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(54) APPARATUS AND CONTROL METHOD FOR AVOIDING SHOCK IN DIESEL FILTERS

(75) Inventor: R. Samuel Boorse, Skillman, NJ (US)

Correspondence Address:
BASF CATALYSTS LLC
100 CAMPUS DRIVE
FLORHAM PARK, NJ 07932 (US)

(73) Assignee: BASF CATALYSTS LLC, Florham Park, NJ (US)

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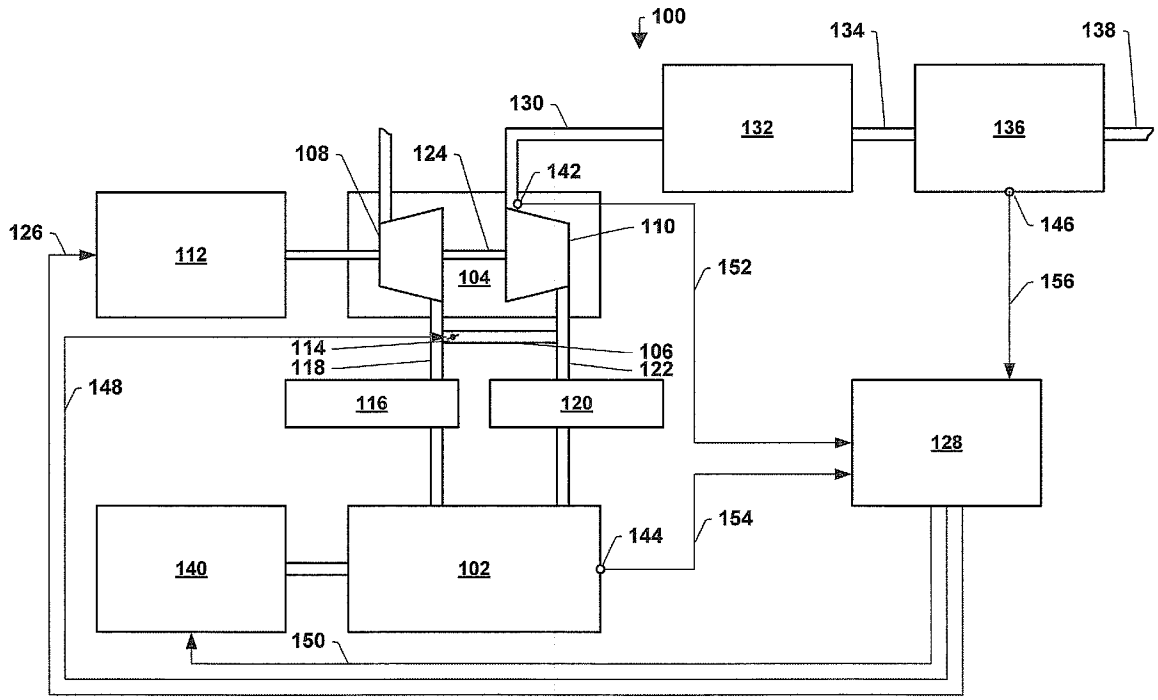
(57) ABSTRACT

Provided are systems and/or methods that facilitate regeneration of a soot filter for a diesel engine. The systems and/or methods can include a bypass tube that connects a compressor side of a turbocharger to an exhaust side of the turbocharger. Compressed air from the turbocharger is introduced through the bypass tube into the soot filter and reduced a soot filter temperature, thereby mitigating the risk of thermal shock and over temperature conditions in the soot filter.



