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2.1 Engine maintenance

2.1.1 Replace the engine air filter

WARNING:
Chemical remains can be present in dirt on the filter elements. Do not breathe the dust. Wear the gloves and the respiratory protection while servicing the filter elements.

IMPORTANT:
The filter no longer has a warranty, once the filter is cleaned.

NOTE:
Never try to clean a safety filter. Replace the safety filter after three primary filter change outs.

Procedure

1. Unfasten the straps (1), and remove the air cleaner cover (2).
2. Check the air cleaner service indicator (3) every day.

   NOTE:
   Indicator is preset by manufacturer to show when service is required. Reset the indicator after service by pushing the top reset button.
3. Check the rubber elbows and the hose clamps on the air intake system every day.

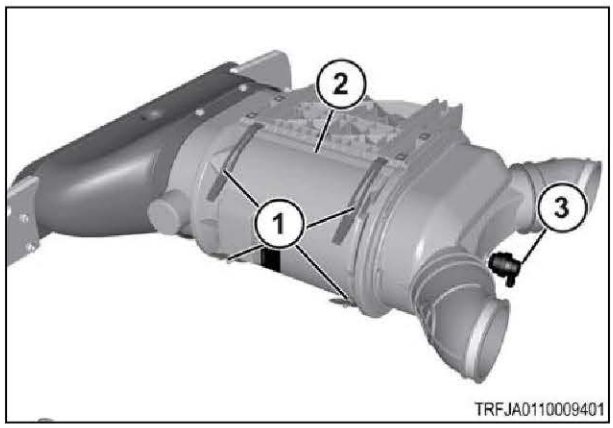


Fig. 1

4. Replace the air filter element (1) with a new element if damaged.
5. Replace the air filter element if the gaskets are damaged or missing.
6. Replace the air filter element with a new element every year.

   IMPORTANT:
   Remove the air filter element, only if being replaced. Replace the air filter when dirty. Do not clean filter.
7. Install the air filter element.

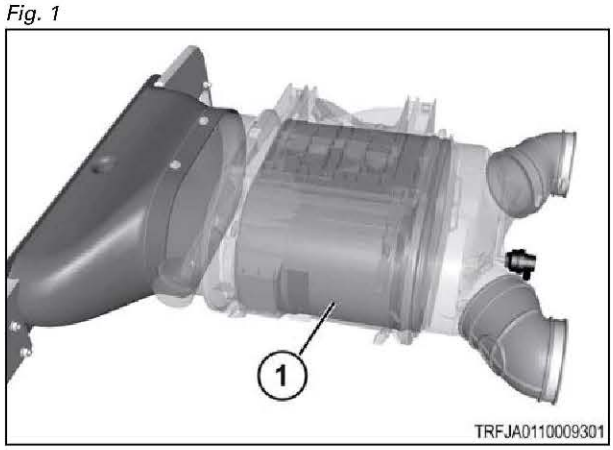


Fig. 2

2.1.2 Change the prefilter and the fuel filters

WARNING: Fire risk

Fuel leaks or spills on hot surfaces or electrical components can cause a fire.

To help prevent possible injury, turn the start switch off and remove the key when you change the fuel filters or water separator element. Clean up fuel spills immediately.

CAUTION:
Escaping fluid under pressure can penetrate skin causing serious injury. Release pressure before disconnecting fuel or other lines. Tighten all connections before you apply pressure. Keep hands and body away from pin holes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

IMPORTANT: *Precaution must be necessary to be sure that the fluids are contained during performance of inspection, maintenance, test, adjust, and repair. Be prepared to collect the fluid with correct containers before opening a compartment or you disassemble a component with fluid. Dispose all fluids in accordance with local regulations and mandates.*

NOTE: *Replace the fuel filter elements at 800 hour intervals or if shown by fault code.*

IMPORTANT: *The engine warranty is applicable only when original AGCO Power Diesel fuel filter elements are used.*

Procedure

1. Clean the fuel filters and adjacent area.
2. Close the fuel valve (5).
3. Drain prefilter (2).
4. Disconnect prefilter water detector connector (1).
5. Turn filter element (2) counterclockwise and remove element from the bracket. Collect fuel into a applicable container.
6. Remove the water detector (3) from the prefilter bottom end.
7. Remove the primary filter (4) in an equivalent procedure.
8. Connect the water detector (3) to the new prefilter bottom end.
9. Lubricate the filter element o-ring seal (6) with clean fuel.
10. Fill the outer shell of the filter element (7) with clean fuel (8).
11. Turn filter element on the bracket.
12. Connect the water detector connector (1).
13. The primary filter (4) is assembled in an equivalent procedure.
14. Open the fuel valve
15. Prime the fuel system.
16. Start the engine and make sure there are no leaks.

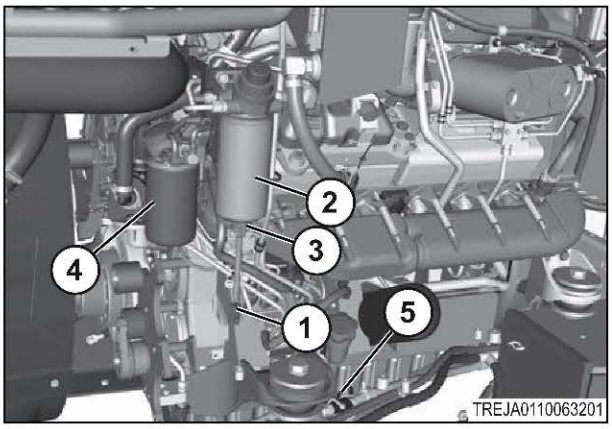


Fig. 3



Fig. 4

Related Links

Prime the fuel system page 2-172

2.2 Engine system components

2.2.1 Remove the main serpentine belt

Procedure

1. **WARNING:**
   Hot components can burn. Severe personal injury can result. Let the engine and the components cool before doing maintenance.

   Park the machine on a solid level surface. Stop the engine, apply the park brake, and take the key with you.

2. Put the battery disconnect switch key (1) in the off position, to close off the battery power. Remove the battery disconnect switch key.

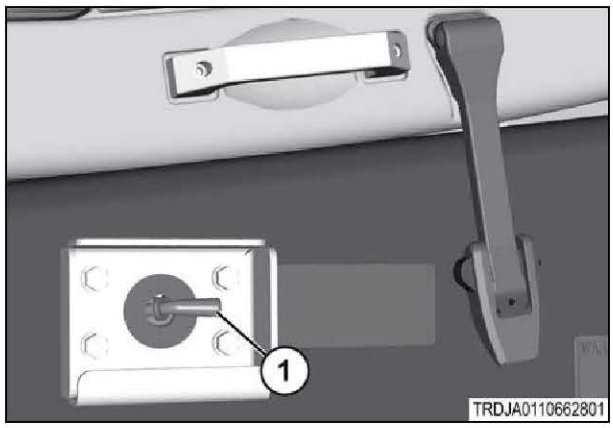


Fig. 5

3. **CAUTION:**
   Safely prop open the engine cover. Closing the engine cover creates a pinch point that can cause serious bodily injury.

   Release both side latches (1) and open the engine cover all the way.

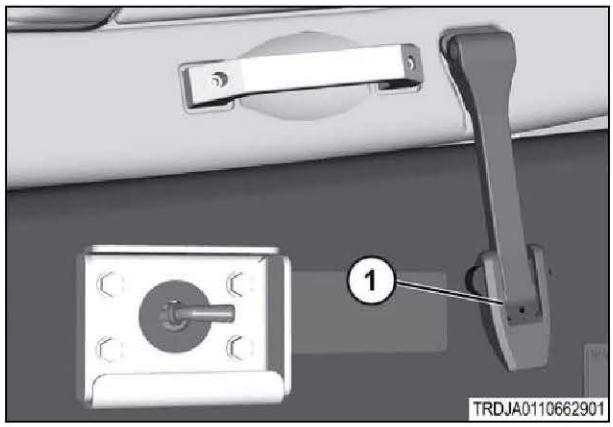


Fig. 6

4. Remove the hardware (1) and the right-hand side engine screen.

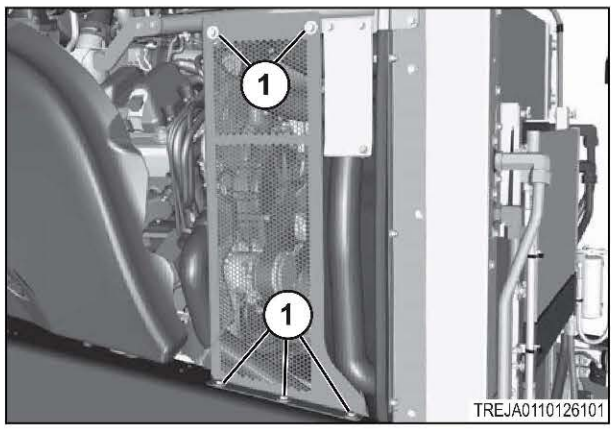


Fig. 7

5. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install a 3/4 inch drive breaker bar into the square drive (1) of the main serpentine belt tensioner (2). Push counterclockwise and remove the main serpentine belt (3) from the pulleys. Slowly release the belt tensioner to the neutral position. Remove the breaker bar. Slide the belt over the fan to remove.

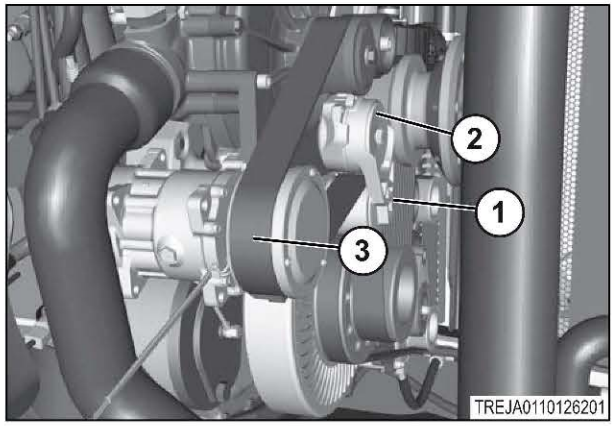


Fig. 8

2.2.2 Install the main serpentine belt

Procedure

1. The main serpentine belt routing diagram.

NOTE:
Some parts have been removed for clarity.

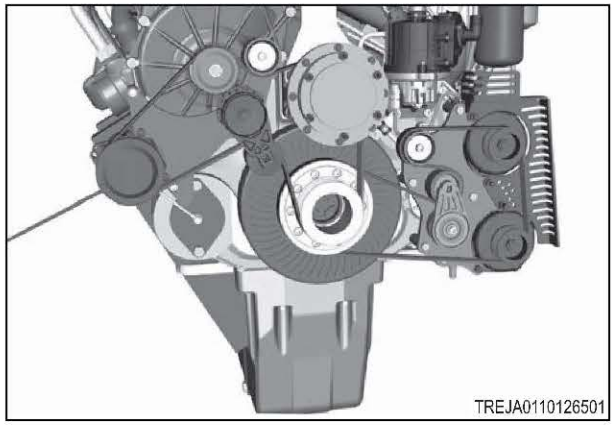


Fig. 9

2. Install the main serpentine belt (3) around the fan. Install the main serpentine belt on all the pulleys except the alternator pulley (4). Correctly seat the belt in the pulley grooves.

3. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install a 3/4 inch drive breaker bar into the square drive hole (1) on the main belt tensioner (2). Push the drive counterclockwise and install the main belt (3) on the alternator pulley (4). Correctly seat the belt in the pulley grooves. Slowly release the tension until the belt tensioner (2) makes contact with the belt. Remove the 3/4 inch drive breaker bar.

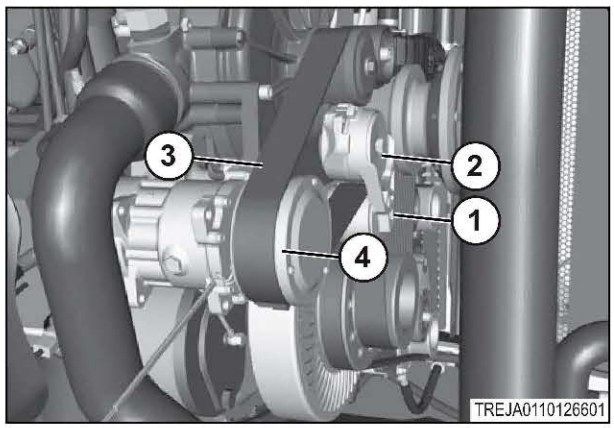


Fig. 10

NOTE:
Supply enough area for the swing of the 3/4 inch breaker bar to let the belt tensioner come to a neutral position.

4. Fasten the right-hand side engine screen to the machine with hardware (1).

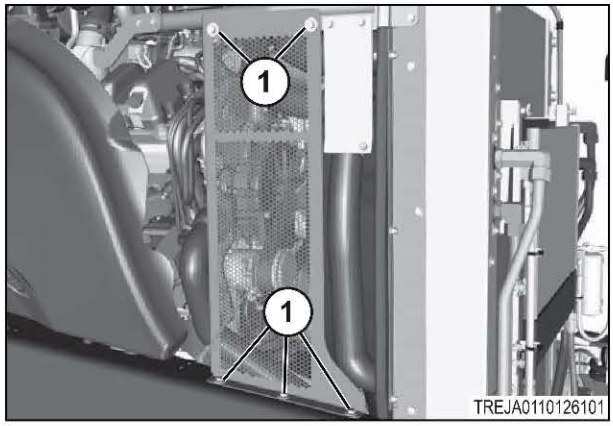


Fig. 11

5. Close the engine cover. Fasten the latch (1) to the keeper on both sides of the frame.

   IMPORTANT:
   Make sure to fasten the latches on both sides of the engine cover.

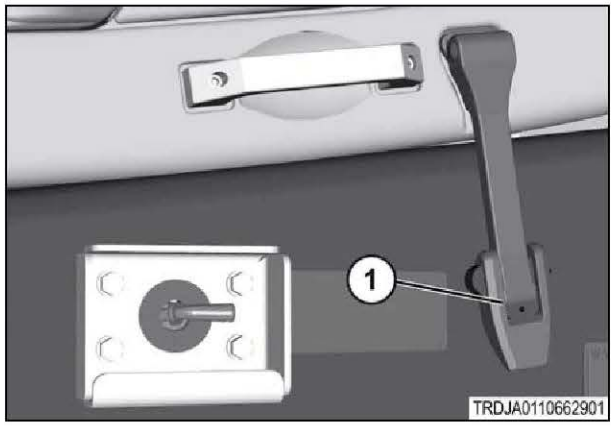


Fig. 12

6. Install the battery disconnect switch key (1).

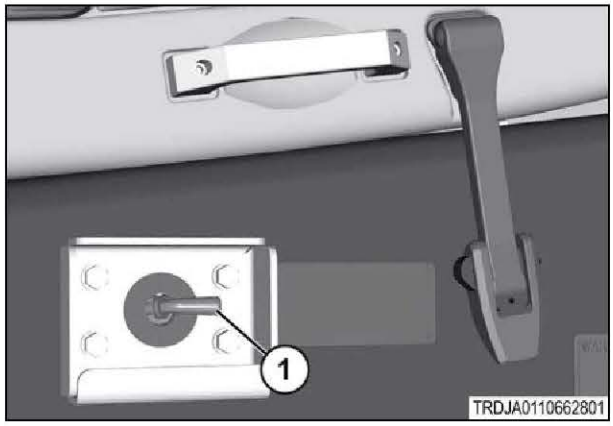


Fig. 13

7. Turn the battery disconnect switch key (1) clockwise to connect the power.

2.2.3 Remove the accessories belt

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Procedure

1. Park the machine on a solid, level surface. Stop the engine, apply the parking brake, and take the key with you.

2. Turn the battery disconnect switch key (1) counterclockwise to disconnect the battery power.

NOTE:
The battery disconnect switch is shown in the off position.

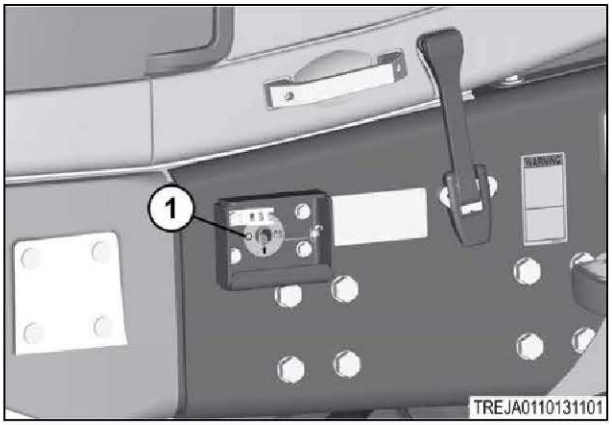


Fig. 14

3. Remove the battery disconnect switch key (1).

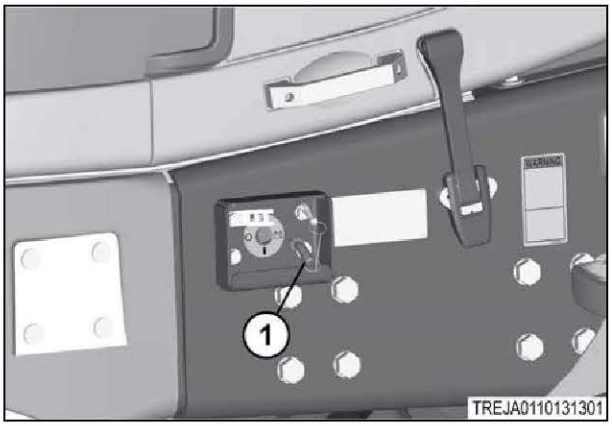


Fig. 15

4. **CAUTION:**
Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

Release both side latches (1) and open the engine cover (2) all the way.

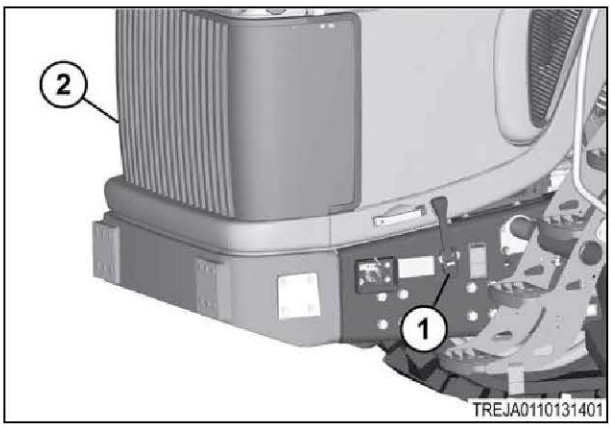


Fig. 16

5. Remove the hardware (1) and the left-hand fan guard (2).

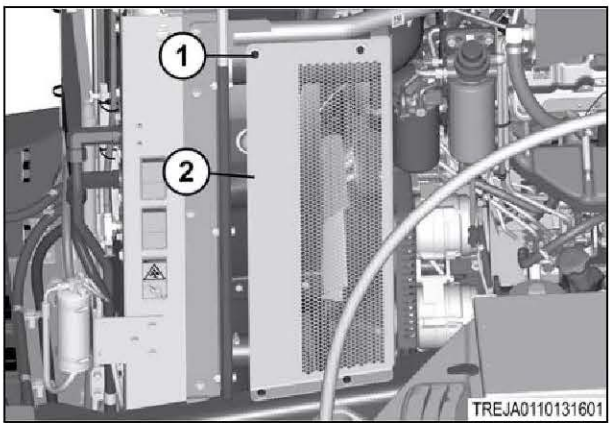


Fig. 17

6. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

NOTE:
The fan drive belt must first be removed to replace the accessories belt.

