.

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