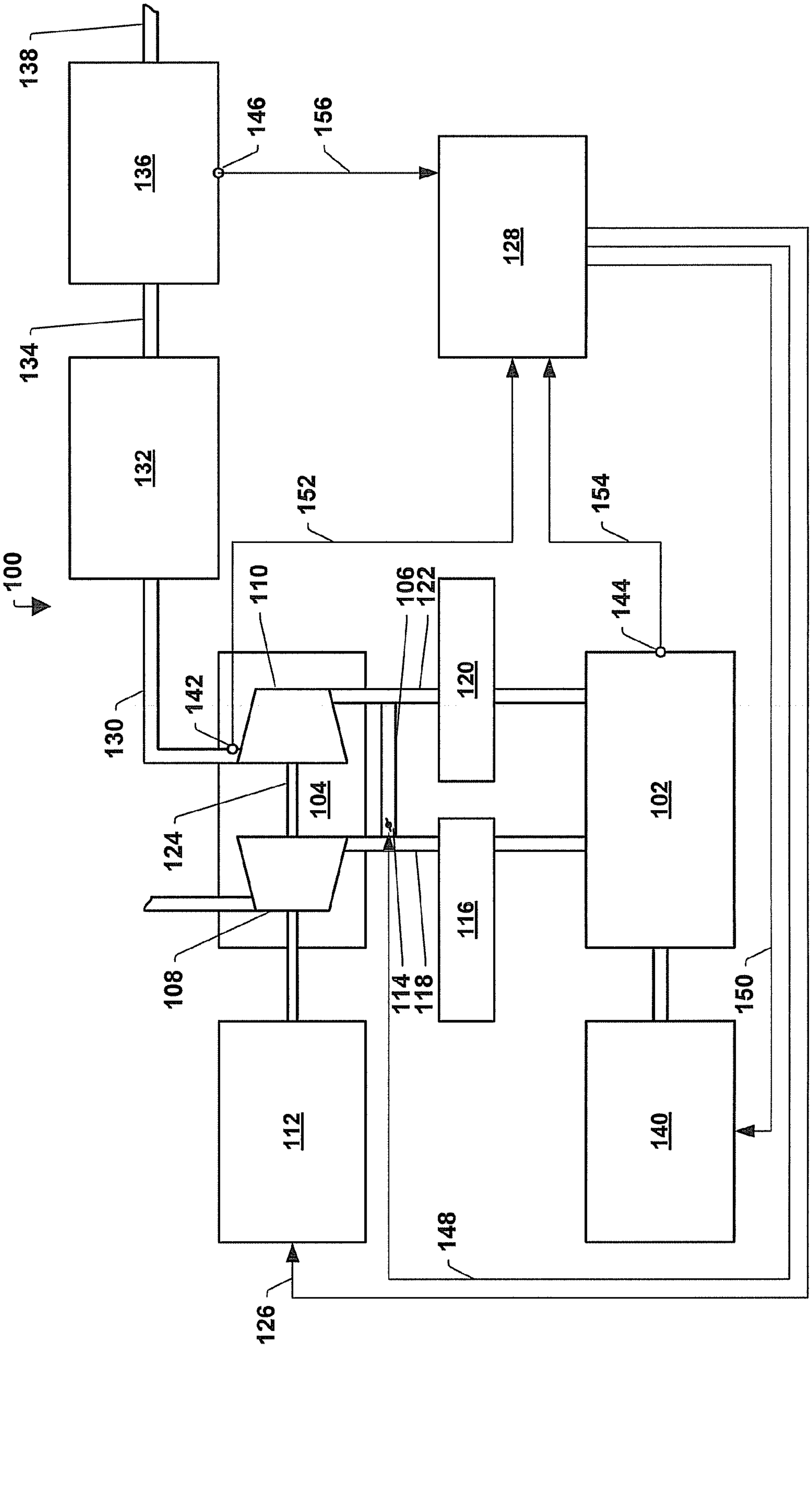

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Figure 1

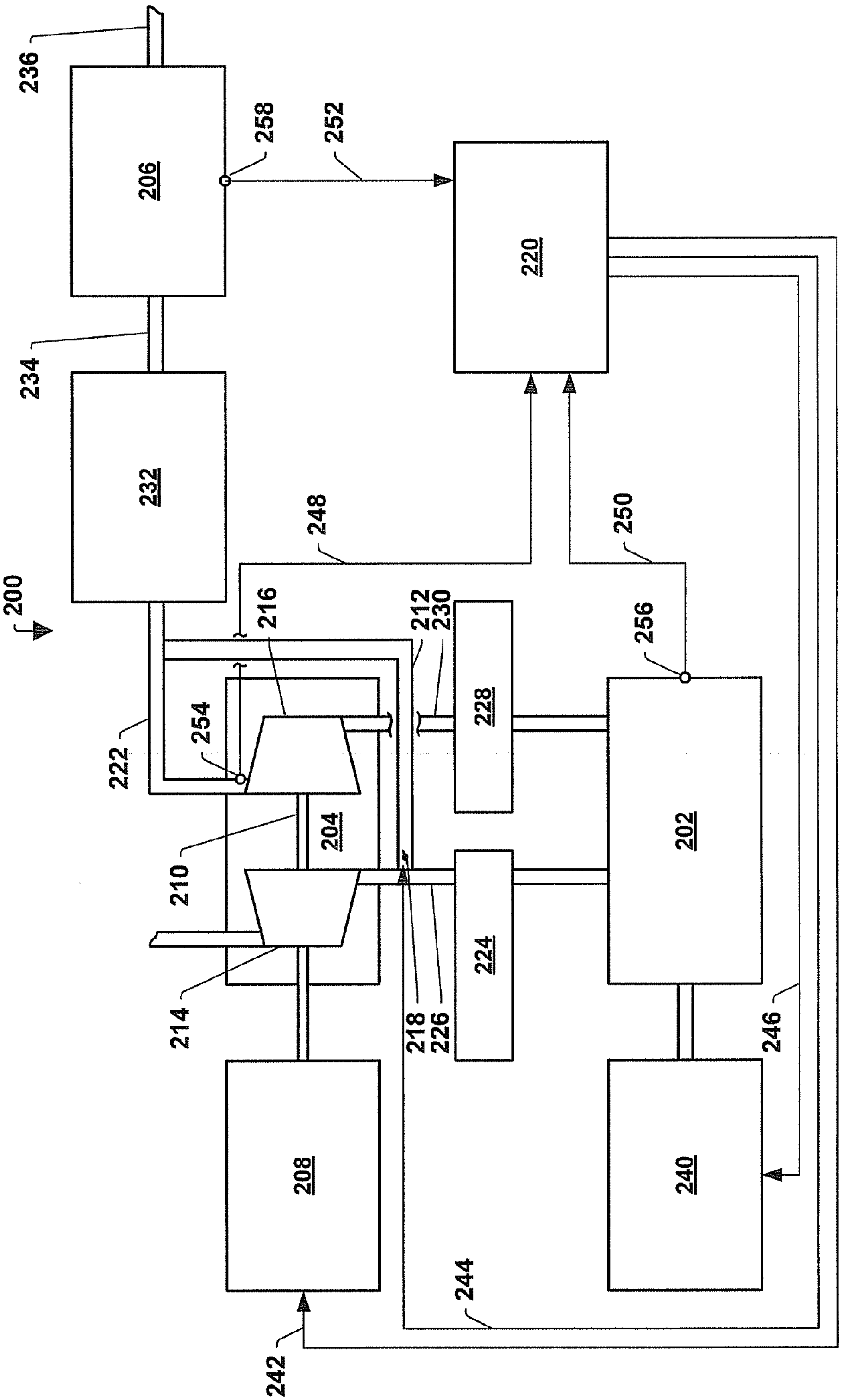
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Figure 2