Install the correct breaker bar into the square drive (1) of the accessories belt tensioner (2). Push counterclockwise and remove the accessories belt (3) from the pulleys. Slowly release the accessories belt tensioner to the neutral position. Remove the breaker bar.

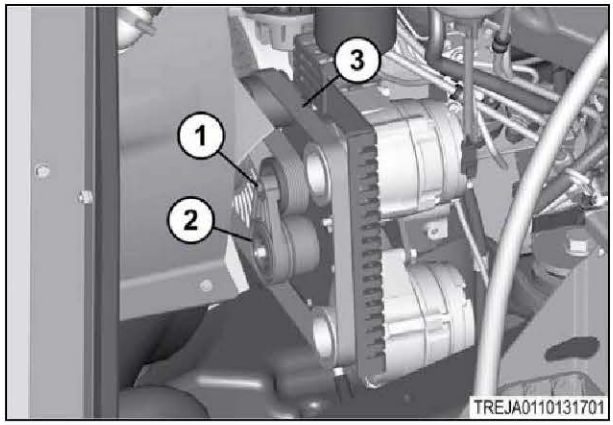


Fig. 18

2.2.4 Installing the accessories belt

Procedure

1. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install the correct breaker bar into the square drive (1) of the accessories belt tensioner (2). Push counterclockwise and install the accessories belt (3) to the pulleys. Slowly release the accessories belt tensioner to the neutral position. Remove the breaker bar.

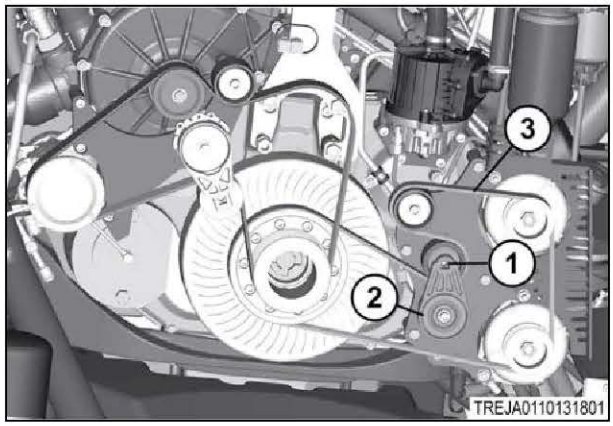


Fig. 19

2. Install the left-hand fan guard (2) with the hardware (1).

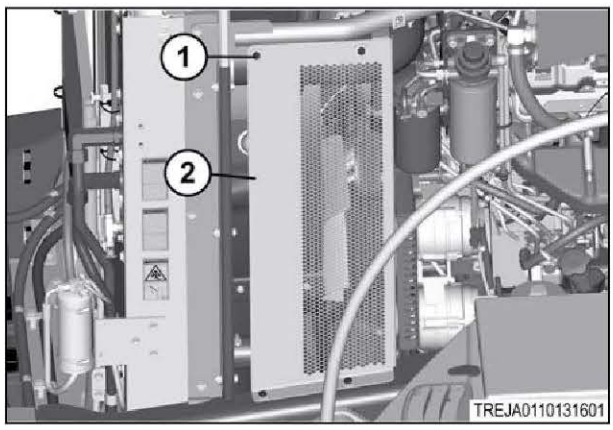


Fig. 20

3. Close the engine cover (2) all the way and connect both side latches (1).

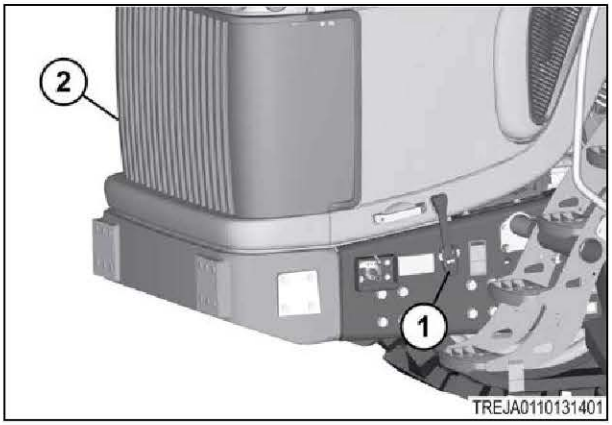


Fig. 21

4. Install the battery disconnect switch key (1).

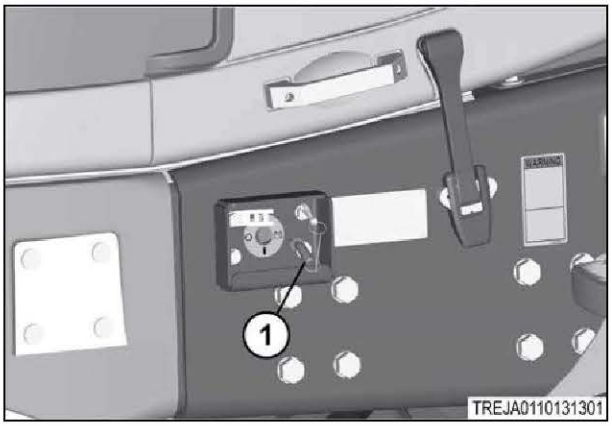


Fig. 22

5. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

   NOTE:
   The battery disconnect switch is shown in the on position.

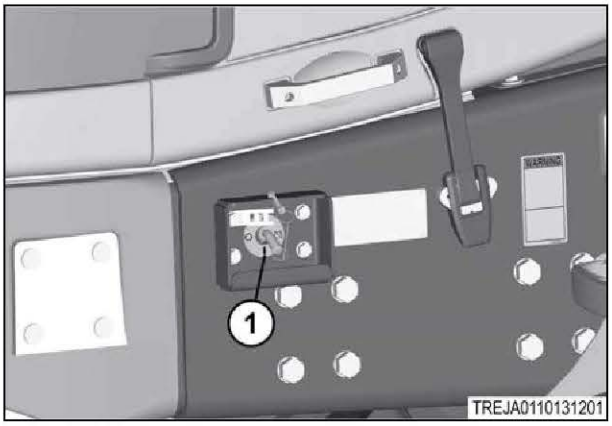


Fig. 23

2.2.5 Remove the alternators

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Procedure

1. Park the machine on a solid level surface. Stop the engine, apply the parking brake, and take the key with you.

2. Turn the battery disconnect switch key (1) counterclockwise to disconnect the battery power.

NOTE:
The battery disconnect switch is shown in the off position.

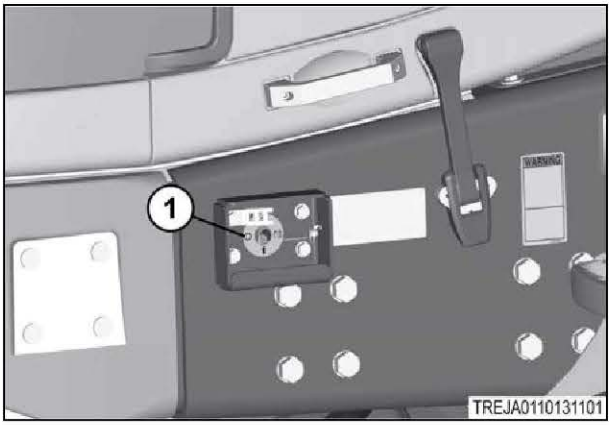


Fig. 24

3. Remove the battery disconnect switch key (1).

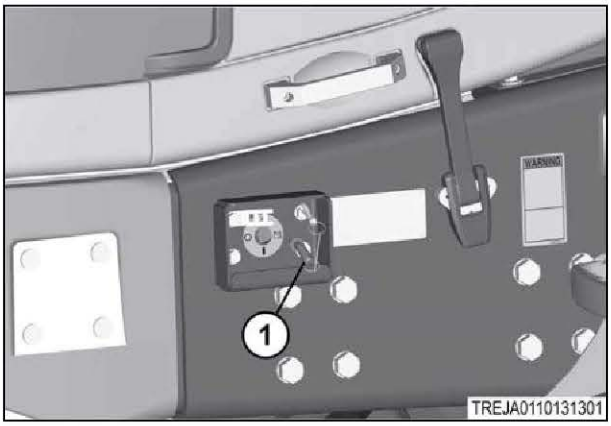


Fig. 25

4. **CAUTION:**
Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

Release both side latches (1) and open the engine cover (2) all the way.

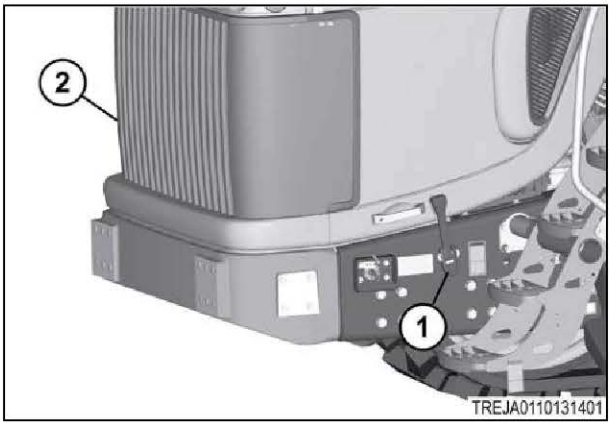


Fig. 26

5. Remove the hardware (1) and the left-hand fan guard (2).

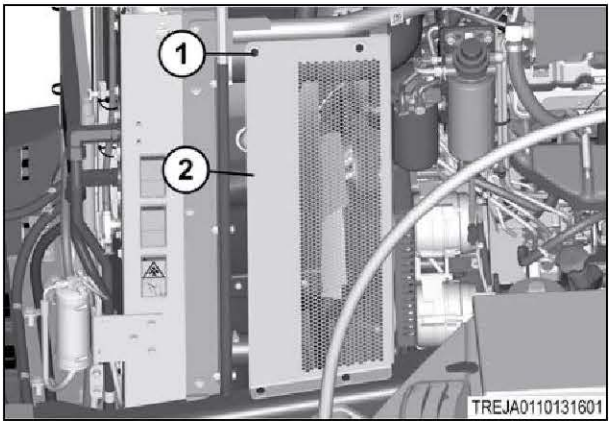


Fig. 27

6. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

NOTE:
The fan drive belt must first be removed to replace the accessories belt.

Install the correct breaker bar into the square drive (1) of the accessories belt tensioner (2). Push counterclockwise and remove the accessories belt (3) from the pulleys. Slowly release the accessories belt tensioner to the neutral position. Remove the breaker bar.

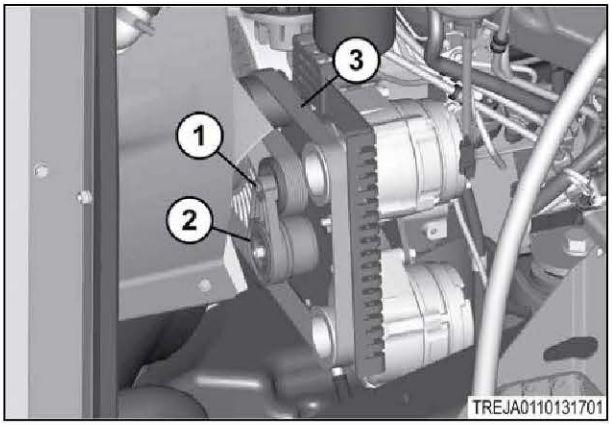


Fig. 28

7. Disconnect the wire harnesses from the alternators (1).

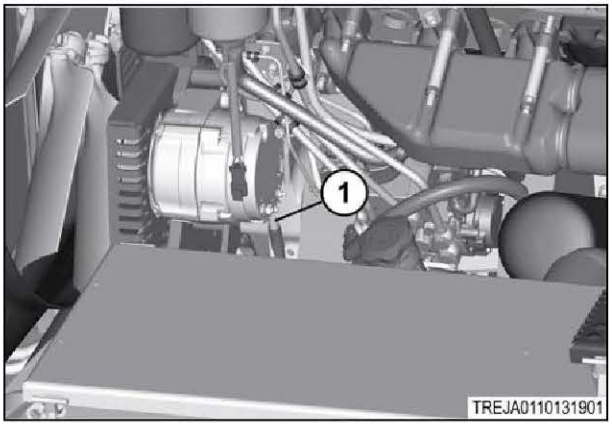


Fig. 29

8. Remove the hardware (1) and the alternators (2).

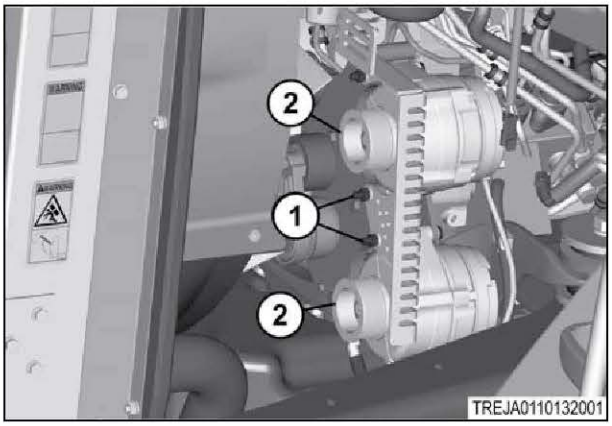


Fig. 30

2.2.6 Install the alternators

Procedure

1. Install the alternators (2) with the hardware (1).

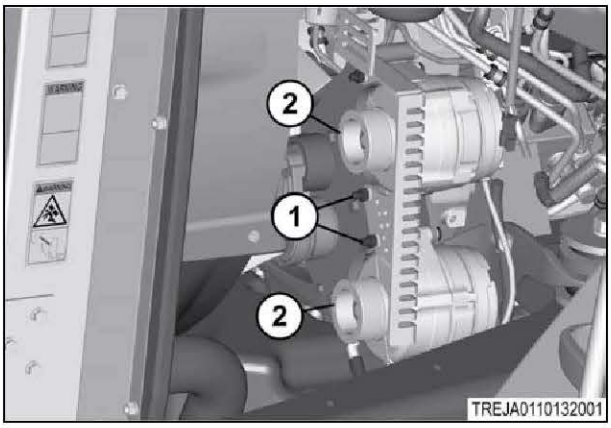


Fig. 31

2. Connect the wiring harnesses to the alternators (1).

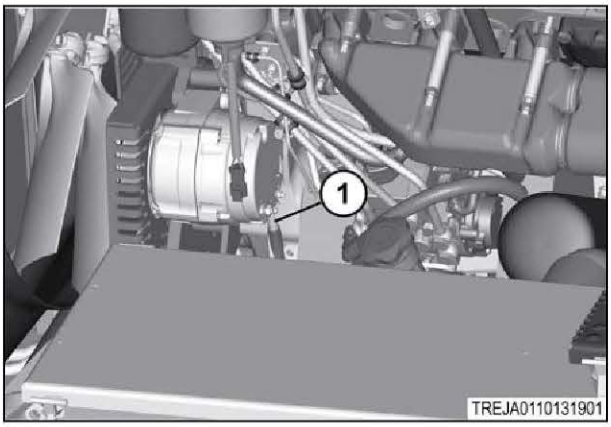


Fig. 32

3. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install the correct breaker bar into the square drive (1) of the main serpentine belt tensioner (2). Push the breaker bar counterclockwise and install the accessories serpentine belt (3) to the pulleys. Slowly release the accessories serpentine belt tensioner to the neutral position. Remove the breaker bar.

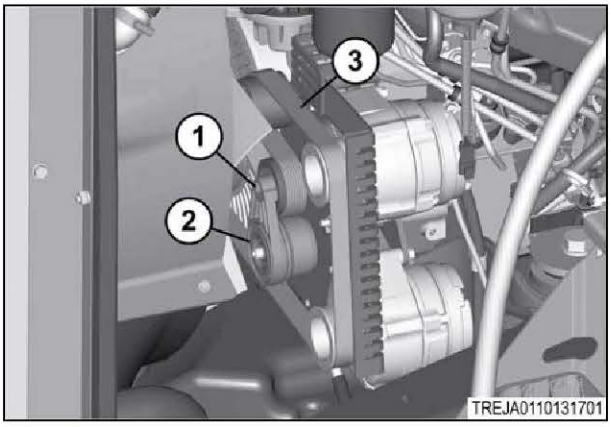


Fig. 33

4. Install the right-hand fan guard (2) with the hardware (1).

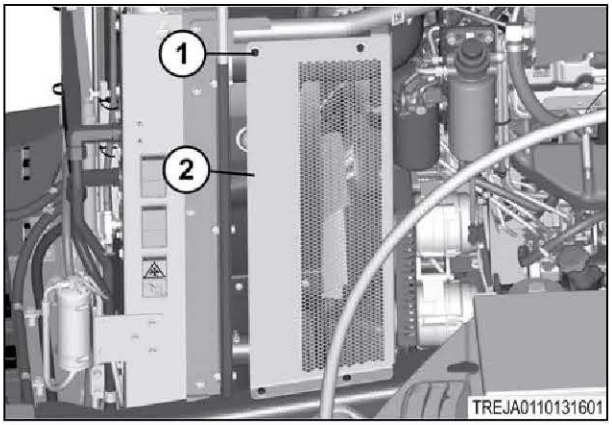


Fig. 34

5. Close the engine cover (2) and connect the side latches (1).

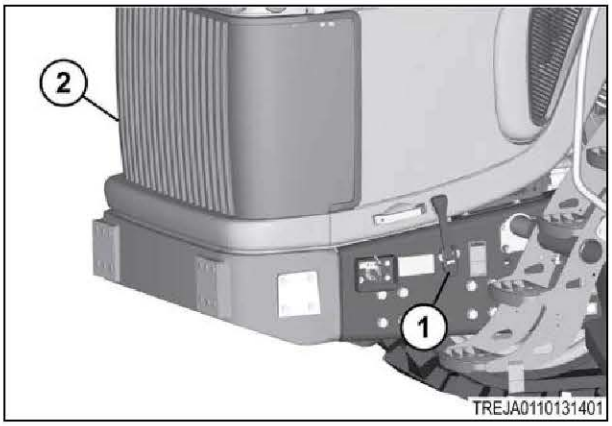


Fig. 35

6. Install the battery disconnect switch key (1).

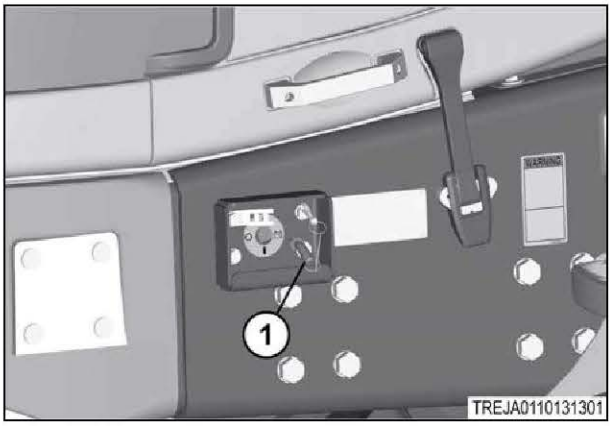


Fig. 36

7. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

NOTE:
The battery disconnect switch is shown in the on position.