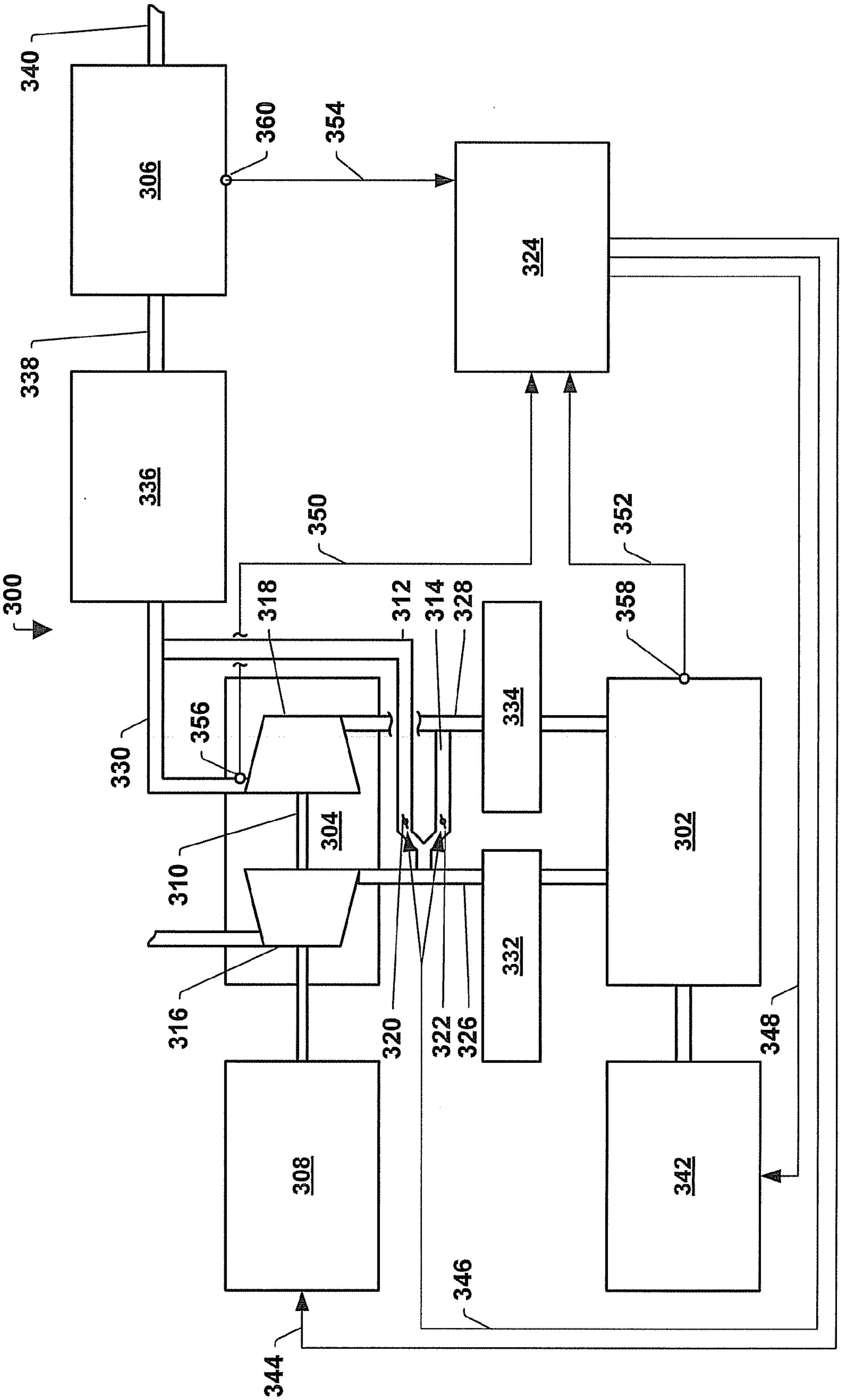

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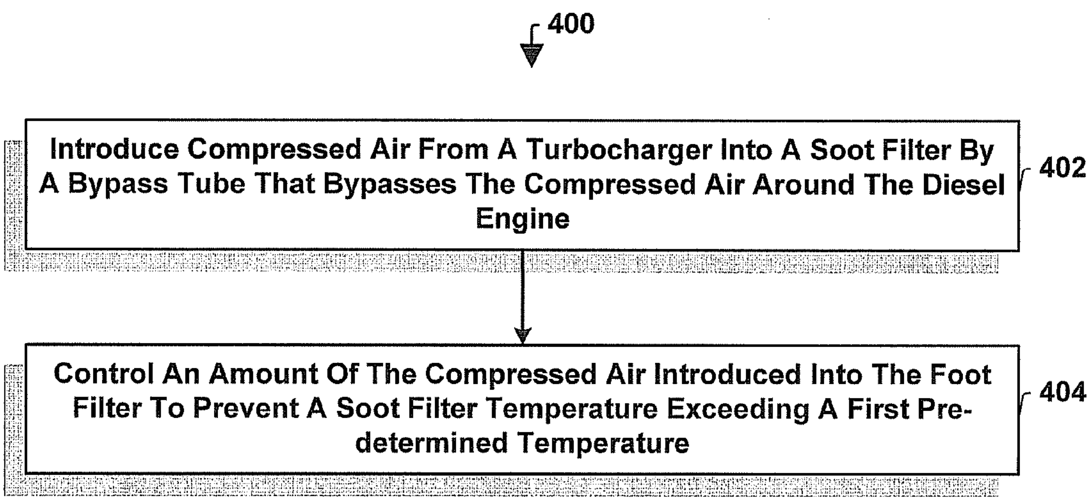
Figure 3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Introduce Compressed Air From A Turbocharger Into A Soot Filter By A Bypass Tube That Bypasses The Compressed Air Around The Diesel Engine
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Control An Amount Of The Compressed Air Introduced Into The Foot Filter To Prevent A Soot Filter Temperature Exceeding A First Pre-determined Temperature
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Figure 4

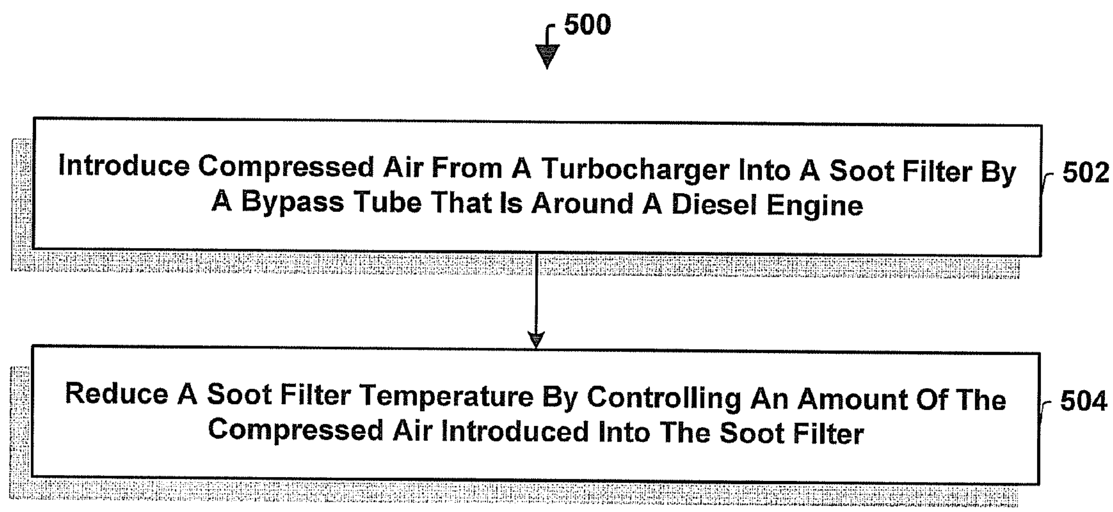
500
Introduce Compressed Air From A Turbocharger Into A Soot Filter By A Bypass Tube That Is Around A Diesel Engine
502
Reduce A Soot Filter Temperature By Controlling An Amount Of The Compressed Air Introduced Into The Soot Filter
504

Figure 5

APPARATUS AND CONTROL METHOD FOR AVOIDING SHOCK IN DIESEL FILTERS

BACKGROUND

[0001] Internal combustion engines used for both mobile and stationary applications are subject to strict emission limits. One approach to reducing emissions is to improve in-cylinder designs, but these improvements have fallen short of meeting emissions limits. Other approaches involve exhaust aftertreatment devices, which have achieved significant emissions reductions.

[0002] Diesel engine exhaust is a heterogeneous mixture which contains not only gaseous emissions such as carbon monoxide ("CO"), unburned hydrocarbons ("HC") and nitrogen oxides ("NO_x"), but also contains phase materials (liquids and solids) which constitute the so-called particulates or particulate matter. The total particulate matter emissions of diesel exhaust are comprised of three main components. One component is a solid, dry, solid carbonaceous fraction or soot fraction. This dry carbonaceous matter contributes to visible soot emissions commonly associated with diesel exhaust.

[0003] A second component of the particulate matter is a soluble organic fraction. The soluble organic fraction is sometimes referred to as a volatile organic fraction. The volatile organic fraction can exist in diesel exhaust either as a vapor or as an aerosol (fine droplets of liquid condensate) depending on the temperature of the diesel exhaust. These liquids arise from two sources: (1) lubricating oil swept from the cylinder walls of the engine each time the pistons go up and down; and (2) unburned or partially burned diesel fuel.

[0004] A third component of the particulate matter is a sulfate fraction. The sulfate fraction is formed from small quantities of sulfur components present in the diesel fuel. Small proportions of SO_3 are formed during combustion of the diesel, which in turn combines rapidly with water in the exhaust to form sulfuric acid. The sulfuric acid collects as a condensed phase with the particulates as an aerosol, or is adsorbed onto the other particulate components, and thereby adds to the mass of total particulate matter.