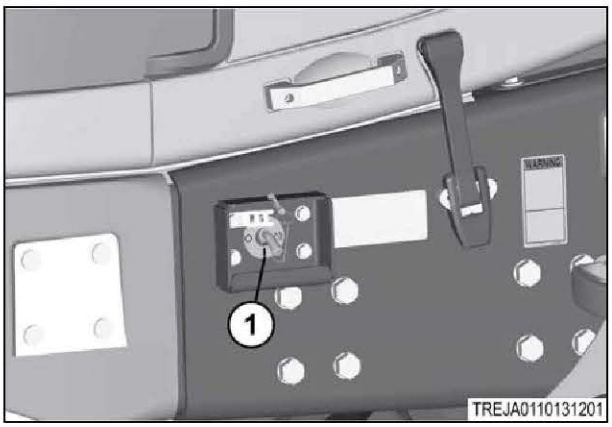


Fig. 37

2.2.7 Remove the cooling package



WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.



WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.



WARNING: Hydraulic fluid under pressure can penetrate the skin or eyes.

Serious personal injury, blindness, or death can occur.

Relieve the pressure from the system or component before disconnecting components. Wear personal protective gear while working on the machine or equipment. Use a piece of cardboard to check for leaks. Never use your hand.

NOTE: *Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.*

NOTE: *Use only certified technicians and equipment to service the air conditioning systems.*

NOTE: *When opening the air conditioning system, replace the air conditioning receiver-dryer. See the information for removing/installing the air conditioning receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Disconnect the battery with the battery disconnect switch.
4. Remove the key from the battery disconnect switch.

5. Release the two latches (1) and remove the engine cover (2).

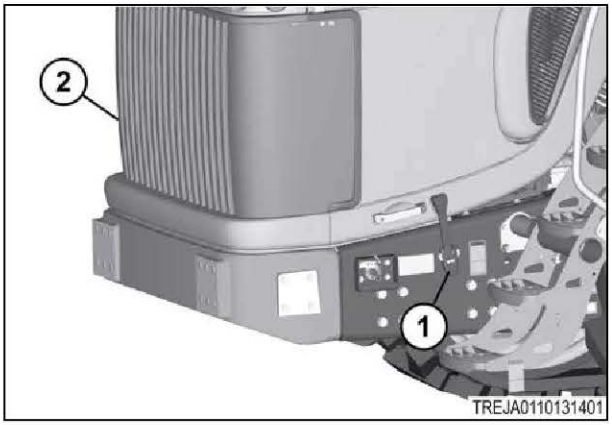


Fig. 38

6. Remove the hardware (1) and the cover plate (2). Install a hose to the radiator drain valve (3) and put through the access hole. Set a correct container under the radiator drain hose. Loosen the radiator drain valve (3) and drain the engine coolant.

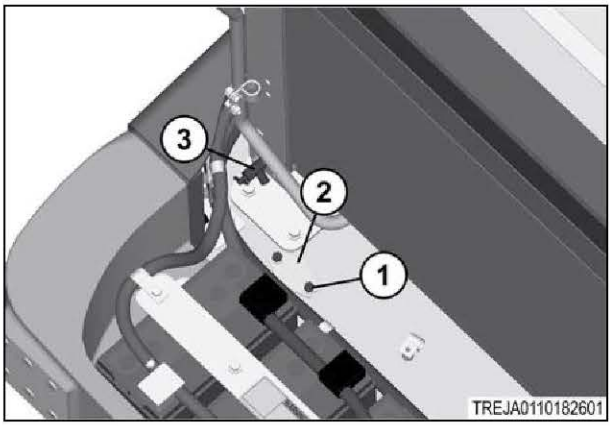


Fig. 39

7. Remove the hardware (1, 3) and the right side fan guard (2).

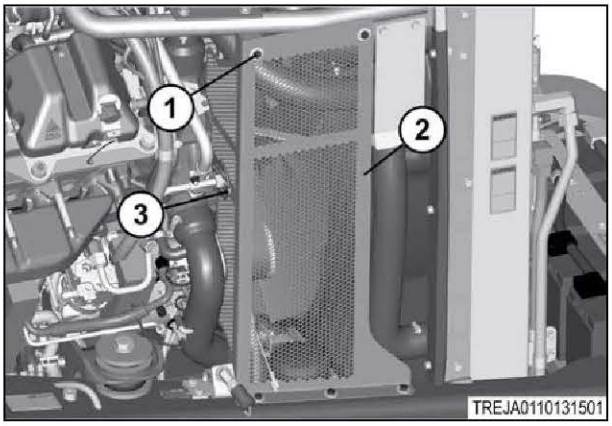


Fig. 40

8. Remove the hardware (1) and the left side fan guard (2).

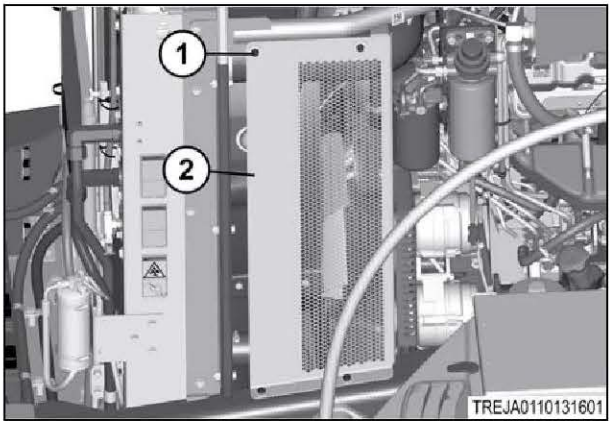


Fig. 41

9. Loosen the hose clamps (1) and disconnect the left side charge air cooler hose (2).

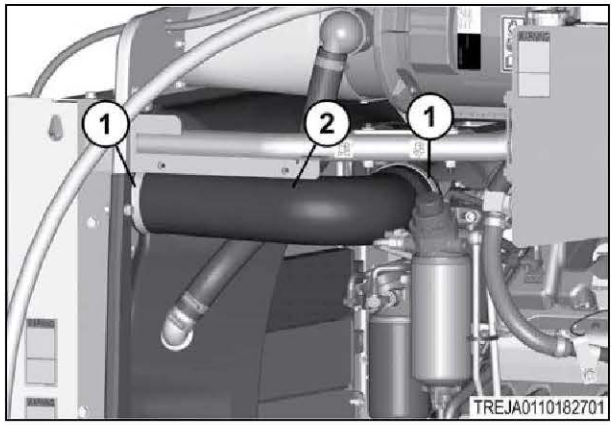


Fig. 42

10. Loosen the hose clamp (1) and disconnect the right side charge air cooler hose (2). Remove the hardware (3) and the hose clamp (4).

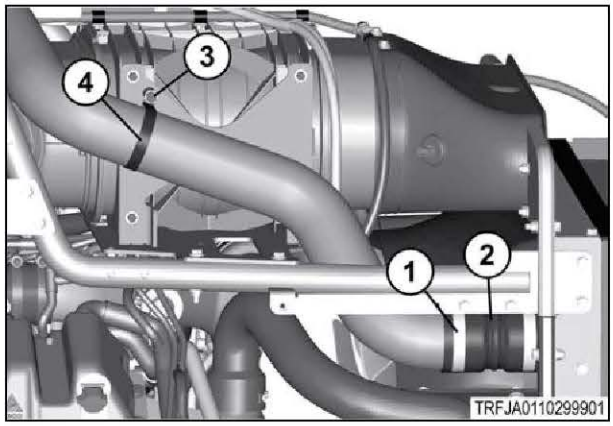


Fig. 43

11. Remove the hardware (1) and put the doser overflow tank and hoses to the side.

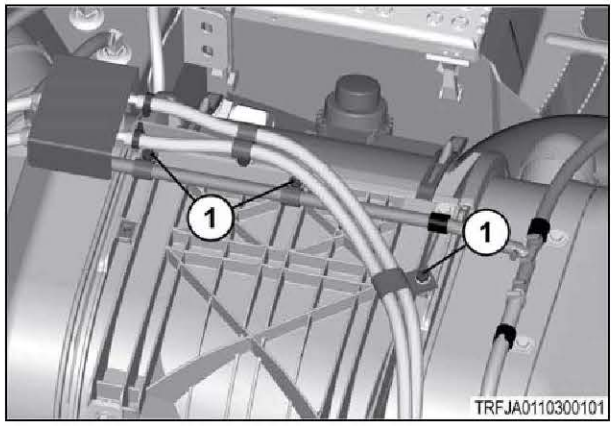


Fig. 44

12. Disconnect the two wire harnesses (1) from the air filter assembly.

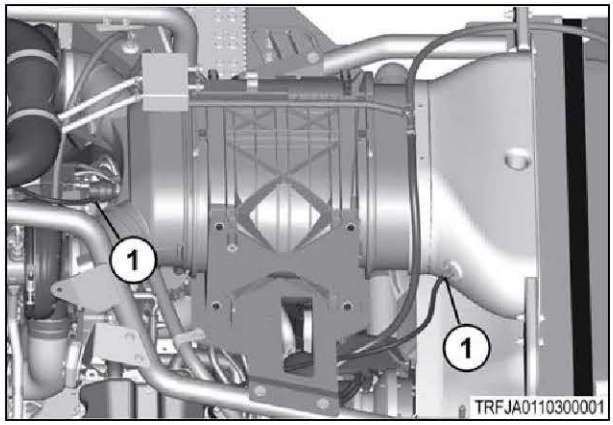


Fig. 45

13. Loosen the hose clamps (1) and disconnect the intake tubes (2).

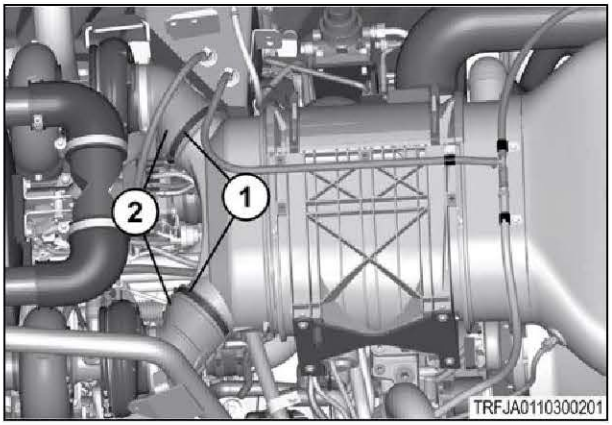


Fig. 46

14. Remove the hardware (1), the hose clamps (2), and the air filter intake (3).

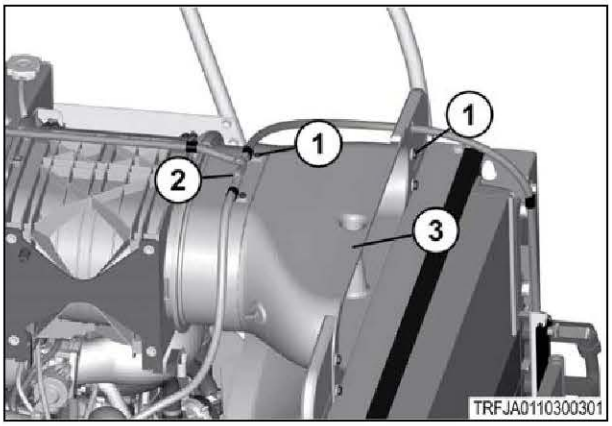


Fig. 47

15. Loosen the hose clamp (1) and disconnect the dust ejector tube (2).

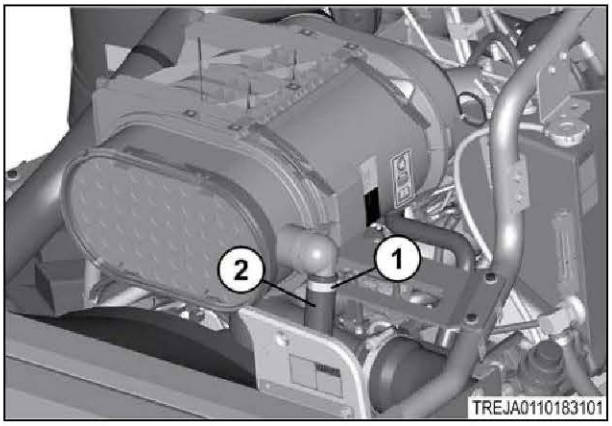


Fig. 48

16. Remove the hardware (1) and the air filter assembly (2).

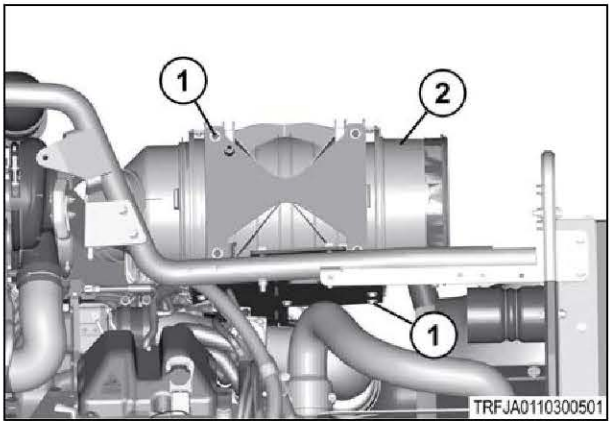


Fig. 49

17. Remove the hardware (1) and the air filter assembly mount (2).

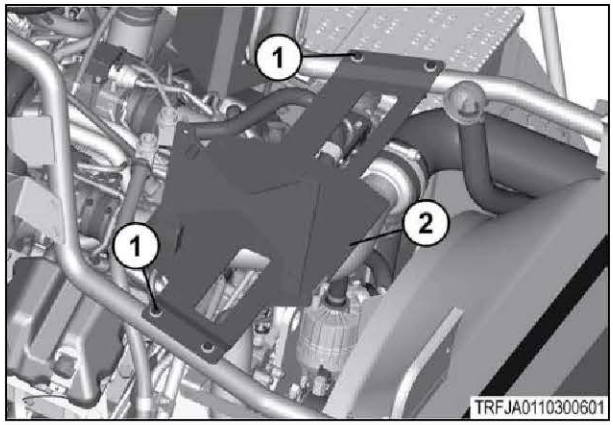


Fig. 50

18. Remove the hardware (1), the hose clamp (2), and the bracket (3). Loosen the hose clamps (4) and disconnect the inlet radiator hose (5).

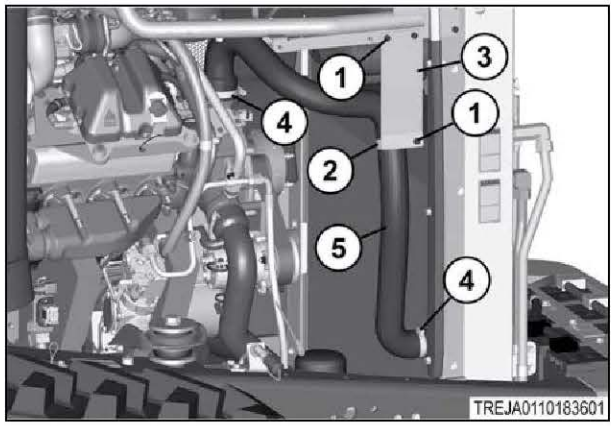


Fig. 51

19. Remove the hardware (1) and the hose clamp (2). Loosen the hose clamps (3) and disconnect the outlet radiator hose (4).