[0005] Diesel engine exhaust systems typically include soot filters (e.g., particulate filters) and NO_x reduction catalysts that clean exhaust and reduce engine emissions. There are many known filter structures that are effective in removing particulate matter from diesel exhaust, such as honeycomb wall flow filters, wound or packed fiber filters, open cell foams, sintered metal filters, etc.

[0006] The filter is a physical structure for removing particles from exhaust, and the accumulating particles increase a back pressure from the filter on the engine. Thus the accumulating particles have to be continuously or periodically burned out of the filter to maintain an acceptable back pressure. For regeneration of soot filters, elevated exhaust gas temperature can contribute to increased regeneration activity. The accumulated particulate matter is typically heated and oxidized, and removed in a regeneration process before excessive levels have accumulated.

SUMMARY

[0007] The following presents a simplified summary of the innovation in order to provide a basic understanding of some aspects described herein. This summary is not an extensive overview of the claimed subject matter. It is intended to neither identify key or critical elements of the claimed subject matter nor delineate the scope of the subject innovation. Its sole purpose is to present some concepts of the claimed subject matter in a simplified form as a prelude to the more detailed description that is presented later.

[0008] The subject innovation relates to systems that facilitate regeneration of a soot filter for a diesel engine. The systems can include a bypass tube that connects a compressor side of a turbocharger to an exhaust side of the turbocharger, and a bypass valve and a controller that control an amount of compressed air that flows through the bypass tube. The compressed air through the bypass tube is introduced into the soot filter and reduced a soot filter temperature, thereby mitigating the risk of thermal shock and over temperature conditions in the soot filter. The compressed air can be generated a motor that is coupled to the turbocharger independently of the diesel engine.

[0009] The subject innovation also relates to methods that facilitate mitigating thermal shock in a soot filter for a diesel engine. In accordance with one aspect of the claimed subject matter, the methods can involve introducing compressed air from a turbocharger into the soot filter by a bypass tube that bypasses the compressed air around the diesel engine, and controlling an amount of the compressed air introduced into the soot filter to prevent a soot filter temperature from exceeding a pre-determined temperature. In accordance with another aspect of the claimed subject matter, the methods can involve introducing compressed air from a turbocharger into the soot filter by a bypass tube that is around the diesel engine, and reducing a soot filter temperature by controlling an amount of the compressed air introduced into the soot filter.

[0010] The following description and the annexed drawings set forth in detail certain illustrative aspects of the claimed subject matter. These aspects are indicative, however, of but a few of the various ways in which the principles of the innovation may be employed and the claimed subject matter is intended to include all such aspects and their equivalents. Other advantages and novel features of the claimed subject matter will become apparent from the following detailed description of the innovation when considered in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a block diagram of an exemplary system that facilitates regeneration of a soot filter for a diesel engine having a turbocharger in accordance with one aspect of the specification.

[0012] FIG. **2** is a block diagram of another exemplary system that facilitates regeneration of a soot filter for a diesel engine having a turbocharger in accordance with one aspect of the specification.

[0013] FIG. **3** is a block diagram of another exemplary system that facilitates regeneration of a soot filter for a diesel engine having a turbocharger in accordance with one aspect of the specification.

[0014] FIG. **4** is a flow diagram of an exemplary methodology for mitigating thermal shock in a soot filter for a diesel engine in accordance with one aspect of the specification.

[0015] FIG. **5** is a flow diagram of another exemplary methodology for mitigating thermal shock in a soot filter for a diesel engine in accordance with one aspect of the specification.

DETAILED DESCRIPTION

[0016] Diesel aftertreatment devices such as a soot filter can be used for controlling diesel engine emissions. During diesel engine operation, carbon particulates are produced as byproducts of combustion. These materials are subsequently collected by the soot filter. As the carbon particulates accumulate within these aftertreatment devices, the aftertreatment devices must be regenerated. This is accomplished by oxidizing the carbon particulates held by these devices.

[0017] Regeneration of a soot filter is typically accomplished by injecting fuel into engine cylinders by a fuel injector during their exhaust cycle to form fuel vapors which are carried with exhaust gas for burning in the soot filter device. Regeneration of soot filters can be accomplished by after-injection, which involves injecting low pressure diesel fuel directly into the exhaust downstream of the engine. The regeneration may increase the potential for thermal shock damages to the soot filter.

[0018] The subject innovation relates to systems, apparatuses, and/or methods that mitigate (e.g., prevent or minimize) thermal shock (e.g., over temperature or rapid cooling) of one or more aftertreatment components (e.g., soot filter) for a diesel engine under active regeneration. The systems, apparatuses and/or methods can involve a turbocharger for a diesel engine that has a bypass tube from a compressor side of the turbocharger to an exhaust side of the turbocharger. The turbocharger can be connected to a motor, thereby allowing independent driving of the turbocharger. When desired, such as when the engine is subjected to "drop to idle" conditions to regenerate soot filters, fresh air from the turbo compressor can be bypassed around the engine and intake air can be used to increase the gas flow through the exhaust system without increasing engine speed.

[0019] The bypass tube can increase gas flow of compressed fresh air through the soot filter, thereby reducing the temperature in the soot filter. As a result, thermal shock and/or over temperature conditions can be mitigated. The control of the valve, the motor, and/or the fuel injector can facilitate mitigating thermal shock and/or thermal excursions in soot filters by increasing fresh air flow through the bypass tube and the through the soot filter thereby reducing the temperature in the soot filter.

[0020] The control system can use inputs such as a turbo out temperature, engine speed, regeneration control state, and turbo speed to control the amount of power to the motor driving the turbocharger, the position of the bypass valve, and the state of the fuel injector being used to regenerate the system. The control system can also use the turbo outlet temperature to determine whether the fuel continues to be injected into the engine, diesel oxidation catalyst (DOC) device, or regeneration burner to maintain regeneration conditions in the filter. The fuel can be injected to the components to avoid thermal shock of cold air bypassed around the engine through the bypass tube from causing thermal shock as it hits the already hot filter. The control system can also use a small burner in the bypass tube to increase the bypass air temperature to reduce to possibility of the thermal shock of cold air bypassed around the engine.

[0021] The claimed subject matter is described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the subject innovation. It may be evident, however, that the claimed subject matter may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate describing the subject innovation.

[0022] FIG. **1** is a block diagram of a system **100** for mitigating thermal shock in aftertreatment devices such as a soot filter device. The system **100** can include an internal combustion diesel engine **102** that can be operatively coupled to a transmission (not shown). The system **100** can involve a turbocharger **104** for a diesel engine **102**. The turbocharger **104** can have a bypass tube (e.g., pipe, conduit) **106** from a compressor side **108** of the turbocharger **104** to an exhaust side **110** of the turbocharger **104**. The turbocharger **104** can be connected to a motor **112**, thereby allowing independent driving of the turbocharger **104**. The bypass tube **106** can have a valve **114** which allows the bypass to be open or closed.