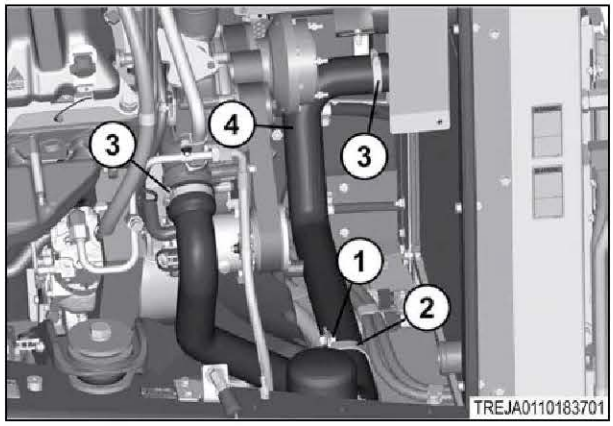


Fig. 52

20. Remove the hardware (1) and the right side support bracket (2).

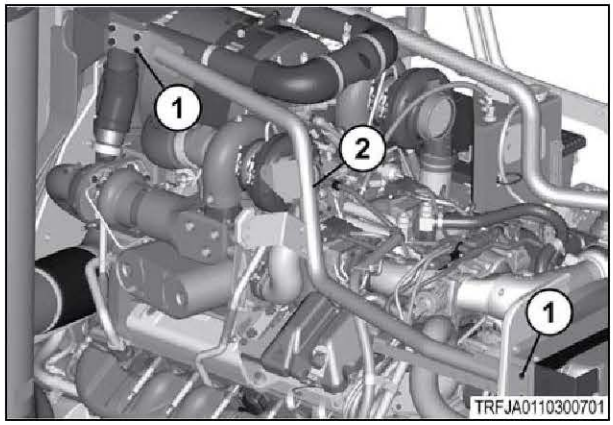


Fig. 53

21. Loosen the hose clamps (1) and disconnect the hoses (2) from the expansion tank.

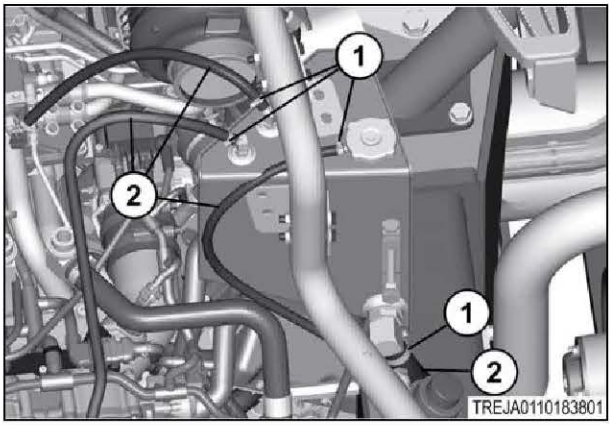


Fig. 54

22. Remove the hardware (1) and the expansion tank (2).

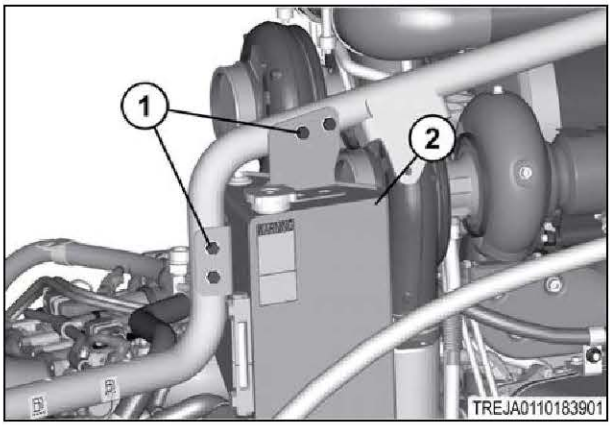


Fig. 55

23. Remove the hardware (1) and the left side support bracket (2).

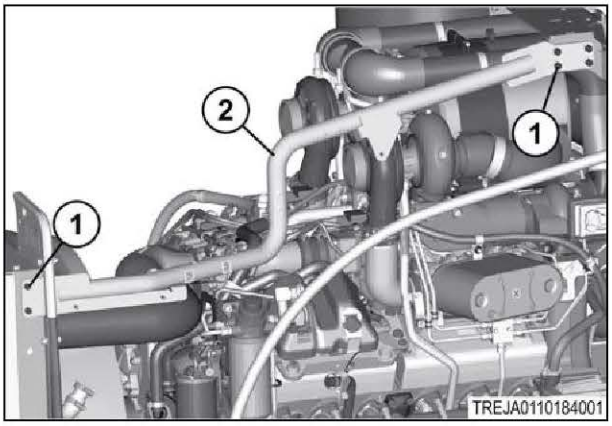


Fig. 56

24. Remove the batteries (1).

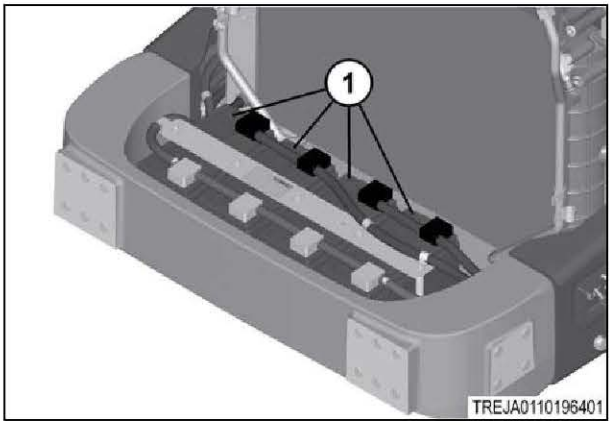


Fig. 57

25. Remove the hardware (1) and the two side seal brackets (2).

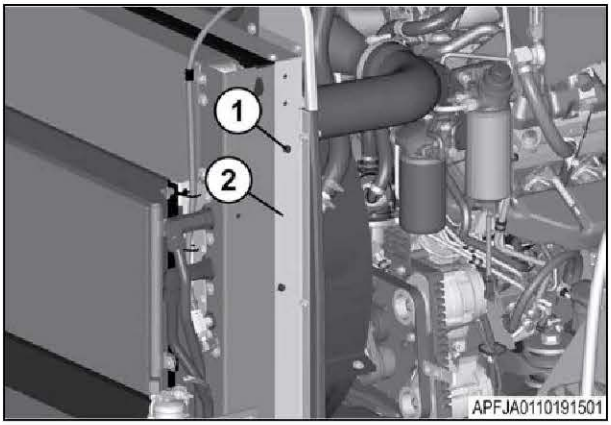


Fig. 58

26. Remove the hardware (1) and the top seal bracket (2) and seal.

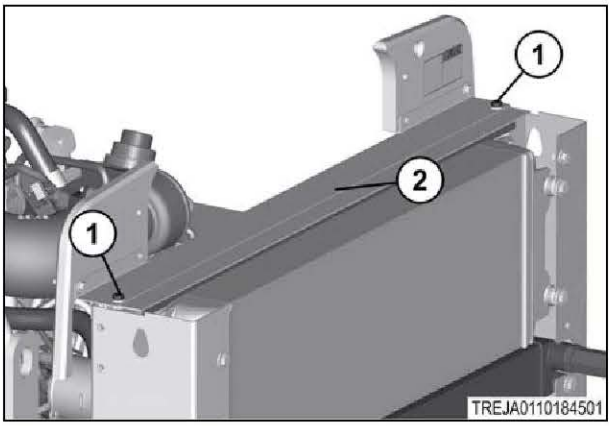


Fig. 59

27. Remove the hardware (1) and the receiver-dryer bracket (2).

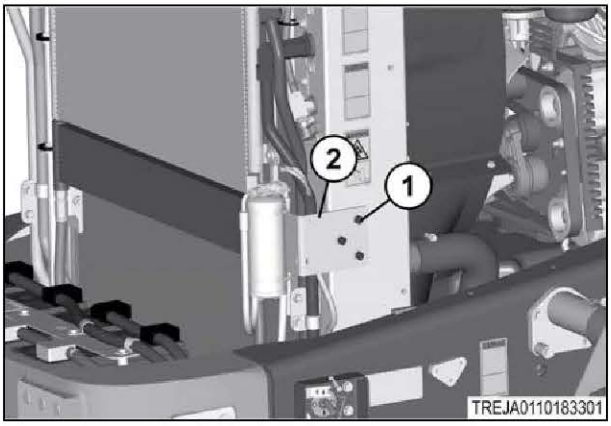


Fig. 60

28. Disconnect the fuel hoses (1).

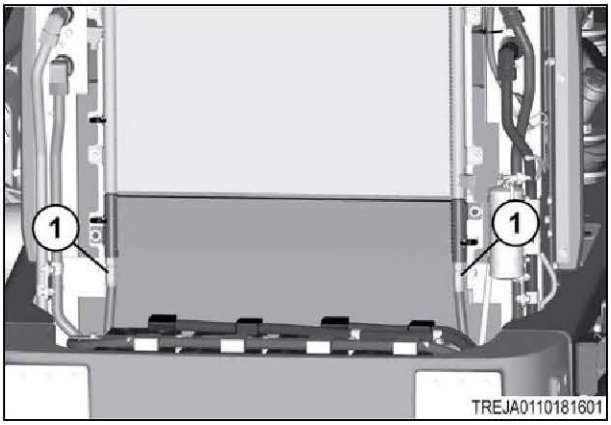


Fig. 61

29. Disconnect the condenser hoses (1).

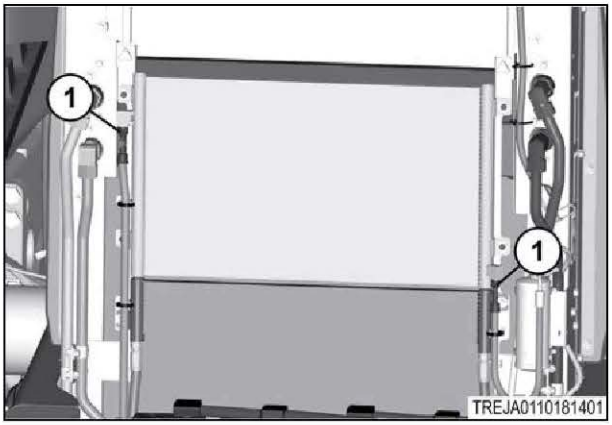


Fig. 62

30. Remove the hardware (2) and the condenser/ fuel cooler assembly (3). Disconnect the hydraulic hoses (1).

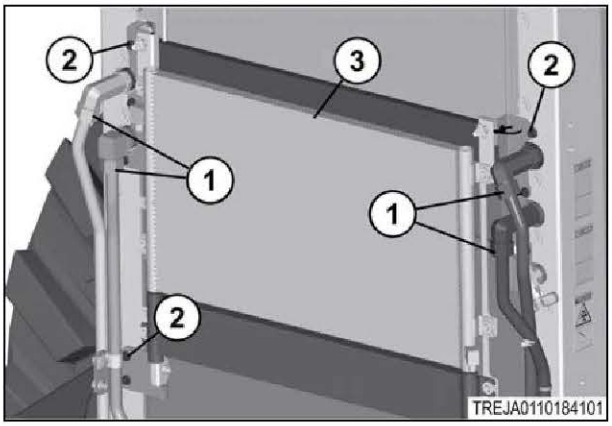


Fig. 63

31. Remove the hardware (1) and the fan shroud (2).

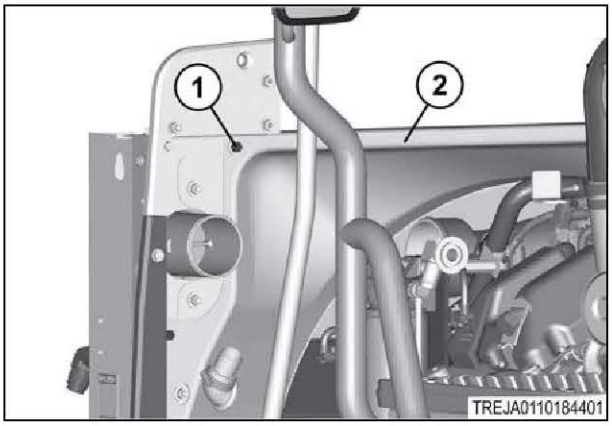


Fig. 64

32. Connect the correct lifting equipment (1) to the cooling package.

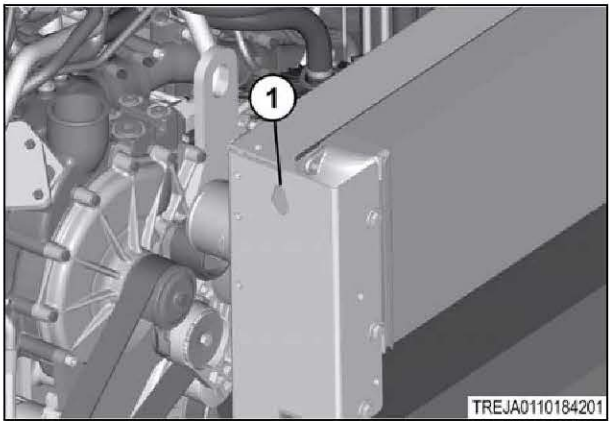


Fig. 65

33. Remove the hardware (1) and the cooling package (2).

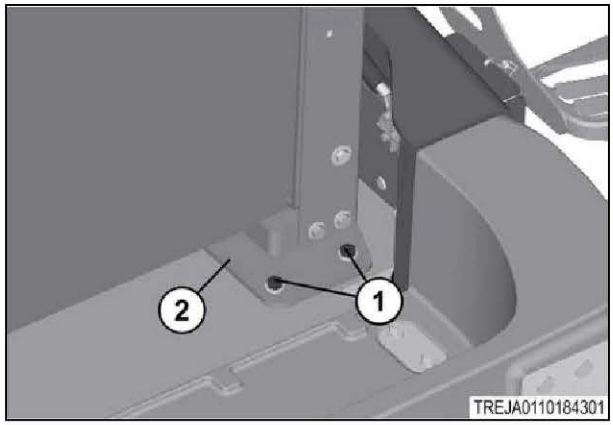


Fig. 66

Related Links

Remove the engine cover page 13-3
Remove the batteries page 10-22

2.2.8 Install the cooling package

Procedure

1. Connect the correct lift equipment (1) to the cooling package.

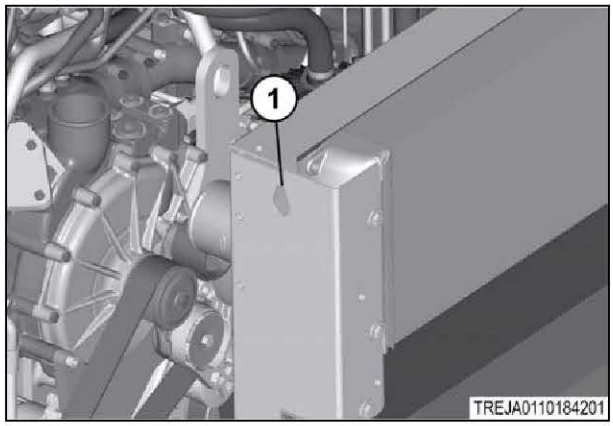


Fig. 67

2. Use the hardware (1) to install the cooling package (2).

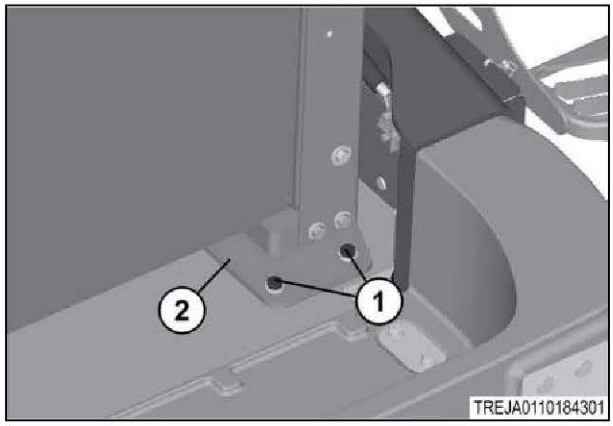


Fig. 68

3. Use the hardware (1) to install the fan shroud (2).

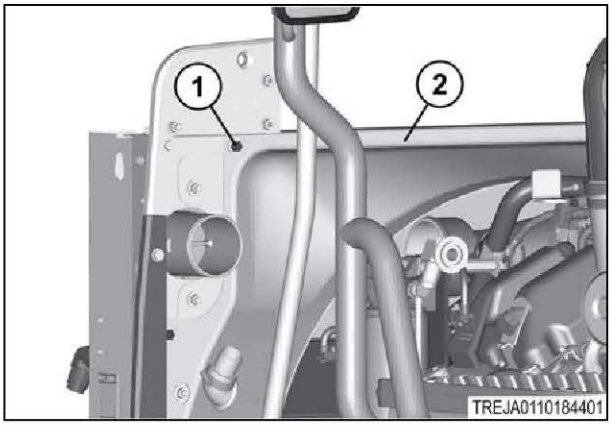


Fig. 69

4. Use the hardware (2) to install the condenser/fuel cooler assembly (3). Connect the hydraulic hoses (1).

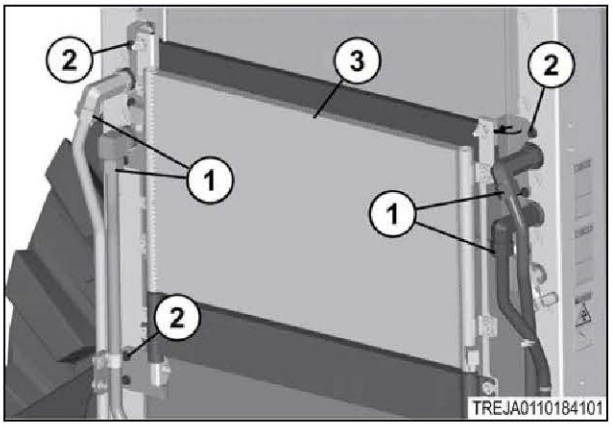


Fig. 70

5. Use the hardware (1) to install the receiver-dryer bracket (2).

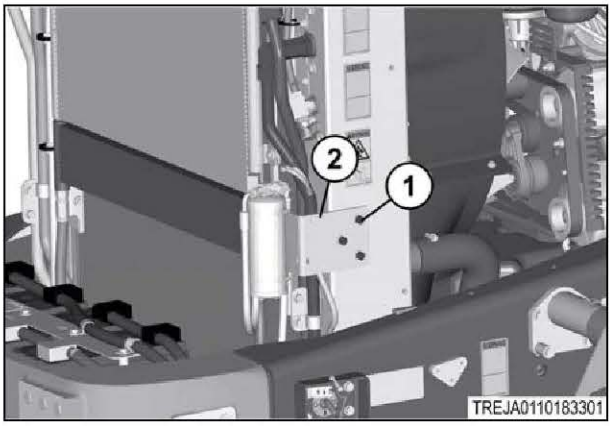


Fig. 71

6. Use the hardware (1) to install the top seal bracket (2).

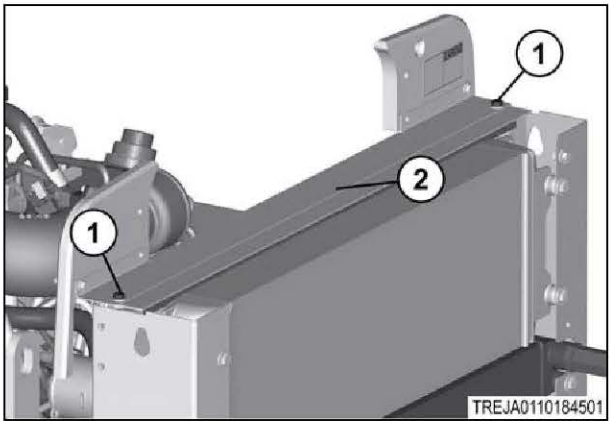


Fig. 72

7. Use the hardware (1) to install the two side seal brackets (2).

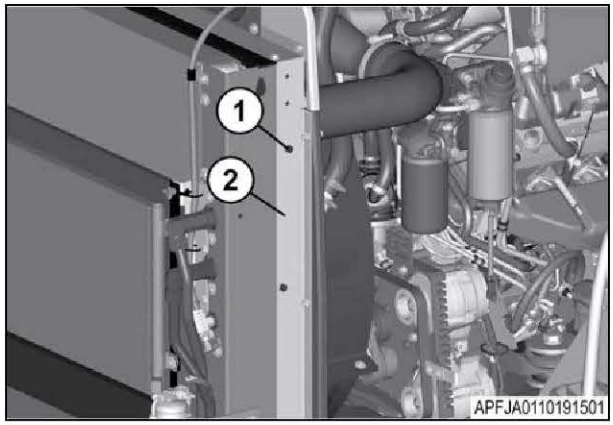


Fig. 73

8. Install the batteries (1).

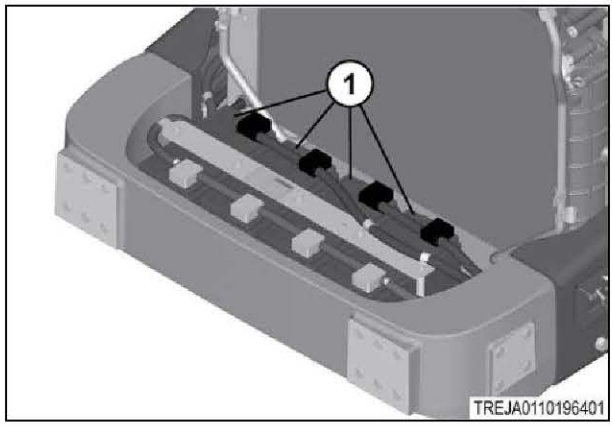


Fig. 74

9. Use the hardware (1) to install the left support bracket (2).

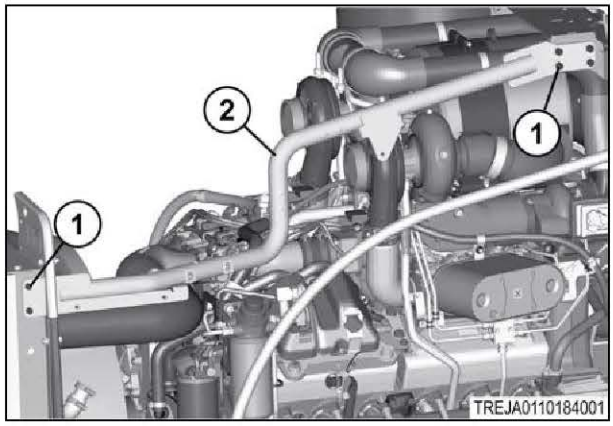


Fig. 75

10. Use the hardware (1) to install the expansion tank (2).

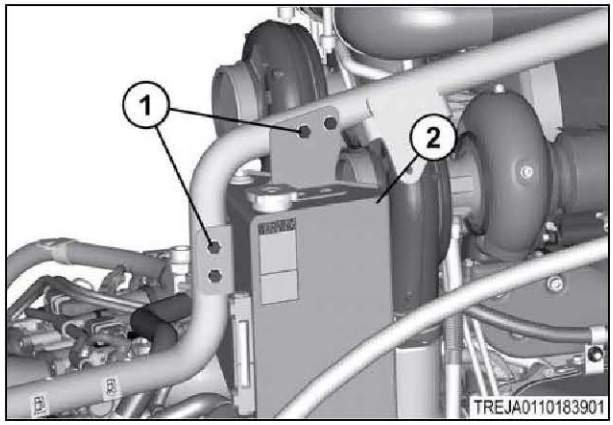


Fig. 76

11. Use the hose clamps (1) to connect the hoses (2) to the expansion tank.

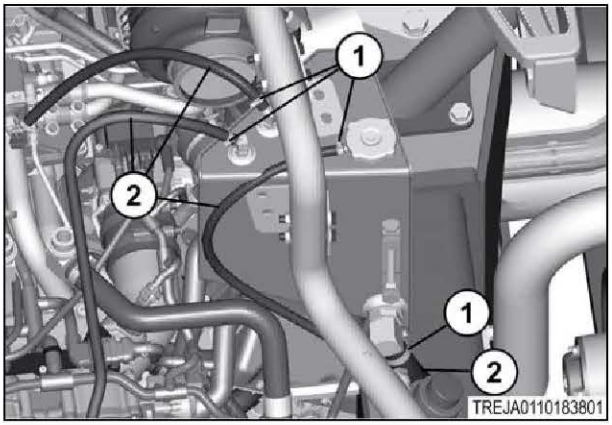


Fig. 77

12. Use the hardware (1) to install the right support bracket (2).

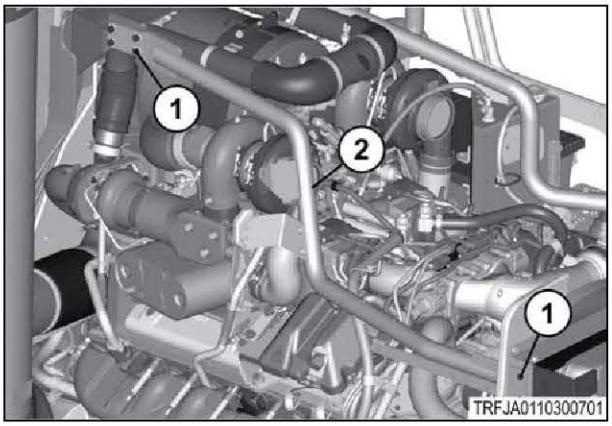


Fig. 78

13. Use the hose clamps (3) to connect the outlet radiator hose (4). Use the hardware (1) to install the hose clamp (2).

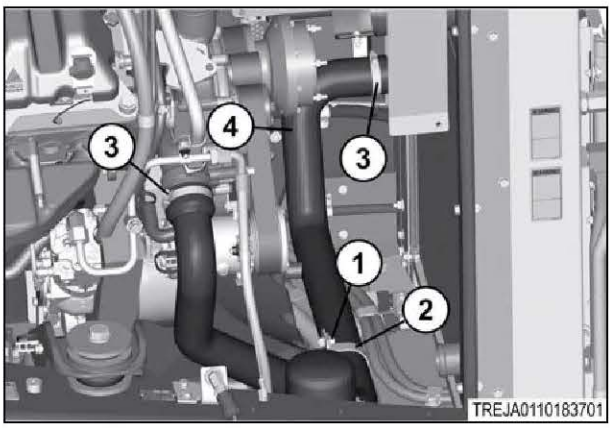


Fig. 79

14. Use the hose clamps (4) to connect the inlet radiator hose (5). Use the hardware (1) to install the bracket (3) and the hose clamp (2).

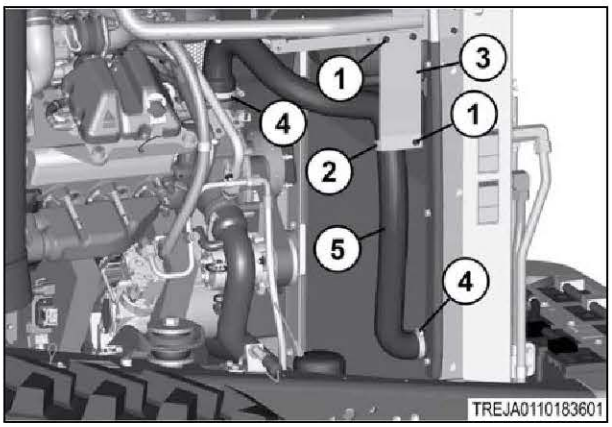


Fig. 80

15. Use the hardware (1) to install the air filter assembly mount (2).

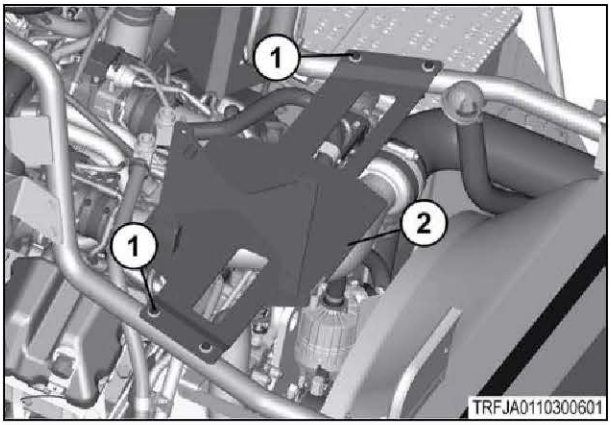


Fig. 81

16. Use the hardware (1) to install the air filter assembly (2).

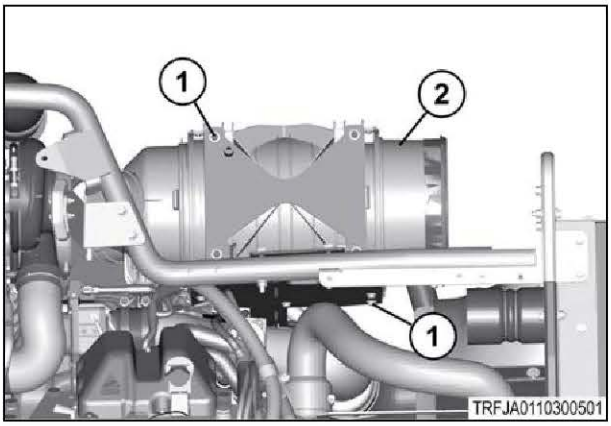


Fig. 82

17. Use the hose clamp (1) to connect the dust ejector tube (2).

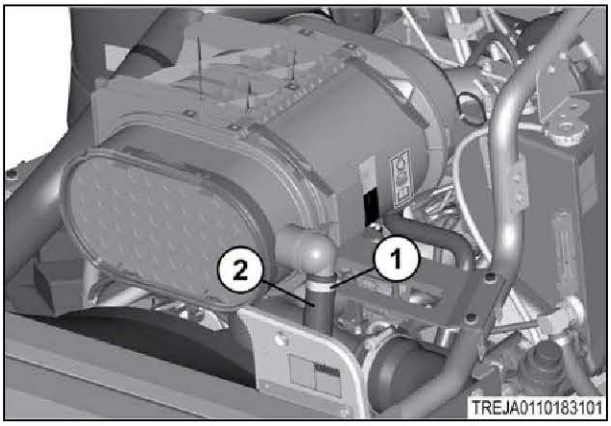


Fig. 83

18. Use the hardware (1) to install the air filter inlet (3) and the hose clamps (2).

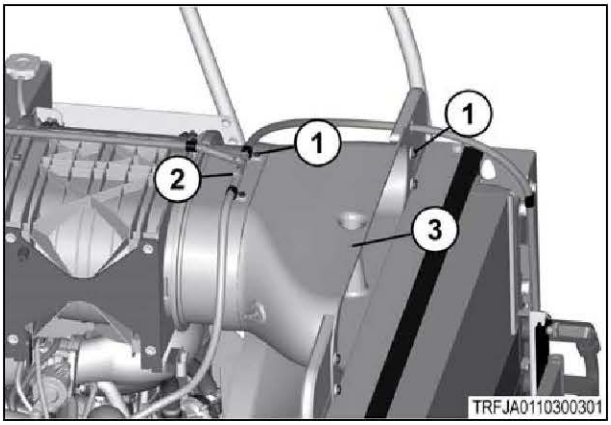


Fig. 84

19. Use the hose clamps (1) to connect the air filter intake tubes (2).

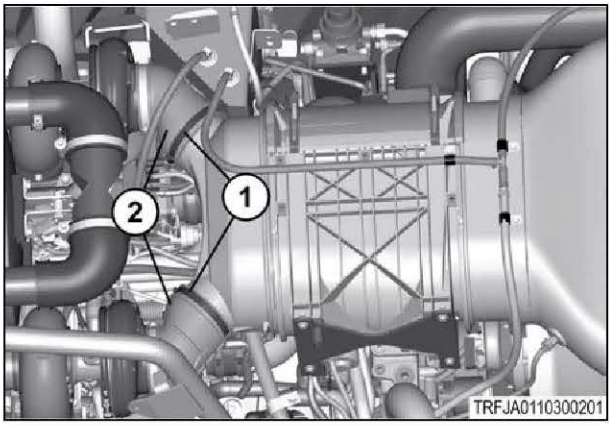


Fig. 85

20. Connect the two wire harnesses (1) from the air filter assembly.

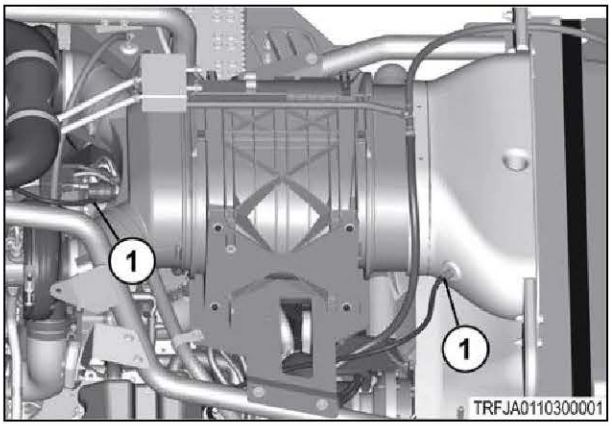


Fig. 86

21. Use the hardware (1) to install the doser overflow tank and the hoses.

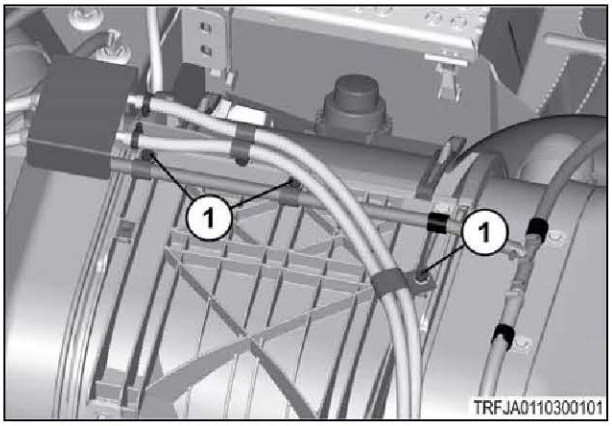


Fig. 87

22. Use the tube clamps (1) to install the right side charge air cooler tube (2). Use the hardware (3) to install the clamp (4).

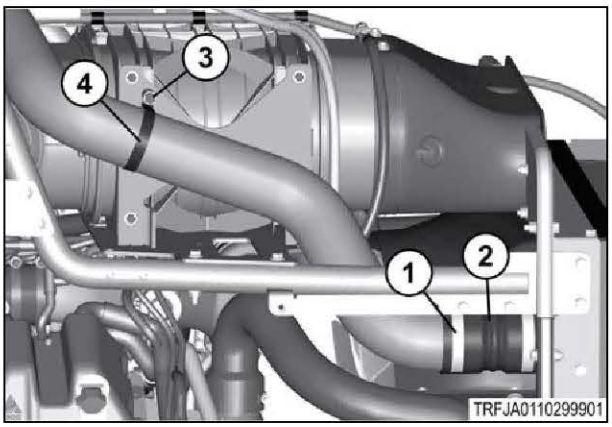


Fig. 88

23. Use the tube clamps (1) to install the left side charge air cooler tube (2).

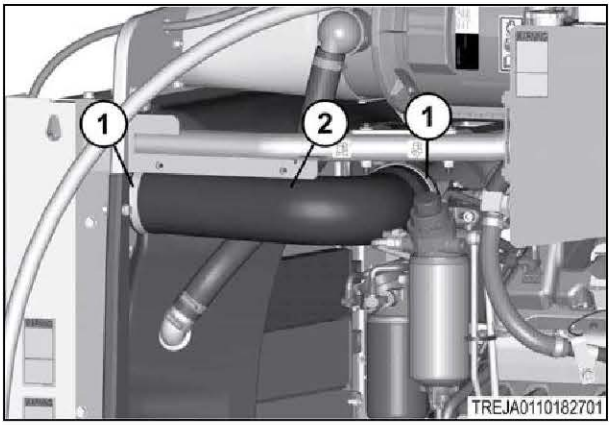


Fig. 89

24. Use the hardware (1) to install the left side fan guard (2).

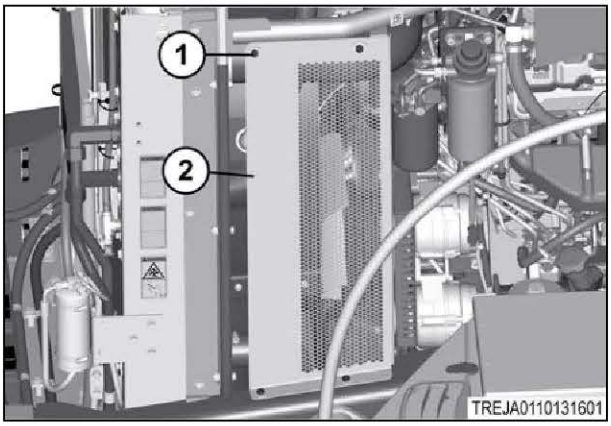


Fig. 90

25. Use the hardware (1, 3) to install the right side fan guard (2).

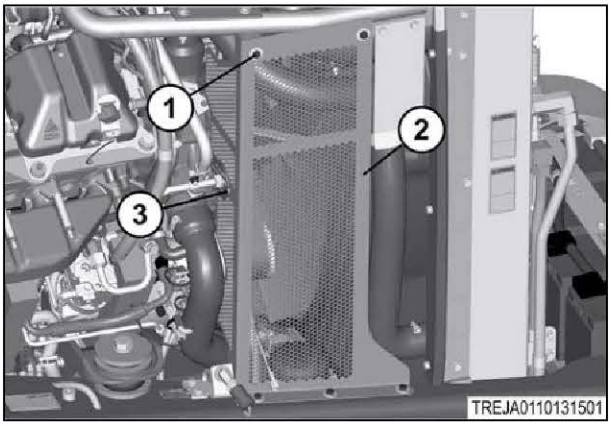


Fig. 91

26. Remove the drain hose and tighten the drain valve (3). Use the hardware (1) to install the cover plate (2). Fill the radiator with the correct amount and type of engine coolant.

NOTE: *Some parts are removed for clarity.*

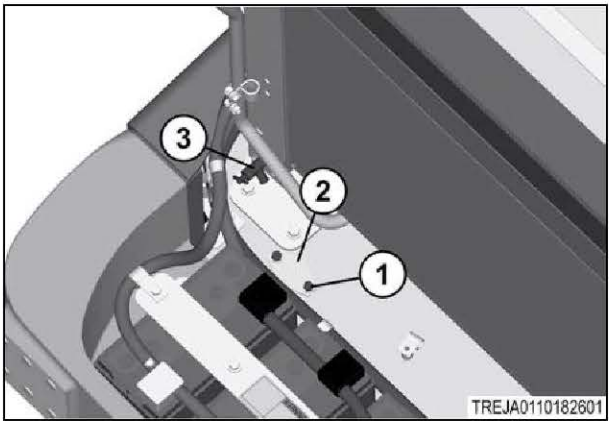


Fig. 92

27. Install the engine cover and connect the latches.

28. Install the battery disconnect switch key (1).

29. Turn on the battery disconnect switch (1).

Related Links

Install the engine cover (MY2015 and earlier) page 13-16
Fill capacities page 1-18
Coolant quality requirements page 2-239
Install the batteries page 10-23
Refill the cooling system page 2-149

2.2.9 Remove the radiator core

Before starting the procedure



WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.



WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.



WARNING: Pressurized gases or fluids can be hazards.

Personal injury can result.

Relieve the pressure from the system or component before disconnecting components.

NOTE: *Before removal, put identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all parts to keep contamination from the system. Contamination can damage the precision parts. Complete the disassembly steps on a clean surface. Put clean material on top of the parts.*

NOTE: *Use only certified technicians and equipment to service the air conditioning system.*

NOTE: *When opening the air conditioning system, replace the receiver-dryer. See the information for removing/installing the receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.