[0023] The engine **102** can include an intake manifold **116** fluidly coupled to an intake conduit (e.g., pipe) **118** for receiving fresh air. An exhaust manifold **120** of the engine **102** is fluidly coupled to an exhaust gas conduit **122**. Exhaust gas produced by the engine **102** exits through the exhaust manifold **120** and exhaust gas conduit **122** to the exhaust side **110** of the turbocharger **104**.

[0024] Operation of the turbocharger **104** is conventional in that a turbine wheel (not shown) housed within the exhaust side **110** of the turbocharger **104** is responsive to the flow of exhaust gas through the exhaust gas conduit **122** to rotationally drive the drive shaft **124** of the turbocharger **104** and thereby rotate a compressor wheel (not shown) housed within the compressor side **108** of the turbocharger **104**. The rotational speed of the turbine wheel is generally related to the flow rate of exhaust gas through the exhaust gas conduit **122**, and the mass flow rate of fresh air into the intake conduit **118** is, in turn, proportional to the rotational speed of the compressor wheel.

[0025] The motor **112** can be any suitable motor such as an electric motor as long as the motor **112** can supply power to a turbocharger shaft **124** and/or remove power from the shaft **124**. The motor **112** can be mechanically coupled to the turbocharger shaft **124** and can receive an electrical control signal **126** from a controller **128**. When the motor **112** is operated, power is supplied to turbocharger shaft **124**, in addition to power supplied from the turbine wheel, which increases turbocharger speed and forces additional air into the intake conduit **118** and/or the bypass **106**.

[0026] By including the motor **112** that drives the turbocharger **104**, the turbocharger **104** can generate the compressed air independently of the engine state. For example, the turbocharger **104** generates the compressed air by the motor **104** while the engine **102** is in an idle mode or a low-demand mode or when the engine stops. As a result, the soot filter regeneration can be performed when the engine **102** is in an idle mode or a low-demand mode, or when the engine stops.

[0027] An exhaust gas conduit **130** from the turbocharger **104** can be fluidly coupled to an inlet of a DOC device **132**. An outlet of the diesel oxidation catalyst device **132** can be fluidly coupled via an exhaust conduit **134** to an inlet of a soot filter **136** having an outlet fluidly coupled to an exhaust conduit **138**. It will be appreciated that in some embodiments of the system **100**, a NO_x aftertreatment device (not shown) may be included between the DOC **132** and the soot filter **136**.

[0028] The bypass tube **106** can fluidly connect the compressor side **108** of the turbocharger **104** to the exhaust side **110**. The bypass tube **106** can bypass fresh air around the engine **102** and provide the air from the compressor side **108**

of the turbocharger **104** to the exhaust side **110**. The bypass tube **106** can go from the compressed intake conduit **118** (e.g., just upstream of the intake manifold **116**) to the exhaust gas conduit **122** upstream of the exhaust side **110** of the turbocharger **104**. The bypass tube **106** can have a valve **114** which allows the bypass to be turned on and off. The bypass valve **114** can open and close the bypass **106**.

[0029] The soot filter **136** can be any suitable filter including a ceramic soot filter that collects carbon particulates in diesel engine emissions produced as byproducts of combustion. The soot filter **136** may be referred to as a particulate filter. As the carbon particulates accumulate within the soot filter **136**, the soot filter can be regenerated by oxidizing the carbon particulates.

[0030] Regeneration of the soot filter **136** can be accomplished by providing fuel vapors in an exhaust gas which are carried with the exhaust gas for burning in the soot filter device **136**. For example, regeneration of the soot filter can be accomplished by injecting fuel into engine cylinders of the engine **102** via a fuel injector **140** to form the fuel vapors. Although not shown in FIG. **1**, regeneration can be accomplished by injecting fuel into the exhaust downstream of the engine or a regeneration burner. The details of the regeneration and fuel injector are not critical to the practice of the subject innovation. The details of the regeneration and fuel injector can be found in, for example, U.S. Pat. No. 7,021,047, which is hereby incorporated by reference.

[0031] The controller **128** is operatively coupled to one or more sensors in the system. The controller **128** is also operatively coupled to one or more components of the system. The controller **128** can receive information from the sensors and control the one or more components based on the information generated by the sensors for mitigating thermal shock (e.g., over temperature or rapid cooling) of one or more aftertreatment components (e.g., soot filter).

[0032] The sensor can generate information indicative of at least one condition of one or more components of the system **100**. Examples of sensors include temperature sensors, pressure sensors, chemical sensors, motion sensors, electrical signal sensors, digital cameras, and other types of devices capable of rendering measurements. Specific examples of sensors include turbo speed sensors, turbo outlet temperature sensors, turbo outlet pressure sensors, engine speed sensors, soot filter temperature sensors, soot filter back pressure sensors, or the like. By way of example, FIG. **1** illustrates turbo outlet temperature sensors **142**, engine speed sensors **144**, and soot filter temperature sensors **146**.

[0033] The controller **128** can change at least one condition of one or more components of the system based on the information generated by the sensors. For example, the controller **128** operates the motor **112**, bypass valve **114**, fuel injector **140**, or the like by sending control signals **126**, **148**, **150** to the motor **112**, bypass valve **114**, fuel injector **140**, or the like based on the information **152**, **154**, **156** from the turbo outlet temperature sensors **142**, engine speed sensors **144**, soot filter temperature sensors **146**, or the like. The controller **128** can change the amount of power to the motor **112** driving the turbocharger **104**, the position of the bypass valve **114**, the state of the fuel injector **140**, or the like. In one embodiment, the controller **128** increases the fresh air flow through the bypass tube **106** to reduce the soot filter temperature by opening the bypass valve **114**, driving the motor **112**, or the like. The intake air from the turbo compressor **108** is bypassed around the engine **102** by the bypass tube **106** and the air can be used to increase the gas flow through the exhaust system **132**, **136** without increasing engine speed, thereby reducing the soot filter temperature. Alternatively, the controller **128** can reduce the air flow through the bypass tube **106** to increase the soot filter temperature by closing the bypass valve **114**, stopping the motor **112**, or the like.

[0034] In one embodiment, the motor **112** functions to increase an amount of air flow through the bypass tube **106**, and to therefore reduce the regeneration temperature in the soot filter **136**. Conversely, when the motor **123** is operated to remove power from the shaft, the turbocharger speed is decreased, thereby reducing the amount of combustion air entering into the bypass tube **116**.

[0035] In another embodiment, the controller **128** uses inputs such as turbo out temperature, engine speed, regeneration control state, and turbo speed to control the amount of power to the motor **112**, the position of the bypass valve **114**, and the state of the fuel injector **140**. The controller **128** can use a soot filter temperature to determine how much power to apply to the motor **112** to drive the turbocharger **104**, how much the bypass valve **114** is opened or closed, how much the fuel is injected by the injector **140**, or the like. The controller **128** can apply power to the motor **112** and/or open the bypass valve **114** when the turbo outlet temperature exceeds a first pre-determined temperature.