2. Apply the parking brake, stop the engine, and take the key with you.

3. Turn off the battery disconnect switch.

4. Remove the battery disconnect switch key.

5. Remove the engine cover.

6. Remove the hardware (1) and the cover plate (2).

7. Install a hose to the radiator drain valve (3) and put through the access hole.

8. Set a correct container under the radiator drain hose.

9. Loosen the radiator drain valve (3) and drain the engine coolant.

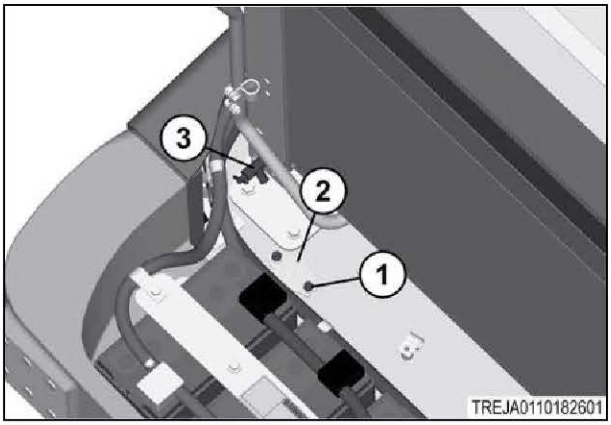


Fig. 93

10. Remove the hardware (1, 3) and the right fan guard (2).

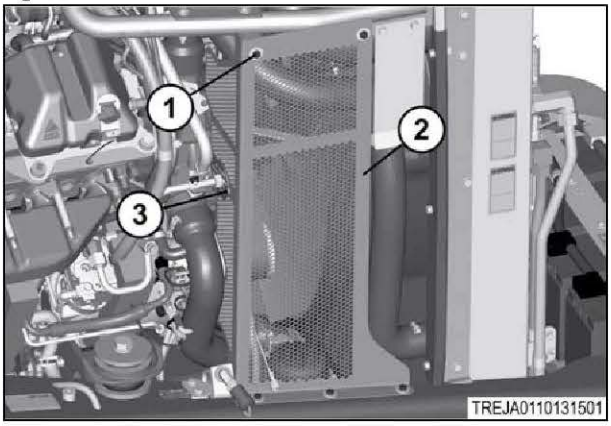


Fig. 94

11. Remove the hardware (1) and the left fan guard (2).

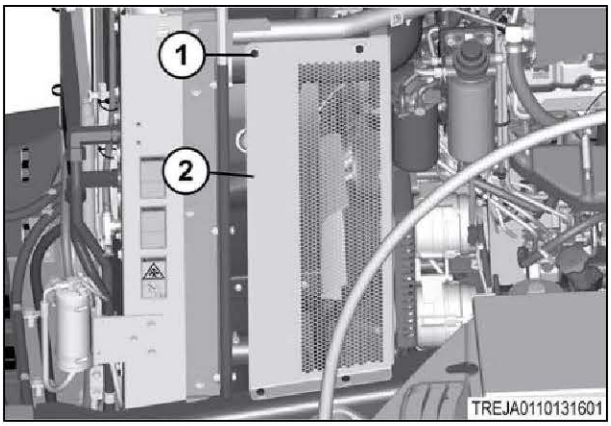


Fig. 95

12. Loosen the hose clamps (1) and disconnect the left charge air cooler hose (2).

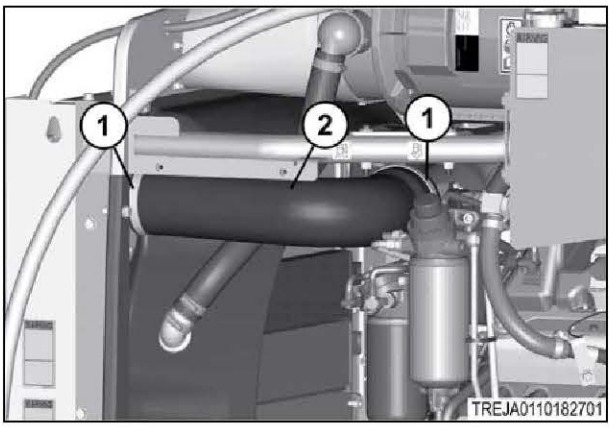


Fig. 96

13. Loosen the hose clamp (1) and disconnect the right charge air cooler hose (2).

14. Remove the hardware (3) and the hose clamp (4).

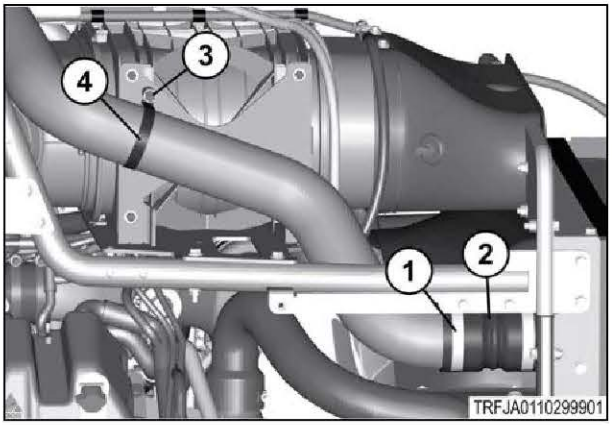


Fig. 97

15. Disconnect the two wire harnesses (1) from the air filter assembly.

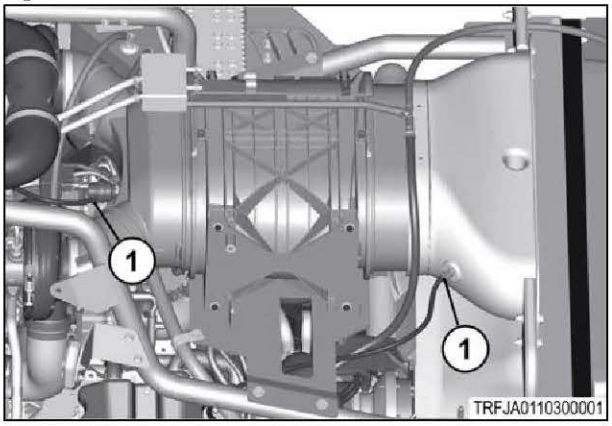


Fig. 98

16. Loosen the hose clamps (1) and disconnect the turbocharger inlet tubes (2).

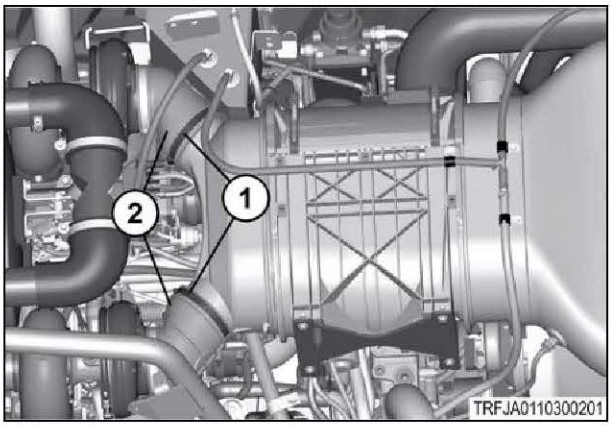


Fig. 99

17. Loosen the two hose clamps (1) and disconnect the two hoses (2).

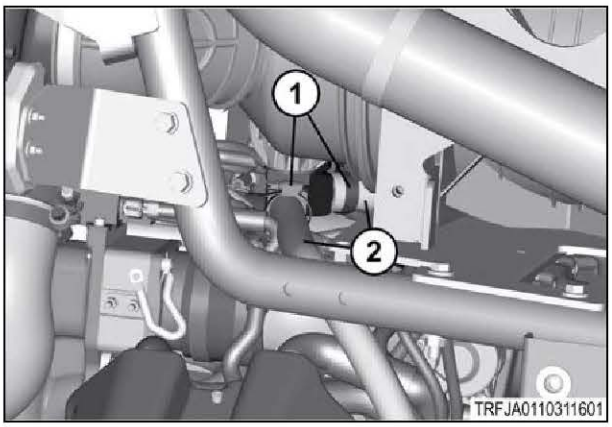


Fig. 100

18. Remove the hardware (1), the hose clips (2), and the doser expansion tank bracket (3).

19. Loosen the two hose clamps (4), and disconnect the two hoses.

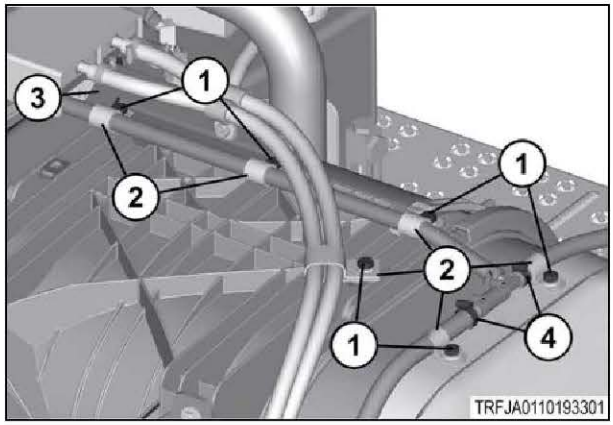


Fig. 101

20. Remove the hardware (1), and the air filter nozzle (2).

21. Remove the hardware (3), and the plastic seals (4).

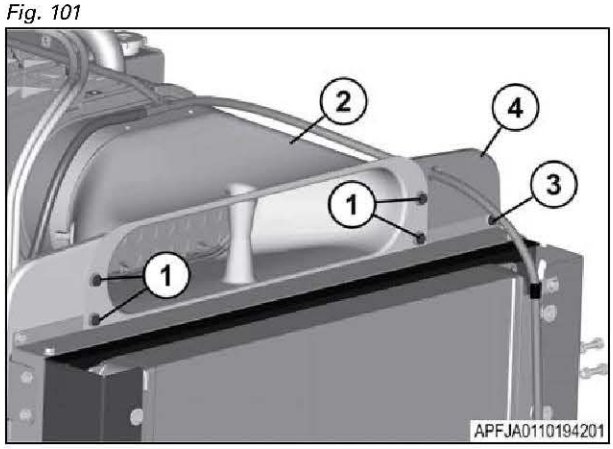


Fig. 102

22. Loosen the hose clamp (1) and disconnect the dust ejector tube (2).

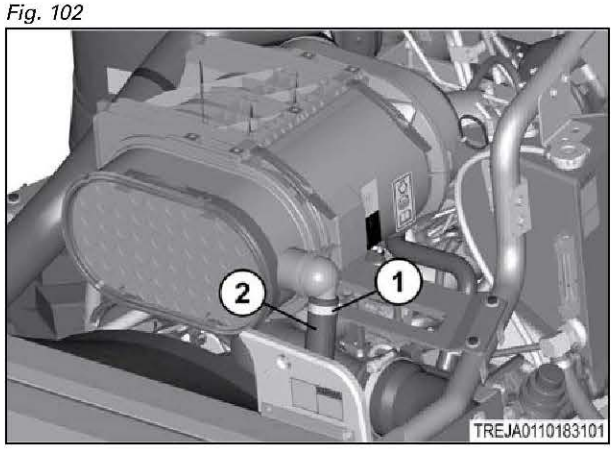


Fig. 103

23. Remove the hardware (1) and the air filter assembly (2).

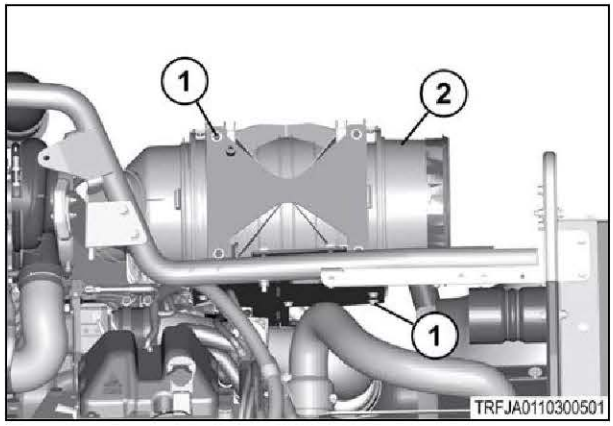


Fig. 104

24. Remove the hardware (1), and the hose clips (2).

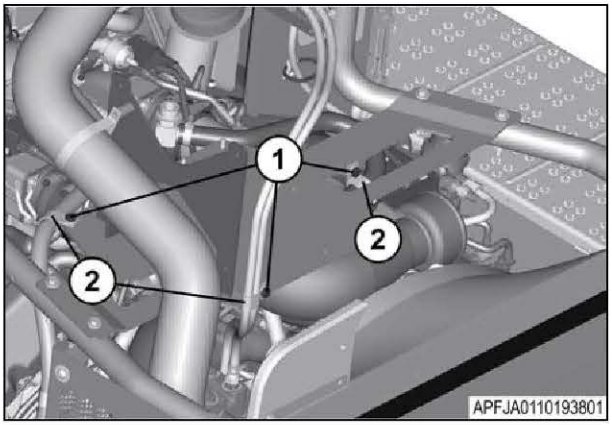


Fig. 105

25. Remove the hardware (1) and the air filter bracket (2).

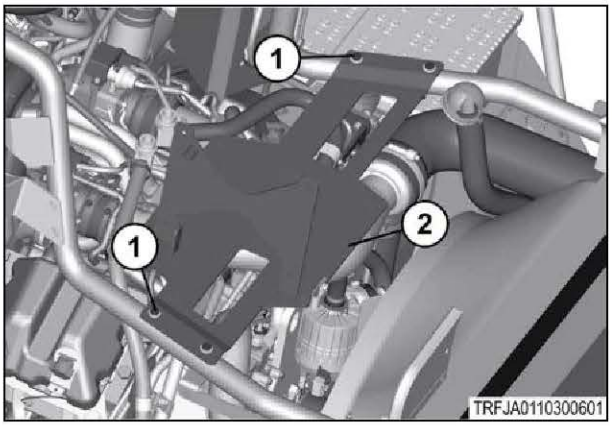


Fig. 106

26. Remove the hardware (1), the hose clamp (2), and the bracket (3).

27. Loosen the hose clamps (4) and disconnect the inlet radiator hose (5).

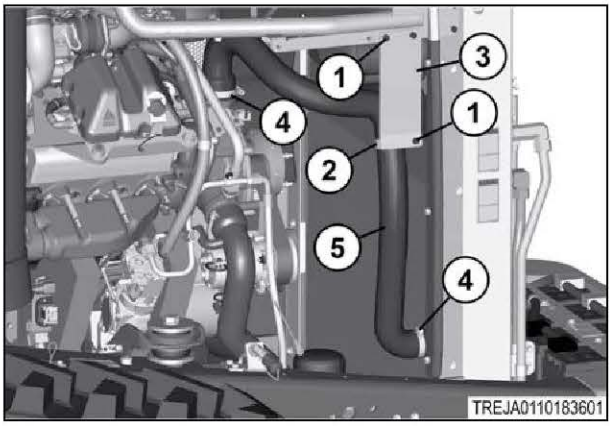


Fig. 107

28. Remove the hardware (1) and the hose clamp (2).

29. Loosen the hose clamps (3) and disconnect the outlet radiator hose (4).

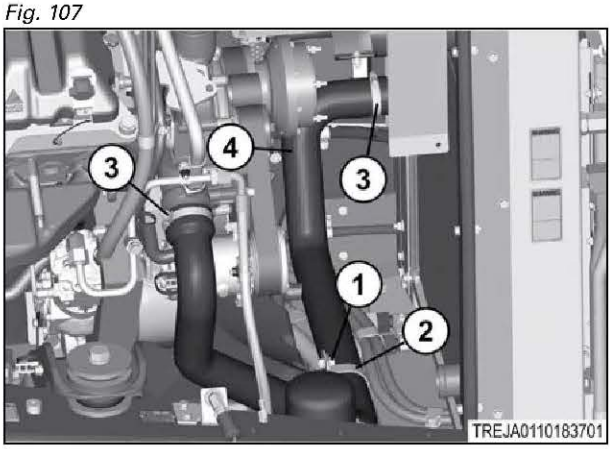


Fig. 108

30. Remove the hardware (1) and the right support bracket (2).

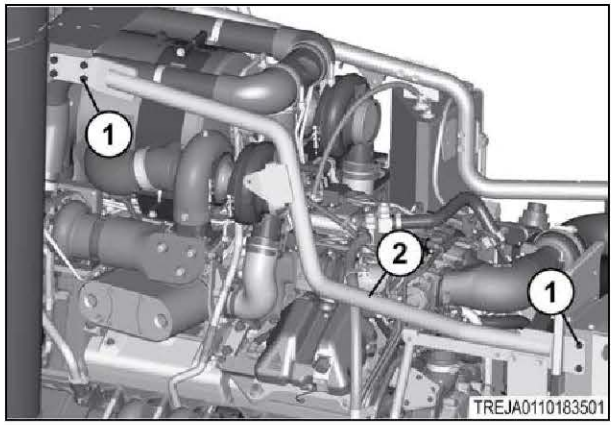


Fig. 109

31. Loosen the hose clamps (1) and disconnect the hoses (2) from the expansion tank.

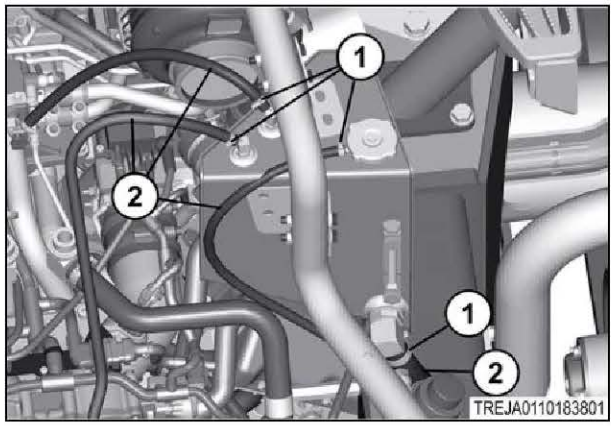


Fig. 110

32. Remove the hardware (1) and the expansion tank (2).

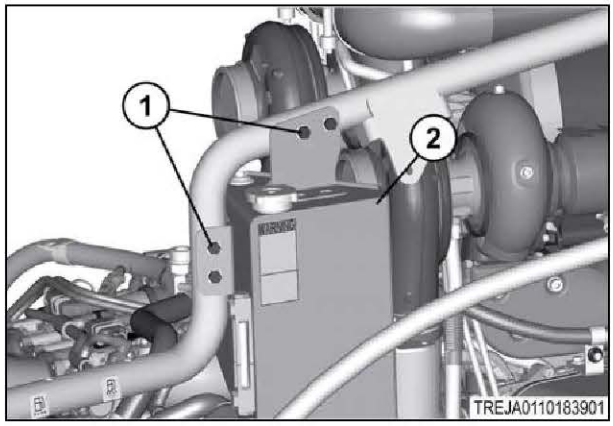


Fig. 111

33. Remove the hardware (1) and the left support bracket (2).

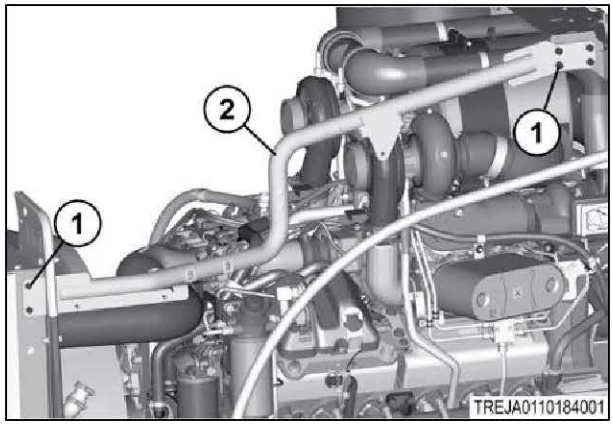