[0036] The controller **128** can change one or more conditions of one or more components of the system **100** to mitigate thermal shock and/or over temperature conditions of the soot filter under regeneration of the soot filter at engine idle. For example, the controller **128** changes one or more conditions of one or more components of the system **100** to prevent the soot filter temperature from exceeding a predetermined temperature. In one embodiment, the controller **128** changes at least one condition of one or more components of the system to prevent the soot filter temperature from exceeding about 650 degrees Celsius. In another embodiment, the controller **128** changes at least one condition of one or more components of the system to prevent the soot filter temperature from exceeding about 600 degrees Celsius. In yet another embodiment, the controller **128** changes at least one condition of one or more components of the system to prevent the soot filter temperature from exceeding about 550 degrees Celsius.

[0037] In one embodiment, the subject innovation can increase an exhaust gas temperature to prevent thermal shock of cold air bypassed around the engine from causing thermal shock as it hits the already hot filter (e.g., thermal shock due to rapid cooling). The controller **128** can use a turbo outlet temperature to determine whether the fuel should continue to be injected into the engine, DOC, or regeneration burner to maintain regeneration conditions (e.g., soot filter temperature) in the soot filter device **136**. The controller **128** operates the fuel injector **140** to inject fuel when the turbo outlet temperature is below a second pre-determined temperature. In another embodiment, the bypass tube **106** includes a small burner (not shown) therein to increase the bypass air temperature to reduce to possibility of the thermal shock.

[0038] The controller **128** can increase a temperature of the exhaust gas from the turbocharger **104** by injecting fuel into the engine, DOC, or regeneration burner and/or by operating the burner in the bypass tube **106** to a second pre-determined temperature. In one embodiment, the controller **128** increases the exhaust gas temperature to about 200 degrees Celsius or more and 600 degrees Celsius or less. In another embodiment, the controller **128** increases the exhaust gas temperature to about 300 degrees Celsius or more and 550 degrees Celsius or less. In yet another embodiment, the controller **128** increases the exhaust gas temperature to about 350 degrees Celsius or more and 500 degrees Celsius or less.

[0039] Regeneration can be performed at any suitable time. Regeneration can be performed periodically at appropriate intervals. In one embodiment, regeneration is performed when the diesel engine **102** is in an idle mode or a low-demand mode. Regeneration can be triggered shortly after the filter performance falls to a pre-determined value during normal operation. After extended operation of a number of hours, the soot/ash is build up as a cake on the soot filter **136** and the engine exhaust back pressure increases. In one embodiment, regeneration is automatically performed when a specified back pressure is reached. The regeneration can be done by using feedback signals such as an exhaust back-pressure, elapsed time since previous regeneration, detection of carbon accumulation, signals from diesel engine parameters indicating a specific engine mode where conditions are right to initiate the soot regeneration. In another embodiment, regeneration can be performed manually.

[0040] FIG. **2** illustrates another exemplary system **200** that facilitates regeneration of a soot filter for a diesel engine having a turbocharger. The system **200** includes a diesel engine **202**; a turbocharger **204** that is coupled to the soot filter **206**; a motor **208** that is coupled to a turbocharger shaft **210**; a bypass tube **212** that connects a compressor side **214** of the turbocharger **204** to an exhaust side **216**; a bypass valve **218**; and a controller **220** that control an amount of compressed air that flows through the bypass tube **212**. The bypass tube **212** can fluidly connect the compressor side **214** of the turbocharger to the exhaust side **216**. The bypass tube **212** can bypass fresh intake air around the engine **202** and provide the air from the compressor side **214** of the turbocharger to the exhaust side **216**. The bypass tube **212** can go from the compressed inlet side **214** (e.g., just upstream of the intake manifold) to the exhaust gas conduit **222** downstream of the turbocharger **204**. In one embodiment, the bypass tube **212** includes a small burner (not shown) therein to increase the bypass air temperature to reduce to possibility of the thermal shock of cold air to the soot filter **206**. It is to be appreciated that the turbocharger **204**, the motor **208**, the bypass valve **218**, and the controller **220** can be substantially similar to the turbocharger **104**, the motor **112**, the bypass valve **114**, and the controller **128** as described in connection with FIG. **1**.

[0041] The engine **202** can include an intake manifold **224** fluidly coupled to an intake conduit (e.g., pipe) **226** for receiving fresh air from the compressor side **214** of the turbocharger **204**. An exhaust manifold **228** of the engine **202** is fluidly coupled to an exhaust gas conduit **230**. Exhaust gas produced by the engine **202** exits through the exhaust manifold **228** and exhaust gas conduit **230**. The exhaust gas then drives the drive shaft **210** of the turbocharger **204** and exits through an exhaust gas conduit **222**.

[0042] The exhaust gas conduit **222** from the turbocharger **204** can be fluidly coupled to an inlet of a DOC device **232**. An outlet of the diesel oxidation catalyst device **232** can be fluidly coupled via an exhaust conduit **234** to an inlet of a soot filter **206** having an outlet fluidly coupled to an exhaust conduit **236**. It will be appreciated that in some embodiments of the system **200**, a NO_x aftertreatment device (not shown) may be included between the DOC **232** and the soot filter **206**.

[0043] The controller **220** can change at least one condition of one or more components of the system based on the information generated by the sensor in the similar manner as described in connection with FIG. **1**. For example, the controller **220** operates the motor **208**, the bypass valve **218**, a fuel injector **240**, or the like by sending control signals **242**, **244**, **246** to the motor **208**, the bypass valve **218**, the fuel injector **240**, or the like based on the information **248**, **250**, **252** from the turbo outlet temperature sensors **254**, engine speed sensors **256**, soot filter temperature sensors **258**, or the like. In one embodiment, the controller **220** increases the air flow through the bypass tube **212** to reduce the soot filter temperature by opening the bypass valve **218** and by driving the motor **208**, or the like. In another embodiment, the controller **220** increases a temperature of the exhaust gas from the turbocharger **204** by injecting fuel into the engine, DOC, or regeneration burner (not shown) and/or by operating the bypass tube burner.

[0044] FIG. **3** illustrates another exemplary system **300** that facilitates regeneration of a soot filter for a diesel engine having a turbocharger. The system **300** includes a diesel engine **302**; a turbocharger **304** that is coupled to the soot filter **306**; a motor **308** that is coupled to a turbocharger shaft **310**; two bypass tubes **312**, **314** that connect a compressor side **316** of the turbocharger **304** to an exhaust side **318**; bypass valves **320**, **322** in the bypass tubes **312**, **314**; and a controller **324** that control an amount of compressed air that flows through the bypass tubes **312**, **314**. The bypass tubes **312**, **314** can fluidly connect the compressor side **316** of the turbocharger to the exhaust side **318**. The bypass tubes **312**, **314** can bypass fresh intake air around the engine **302** and provide the air from the compressor side **316** of the turbocharger to the exhaust side **318**. The bypass tubes **312**, **314** can go from a compressed intake conduit **326** (e.g., just upstream of the intake manifold **116**) to an exhaust gas conduit **328** upstream of the exhaust side **318** of the turbocharger **304** and to an exhaust pipe **330** downstream of the turbocharger **304**.