Fig. 112

34. Remove the batteries (1).

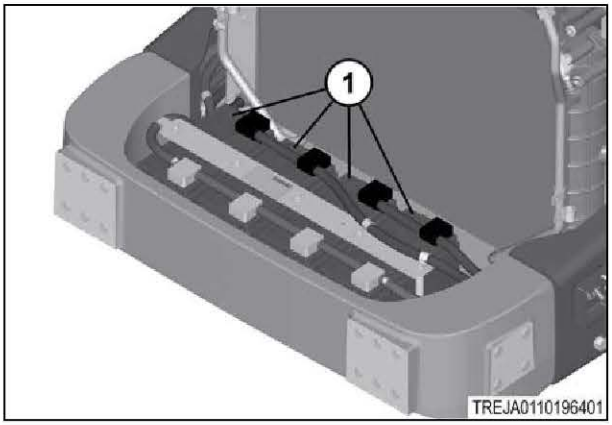


Fig. 113

35. Remove the hardware (1) and the two side seal brackets (2).

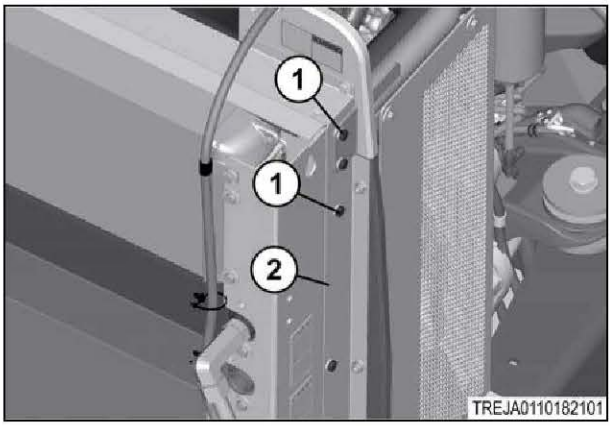


Fig. 114

36. Remove the hardware (1) and the top seal bracket (2) with the seal.

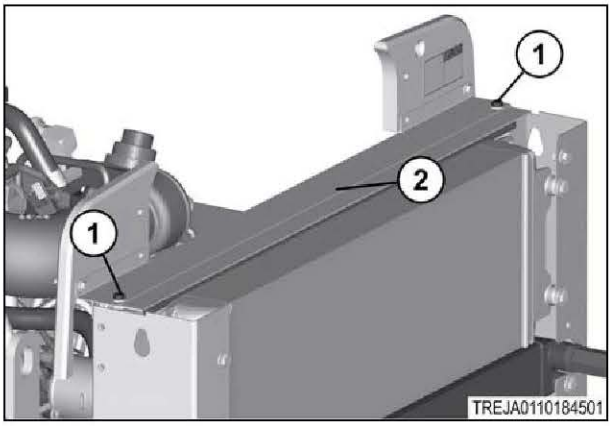


Fig. 115

37. Remove the hardware (1) and the air conditioning receiver-dryer bracket (2).

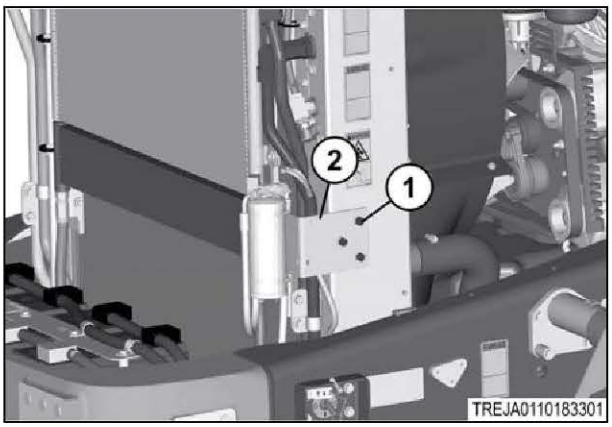


Fig. 116

38. Disconnect the fuel hoses (1).

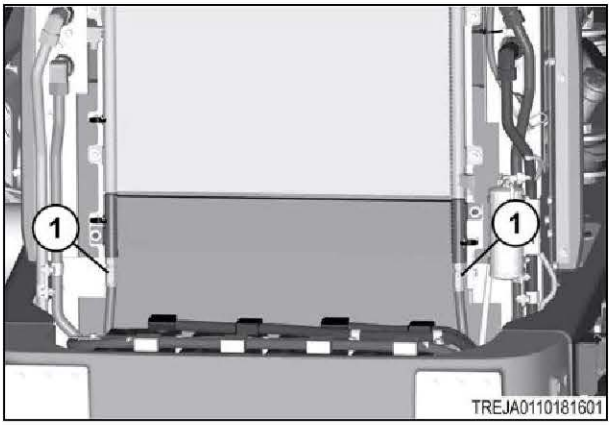


Fig. 117

39. Disconnect the air conditioning condenser hoses (1).

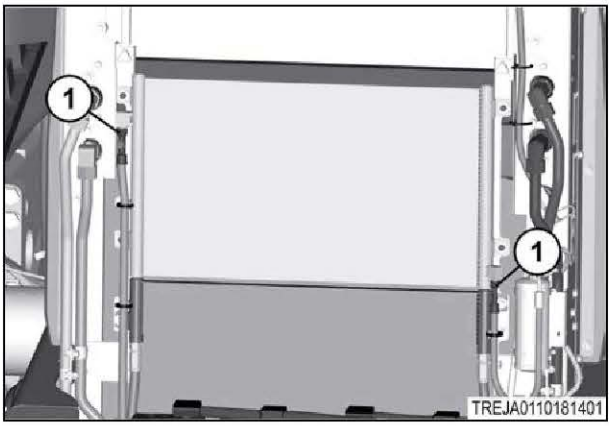


Fig. 118

40. Remove the hardware (2) and the air conditioning condenser/fuel cooler assembly (3).

41. Disconnect the hydraulic hoses (1).

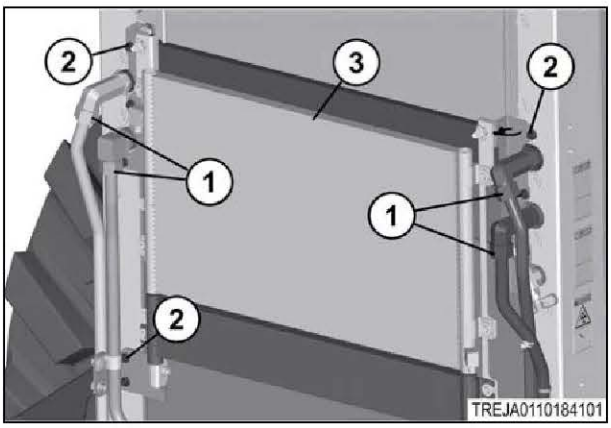


Fig. 119

42. Remove the hardware (1) and the fan shroud (2).

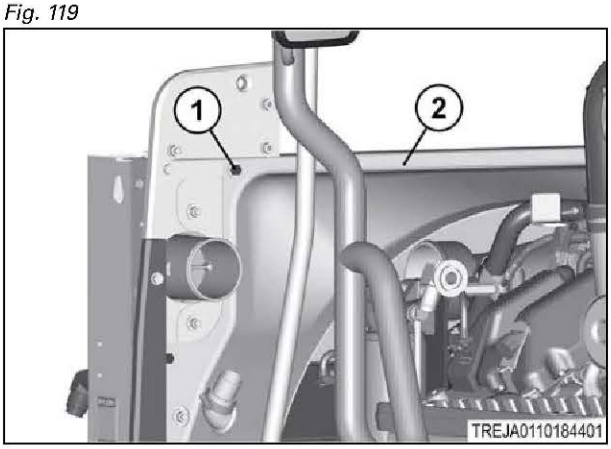


Fig. 120

43. Connect the correct lift equipment (1) to the cooling package.

IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

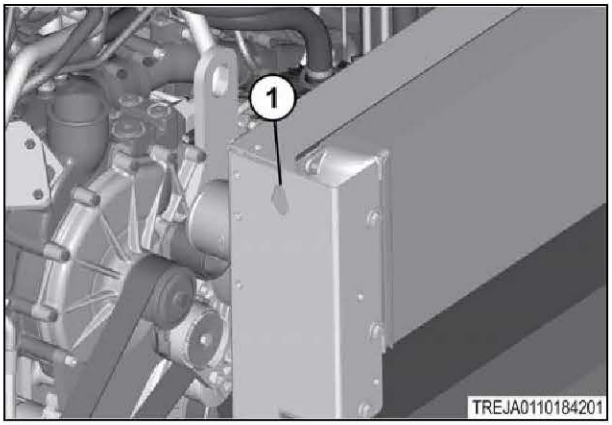


Fig. 121

44. Remove the hardware (1) and the cooling package (2).

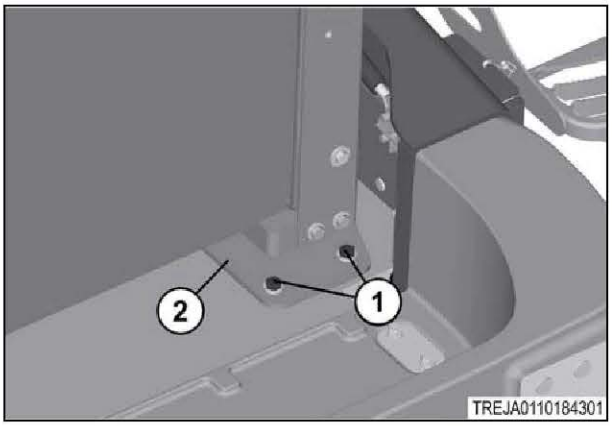


Fig. 122

45. Remove the hardware (1) and the bottom and top cross members (2).

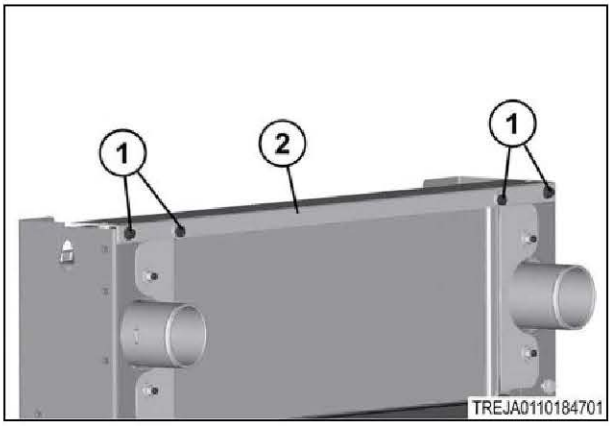


Fig. 123

46. Remove the hardware (1) and the two side channels (2).

47. Remove the radiator core (3).

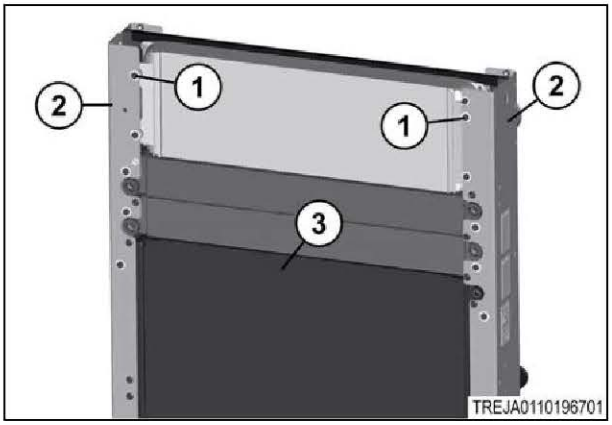


Fig. 124

Related Links

Remove the engine cover page 13-3
Remove the batteries page 10-22

2.2.10 Install the radiator core

Procedure

1. Use the hardware (1), to install the foam seals and the implement oil cooler (3), to the two side channels (2).

   NOTE: *Make sure the foam seals are in the correct location. Replace if worn.*

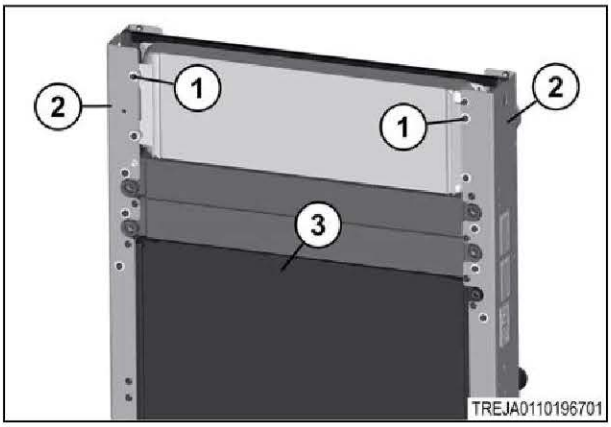


Fig. 125

2. Use the hardware (1) to install the bottom and the top cross members (2).

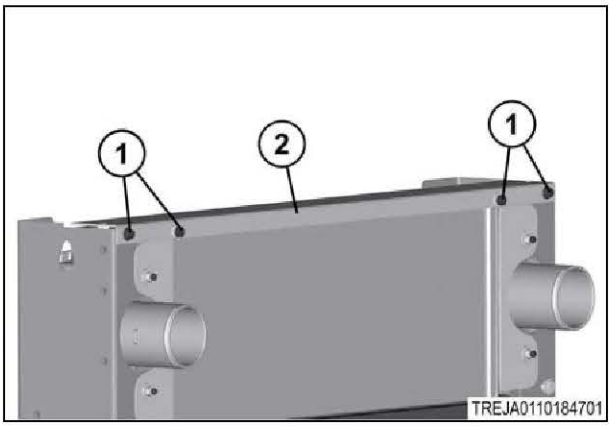


Fig. 126

3. Connect the correct lifting equipment (1) to the cooling package.

   IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

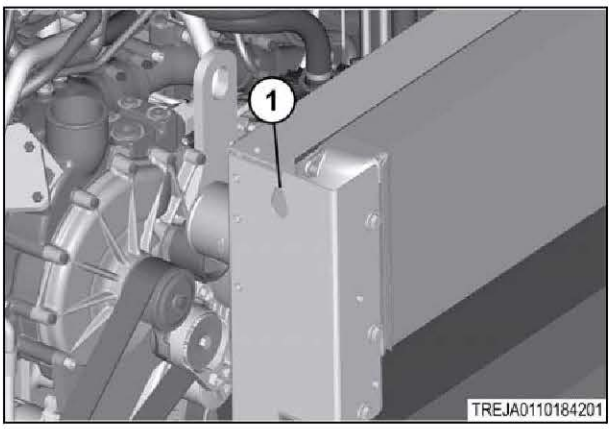


Fig. 127

4. Use the hardware (1) to install the cooling package (2).

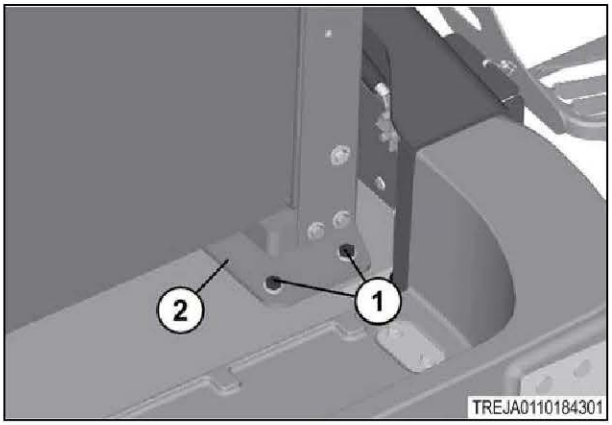


Fig. 128

5. Use the hardware (1) to install the fan shroud (2).

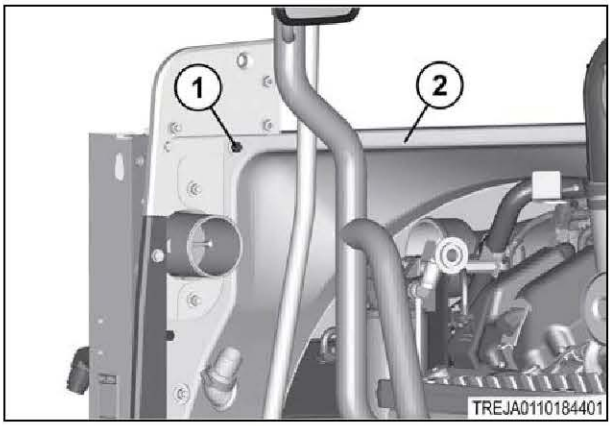


Fig. 129

6. Use the hardware (2) to install the air conditioning condenser/fuel cooler assembly (3).

7. Connect the hydraulic hoses (1).

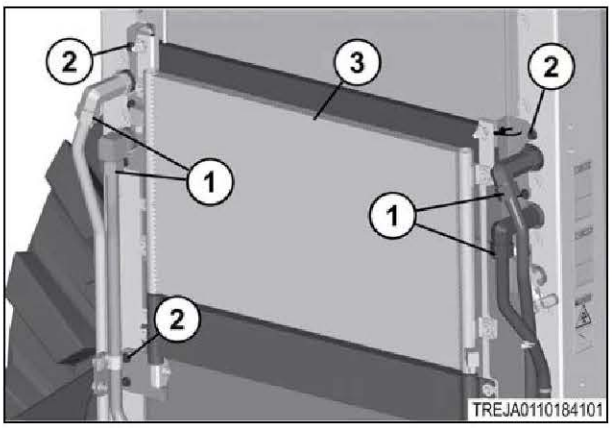


Fig. 130

8. Use the hardware (1) to install the air conditioning receiver-dryer bracket (2).

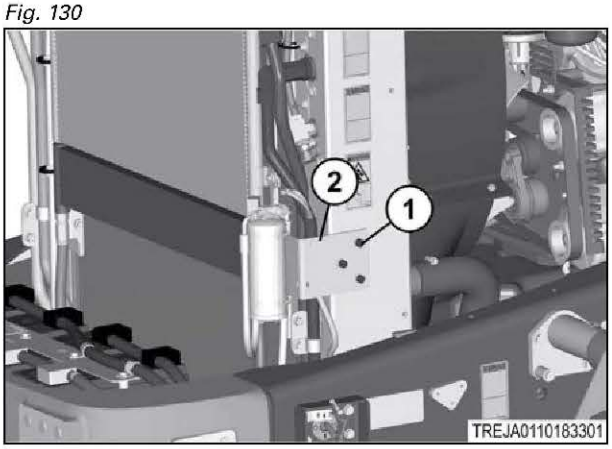


Fig. 131

9. Use the hardware (1) to install the seal, and the top seal bracket (2).

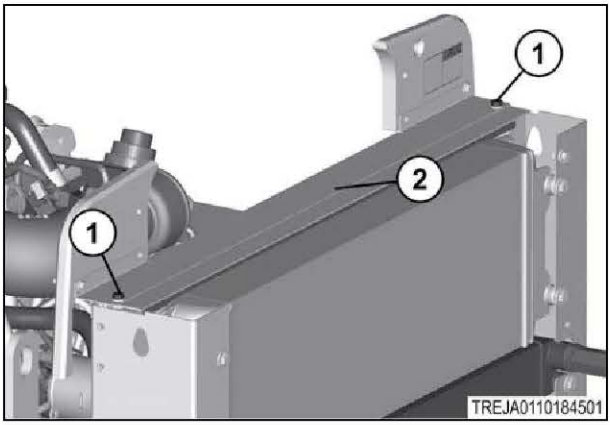


Fig. 132

10. Use the hardware (1) to install the seals, and the two side seal brackets (2).

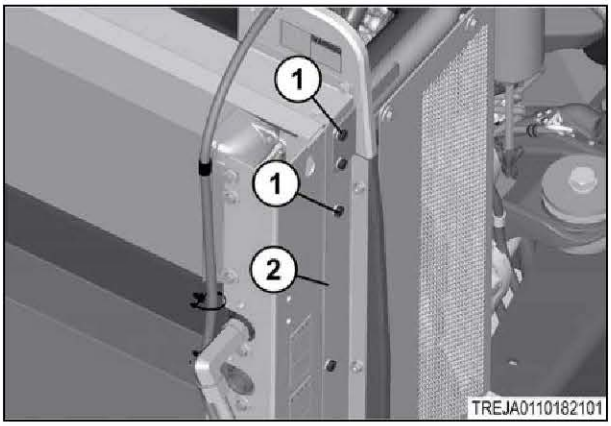


Fig. 133

11. Install the batteries (1).

See the information for installing the batteries.