[0045] The two bypass tubes **312**, **314** can have a common intake. In another embodiment, the two bypass tubes **312**, **314** have separate intakes, respectively (not shown). In one embodiment, at least one of the bypass tubes **312**, **314** include a small burner (not shown) therein to increase the bypass air temperature to reduce to possibility of the thermal shock of cold air to the soot filter **306**.

[0046] It is to be appreciated that the turbocharger **304**, the motor **308**, the bypass valves **320**, **322**, and the controller **324** can be substantially similar to the turbocharger **104**, the motor **112**, the bypass valve **114**, and the controller **128** as described in connection with FIG. **1**. The engine **302** can include an intake manifold **332** fluidly coupled to an intake conduit (e.g., pipe) **326** for receiving fresh air from the compressor side **316** of the turbocharger **304**. An exhaust manifold **334** of the engine **302** is fluidly coupled to the exhaust gas conduit **328** upstream of the exhaust side **318** of the turbocharger **304**. Exhaust gas produced by the engine **302** exits through the exhaust manifold **334** and exhaust gas conduit **328**. The exhaust gas then drives the drive shaft **310** of the turbocharger **304** and exits through an exhaust gas pipe **330** downstream of the turbocharger **304**.

[0047] The exhaust gas pipe **330** from the turbocharger **304** can be fluidly coupled to an inlet of a DOC device **336**. An outlet of the diesel oxidation catalyst device **336** can be fluidly coupled via an exhaust conduit **338** to an inlet of a soot filter **306** having an outlet fluidly coupled to an exhaust conduit **340**. It will be appreciated that in some embodiments of the system **300**, a NO_x aftertreatment device (not shown) may be included between the DOC and the soot filter.

[0048] The controller **324** can change at least one condition of one or more components of the system based on information generated by one or more sensors in the similar manner as described in connection with FIG. **1**. For example, the controller **324** operates the motor **308**, at least one of the two bypass valves **320**, **322**, a fuel injector **342**, or the like by sending control signals **344**, **346**, **348** to the motor **308**, at least one of the two bypass valves **320**, **322**, the fuel injector **342**, or the like based on the information **350**, **352**, **354** from the turbo outlet temperature sensors **356**, engine speed sensors **358**, soot filter temperature sensors **360**, or the like. In one embodiment, the controller **324** increases the air flow through at least one of the two bypass tubes **312**, **314** to reduce the soot filter temperature by opening at least one of the two bypass valves **320**, **322** and by driving the motor **308**, or the like. In another embodiment, the controller **324** increases a temperature of the exhaust gas from the turbocharger **304** by injecting fuel into the engine, DOC, or regeneration burner (not shown) and/or by operating the bypass tube burner.

[0049] FIG. **4** illustrates an exemplary methodology **400** of mitigating thermal shock in a soot filter for a diesel engine. At **402**, compressed air is introduced from a turbocharger into the soot filter by a bypass tube that bypasses the compressed air around the diesel engine. At **404**, an amount of the compressed air introduced into the soot filter is controlled to prevent a soot filter temperature from exceeding a first predetermined temperature.

[0050] FIG. **5** illustrates another exemplary methodology **500** of mitigating thermal shock in a soot filter for a diesel engine. At **502**, compressed air is introduced from a turbocharger into the soot filter by a bypass tube that is around the diesel engine. At **504**, a soot filter temperature is reduced by controlling an amount of the compressed air introduced into the soot filter.

[0051] Although not shown in FIGS. **4** and **5**, in one embodiment, the bypass tube connects the compressor side to an exhaust gas conduit upstream of the exhaust side of the turbocharger. In another embodiment, the bypass tube connects the compressor side to an exhaust pipe downstream of the turbocharger. In yet another embodiment, the bypass tube connects the compressor side to both an exhaust conduit upstream of the exhaust side of the turbocharger and to an exhaust pipe downstream of the turbocharger.

[0052] In one embodiment, the amount of the compressed air introduced into the soot filter is controlled based on a turbo speed, turbo outlet temperature, turbo outlet pressure, engine speed, soot filter temperature, soot filter back pressure, combinations thereof. The amount of the compressed air introduced into the soot filter can be controlled by operating a bypass valve in the bypass tube, a motor that drives the turbocharger, a fuel injector that injects fuel into an exhaust gas, or combinations thereof.

[0053] In another embodiment, the methodologies in FIGS. **4** and **5** further involve increasing a temperature of a gas exhaust that flows into the soot filter by operating a motor that drives the turbocharger, a fuel injector that injects fuel into the exhaust gas, a burner in the bypass tube, or combinations thereof. By increasing the exhaust gas temperature, the methodologies can prevent thermal shock of cold air bypassed around the engine from causing thermal shock as it hits the already hot filter.

[0054] The claimed subject matter can be implemented on existing engine systems that can be used for both mobile and stationary applications. Examples of engine systems include automobiles, farm tractors, stationary machinery, portable machinery including generators, snow-blowers, lawn mowers, small watercraft engines, and the like, construction vehicles and machinery such as diggers, front end loaders, trucks, cranes, fork lifts, pavers, graders, bulldozers and the like, boats, ships, helicopters, aircraft, trains, motorbikes, motorcycles, all-terrain vehicles, and related transportation machinery.

[0055] As utilized herein, terms "controller," "component," "system," "device," and the like can be intended to refer to a computer-related entity, either hardware, software (e.g., in execution), and/or firmware. For example, a component can be a process running on a processor, an object, an executable, a program, a function, a library, a subroutine, and/or a computer or a combination of software and hardware. By way of illustration, both an application running on a computer that is mounted on a vehicle and the computer can be a controller or a component. One or more components can reside within a process and a component can be localized on one computer and/or distributed between two or more computers.

[0056] Furthermore, the claimed subject matter may be implemented as a method, apparatus, or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof to control a computer to implement the disclosed subject matter. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device, carrier, or media. For example, computer readable media can include but are not limited to magnetic storage devices (e.g., hard disk, floppy disk, magnetic strips, or the like), optical disks (e.g., compact disk (CD), digital versatile disk (DVD), or the like), smart cards, and flash memory devices (e.g., card, stick, key drive, or the like). Additionally it should be appreciated that a carrier wave can be employed to carry computer-readable electronic data such as those used in transmitting and receiving electronic mail or in accessing a network such as the Internet or a local area network (LAN). Of course, those skilled in the art will recognize many modifications may be made to this configuration without departing from the scope or spirit of the claimed subject matter. Moreover, the word "exemplary" is used herein to mean serving as an example, instance, or illustration. Any aspect or design described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects or designs.

[0057] While the claimed subject matter has been described above in the general context of computer-executable instructions of a computer program that runs on a local computer and/or remote computer, those skilled in the art will recognize that the subject innovation also may be implemented in combination with other program modules. Generally, program modules include routines, programs, components, data structures, etc., that perform particular tasks and/or implement particular abstract data types.

[0058] Moreover, those skilled in the art will appreciate that the inventive methods may be practiced with other computer system configurations, including single-processor or multiprocessor computer systems, minicomputers, mainframe computers, as well as personal computers, hand-held computing devices, microprocessor-based and/or programmable consumer electronics, and the like, each of which may operatively communicate with one or more associated devices. The illustrated aspects of the claimed subject matter may also be practiced in distributed computing environments where certain tasks are performed by remote processing devices that are linked through a communications network. However, some, if not all, aspects of the subject innovation may be practiced on stand-alone computers. In a distributed computing environment, program modules may be located in local and/or remote memory storage devices.

[0059] What has been described above includes examples of the subject innovation. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the claimed subject matter, but one of ordinary skill in the art may recognize that many further combinations and permutations of the subject innovation are possible. Accordingly, the claimed subject matter is intended to embrace all such alterations, modifications, and variations that fall within the spirit and scope of the appended claims.

[0060] In particular and in regard to the various functions performed by the above described systems, components, devices, and the like, the terms used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (e.g., a functional equivalent), even though not structurally equivalent to the disclosed structure, which performs the function in the herein illustrated exemplary aspects of the claimed subject matter. In this regard, it will also be recognized that the innovation includes a system as well as a computer-readable medium having computer-executable instructions for performing the acts and/or events of the various methods of the claimed subject matter.

[0061] There are multiple ways of implementing the subject innovation, e.g., an appropriate API, tool kit, driver code, operating system, control, standalone, downloadable software object, etc. which enables applications and services to use the advertising techniques of the innovation. The claimed subject matter contemplates the use from the standpoint of an API (or other software object), as well as from a software or hardware object that operates according to the advertising techniques in accordance with the innovation. Thus, various implementations of the innovation described herein may have aspects that are wholly in hardware, partly in hardware and partly in software, as well as in software.

[0062] The aforementioned systems have been described with respect to interaction between several components. It can be appreciated that such systems and components can include those components or specified sub-components, some of the specified components or sub-components, and/or additional components, and according to various permutations and combinations of the foregoing. Sub-components can also be implemented as components communicatively coupled to other components rather than included within parent components (hierarchical). Additionally, it should be noted that one or more components may be combined into a single component providing aggregate functionality or divided into several separate sub-components, and any one or more middle layers, such as a management layer, may be provided to communicatively couple to such sub-components in order to provide integrated functionality. Any components described herein may also interact with one or more other components not specifically described herein but generally known by those of skill in the art.

[0063] In addition, while a particular feature of the subject innovation may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application. Furthermore, to the extent that the terms "includes," "including," "has," "contains," variants thereof, and other similar words are used in either the detailed description or the claims, these terms are intended to be inclusive in a manner similar to the term "comprising" as an open transition word without precluding any additional or other elements.

What is claimed is:

1. A system that facilitates regeneration of a soot filter for a diesel engine, comprising:

a turbocharger that is coupled to the diesel engine and the soot filter;

a motor that is coupled to a turbocharger shaft;

a bypass tube that connects a compressor side of the turbocharger to an exhaust side of the turbocharger; and

a bypass valve and a controller that control an amount of compressed air that flows through the bypass tube.

2. The system of claim **1**, wherein the motor drives the turbocharger independently of the diesel engine.

3. The system of claim **1**, wherein the bypass tube comprises a burner therein to increase a compressed air temperature.

4. The system of claim **1** further comprising a fuel injector that provides fuel vapors in an exhaust gas of the diesel engine.

5. The system of claim **4**, wherein the controller controls the amount of compressed air by operating the motor, the bypass valve, or combinations thereof.

6. The system of claim **1**, wherein the soot filter is a ceramic soot filter.

7. The system of claim **1**, wherein the bypass tube connects the compressor side to an exhaust conduit upstream of the exhaust side of the turbocharger, to an exhaust pipe downstream of the turbocharger, or a combination thereof.

8. The system of claim **1** further comprising a soot filter temperature sensor, a turbo outlet temperature sensor, an engine speed sensor, or combinations thereof.

9. A method that facilitates mitigating thermal shock in a soot filter for a diesel engine, comprising:

introducing compressed air from a turbocharger into the soot filter by a bypass tube that bypasses the compressed air around the diesel engine, the bypass tube comprising a bypass valve; and

controlling an amount of the compressed air introduced into the soot filter to prevent a soot filter temperature from exceeding a first pre-determined temperature.

10. The method of claim **9**, wherein the compressed air is introduced by the bypass tube that connects the compressor side to an exhaust conduit upstream of the exhaust side of the turbocharger, to an exhaust pipe downstream of the turbocharger, or a combination thereof.

11. The method of claim **9**, wherein the amount of the compressed air introduced into the soot filter is controlled based on a turbo speed, turbo outlet temperature, turbo outlet pressure, engine speed, soot filter temperature, soot filter back pressure, or combinations thereof.

12. The method of claim **9**, wherein the amount of the compressed air introduced into the soot filter is controlled by operating the bypass valve in the bypass tube, a motor that drives the turbocharger, or combinations thereof.

13. The method of claim **9** further comprising increasing a temperature of an exhaust gas that flows into the soot filter by operating a motor that drives the turbocharger, a fuel injector that injects fuel into the exhaust gas, a burner in the bypass tube, or combinations thereof.

14. The method of claim **1**, wherein the amount of the compressed air introduced into the soot filter is controlled when the diesel engine is in an idle mode or a low-demand mode, or when the diesel engine stops.

15. A method that facilitates mitigating thermal shock in a soot filter for a diesel engine, comprising:

introducing compressed air from a turbocharger into the soot filter by a bypass tube that is around the diesel engine and that comprises a bypass valve; and

reducing a soot filter temperature by controlling an amount of the compressed air introduced into the soot filter.

16. The method of claim **15**, wherein the compressed air is introduced by the bypass tube that connects the compressor side to an exhaust conduit upstream of the exhaust side of the turbocharger, to an exhaust pipe downstream of the turbocharger, or a combination thereof.

17. The method of claim **15**, wherein the amount of the compressed air introduced into the soot filter is controlled based on a turbo speed, turbo outlet temperature, turbo outlet pressure, engine speed, soot filter temperature, soot filter back pressure, or combinations thereof.

18. The method of claim **15**, wherein the amount of the compressed air introduced into the soot filter is controlled by operating the bypass valve in the bypass tube, a motor that drives the turbocharger or combinations thereof.

19. The method of claim **15** further comprising increasing a temperature of an exhaust gas that flows into the soot filter by operating a motor that drives the turbocharger, a fuel injector that injects fuel into the exhaust gas, a burner in the bypass tube, or combinations thereof.

20. The method of claim **15**, wherein the amount of the compressed air introduced into the soot filter is controlled when the diesel engine is in an idle mode or a low-demand mode, or when the diesel engine stops.

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