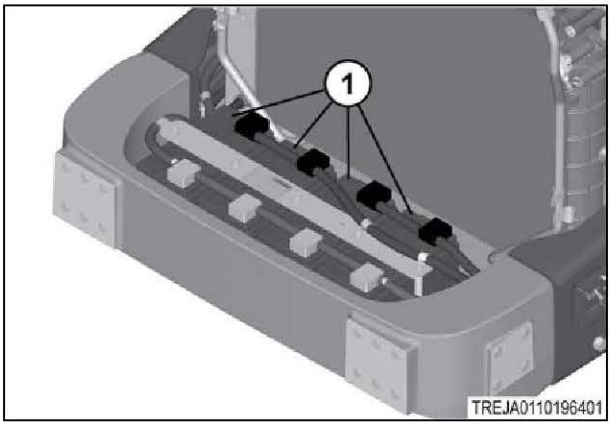


Fig. 134

12. Use the hardware (1) to install the left support bracket (2).

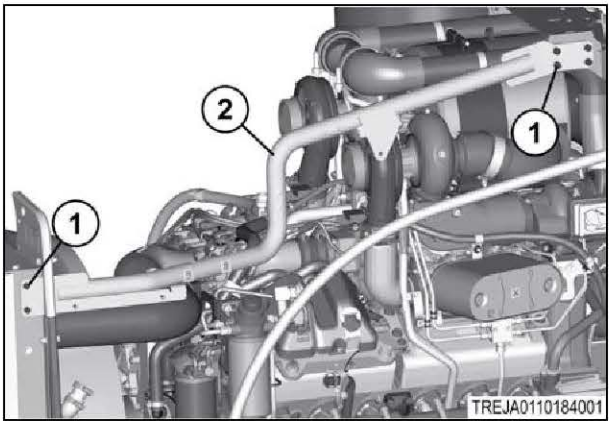


Fig. 135

13. Use the hardware (1) to install the expansion tank (2).

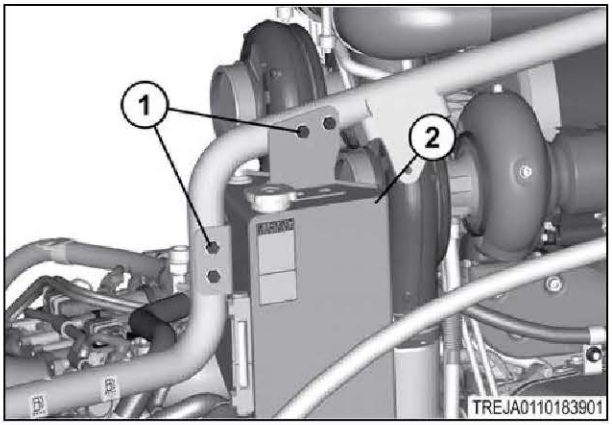


Fig. 136

14. Use the hose clamps (1) to connect the hoses (2) to the expansion tank.

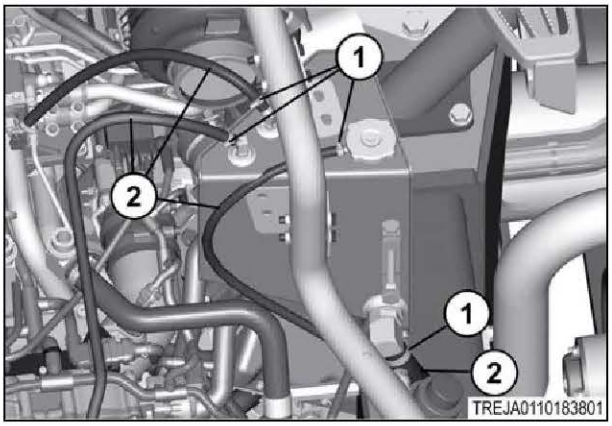


Fig. 137

15. Use the hardware (1) to install the right support bracket (2).

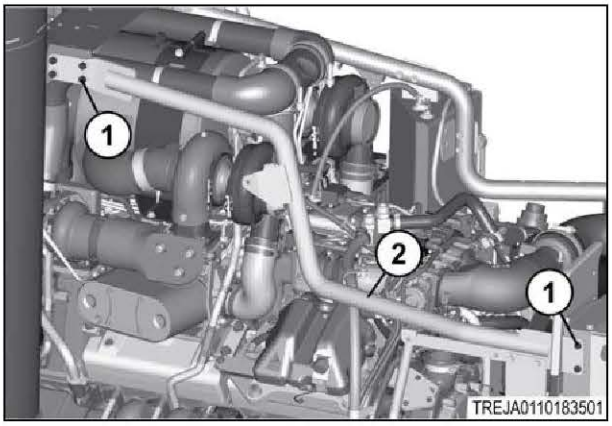


Fig. 138

16. Use the hose clamps (3) to connect the outlet radiator hose (4).

17. Use the hardware (1) to install the hose clamp (2).

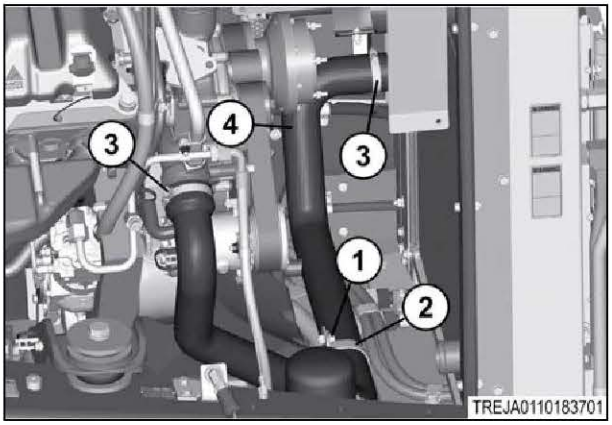


Fig. 139

18. Use the hose clamps (4) to connect the inlet radiator hose (5).

19. Use the hardware (1) to install the bracket (3) and the hose clamp (2).

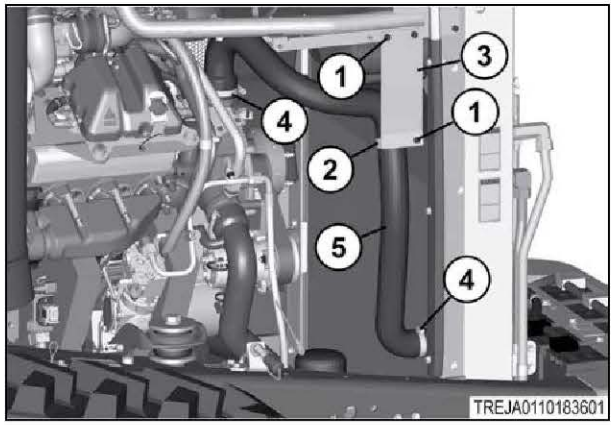


Fig. 140

20. Use the hardware (1) to install the air filter assembly mount (2).

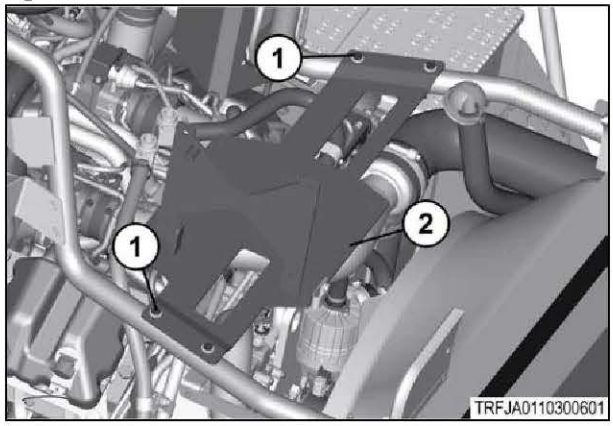


Fig. 141

21. Use the hardware (1), to install the hose clips (2).

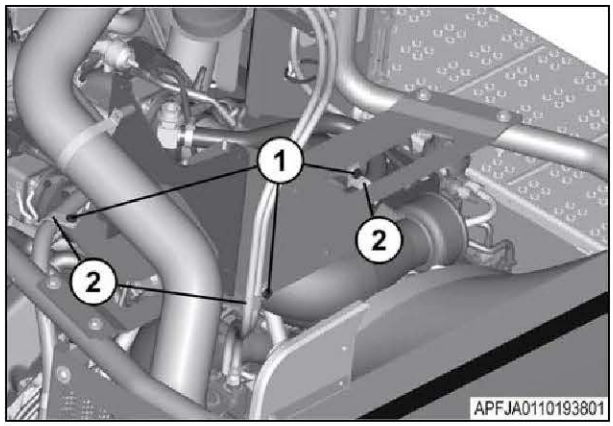


Fig. 142

22. Use the hardware (1) to install the air filter assembly (2).

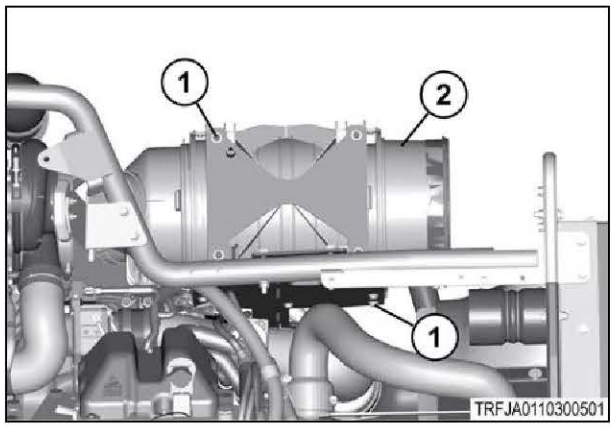


Fig. 143

23. Use the hose clamp (1) to connect the dust ejector tube (2).

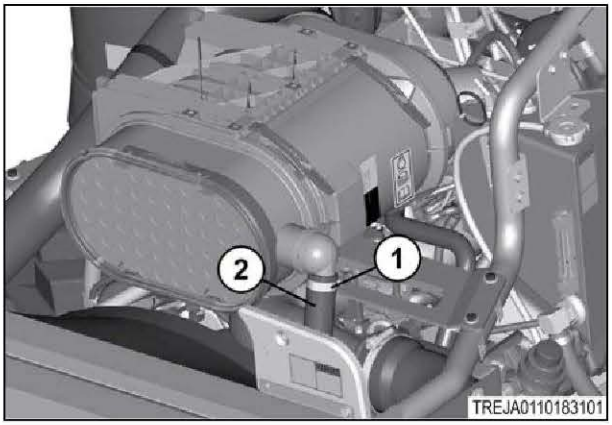


Fig. 144

24. Use the hose clamps (1) to connect the turbocharger inlet tubes (2).

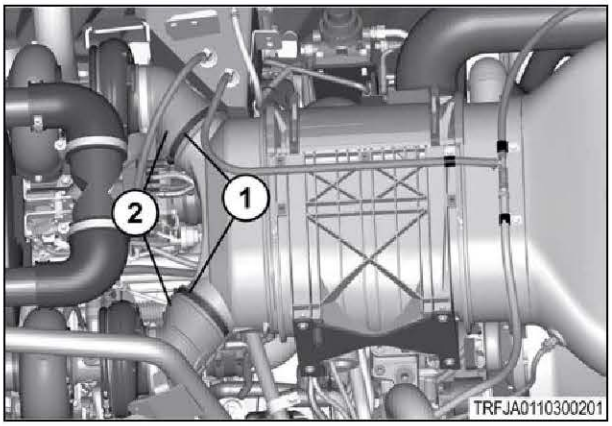


Fig. 145

25. Connect the two wire harnesses (1) to the air filter.

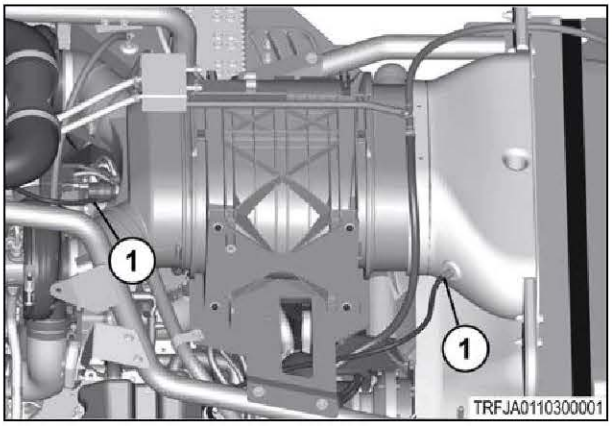


Fig. 146

26. Use the hardware (1), to install the hose clips (2), and the doser expansion tank bracket (3).

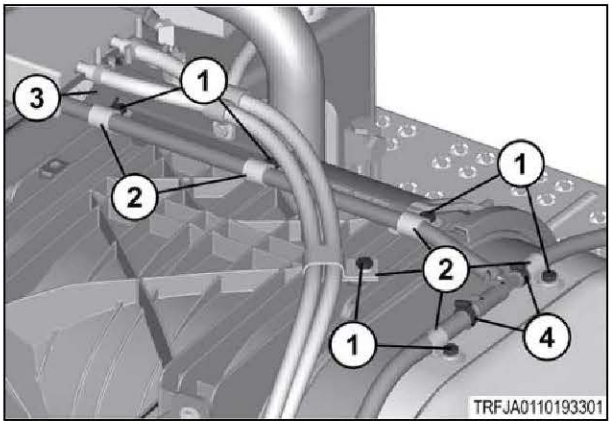


Fig. 147

27. Use the hardware (1) to install the air filter nozzle (2).

28. Use the hardware (3), to install the plastic seals (4).

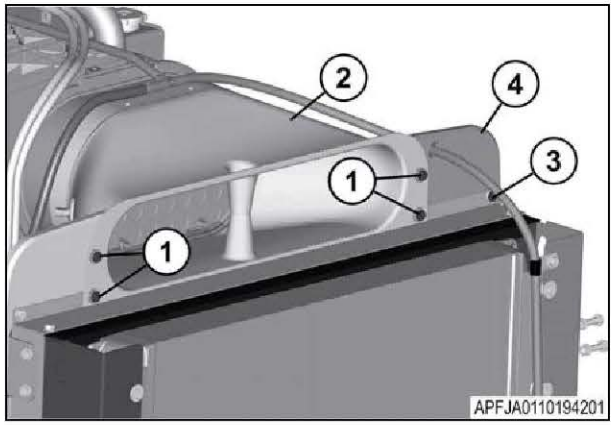


Fig. 148

29. Use the tube clamps (1) to install the right charge air cooler tube (2).

30. Use the hardware (3) to install the clamp (4).

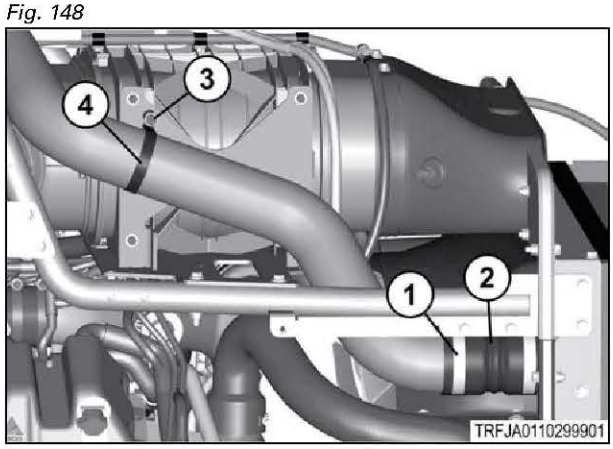


Fig. 149

31. Use the tube clamps (1) to install the left charge air cooler tube (2).

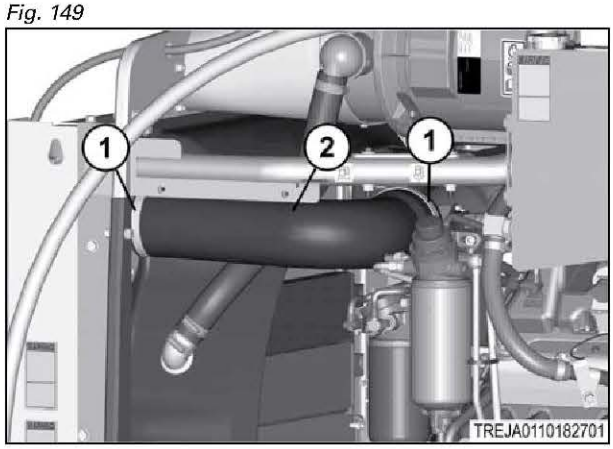


Fig. 150

32. Use the hardware (1) to install the left fan guard (2).

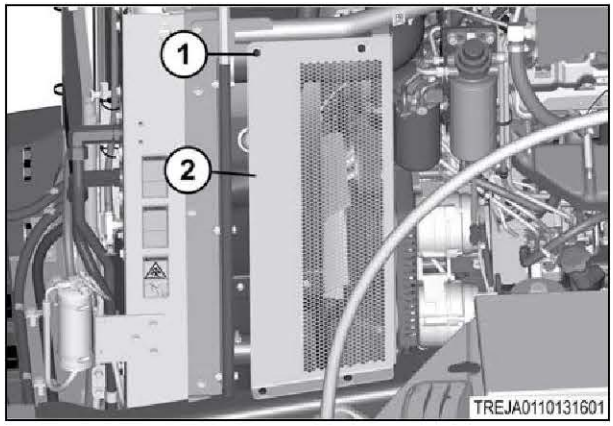


Fig. 151

33. Use the hardware (1, 3) to install the right fan guard (2).

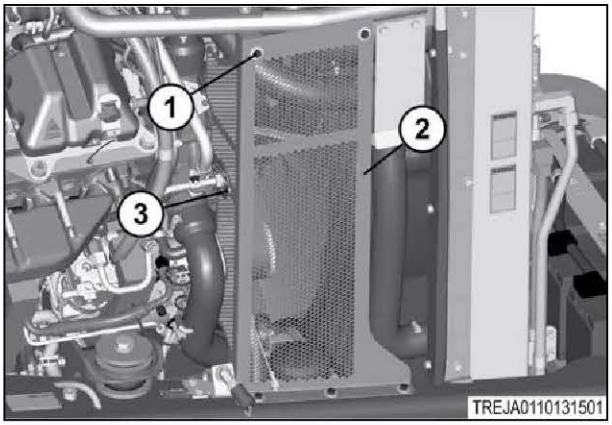


Fig. 152

34. Remove the drain hose and tighten the drain valve (3).

35. Use the hardware (1), to install the cover plate (2).

36. Fill the radiator with the correct type and quantity of engine coolant.

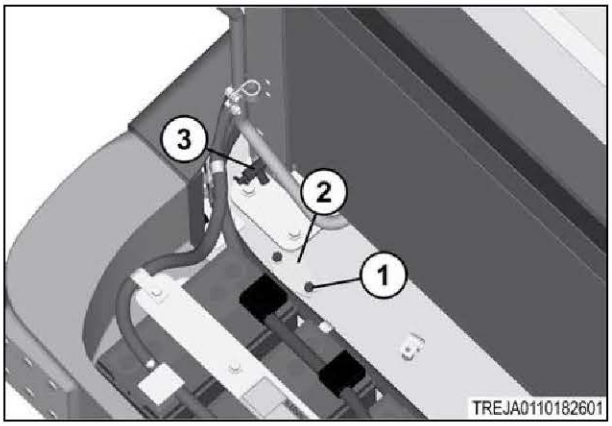


Fig. 153

37. Install the engine cover.

38. Install the battery disconnect switch key.

39. Turn on the battery disconnect switch.

Related Links

Install the engine cover (MY2015 and earlier) page 13-16
Fill capacities page 1-18
Coolant quality requirements page 2-239
Install the batteries page 10-23
Refill the cooling system page 2-149

2.2.11 Remove the implement oil cooler

Before starting the procedure

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.

WARNING: Pressurized gases or fluids can be hazards.

Personal injury can result.

Relieve the pressure from the system or component before disconnecting components.

NOTE: *Before removal, put identification tags on the components for correct installation at assembly. Put covers and plugs on all hoses, fittings, and ports to prevent contamination from the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all parts to keep contamination from the system. Contamination can damage the precision parts. Complete the disassembly steps on a clean surface. Put clean material on top of the parts.*

NOTE: *Use only certified technicians and equipment to service the air conditioning system.*

NOTE: *When opening the air conditioning system, replace the receiver-dryer. See the information for removing/installing the receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn off the battery disconnect switch.
4. Remove the battery disconnect switch key.
5. Remove the engine cover.
6. Remove the hardware (1) and the cover plate (2).
7. Install a hose to the radiator drain valve (3) and put through the access hole.
8. Set a correct container under the radiator drain hose. Loosen the radiator drain valve (3) and drain the engine coolant.

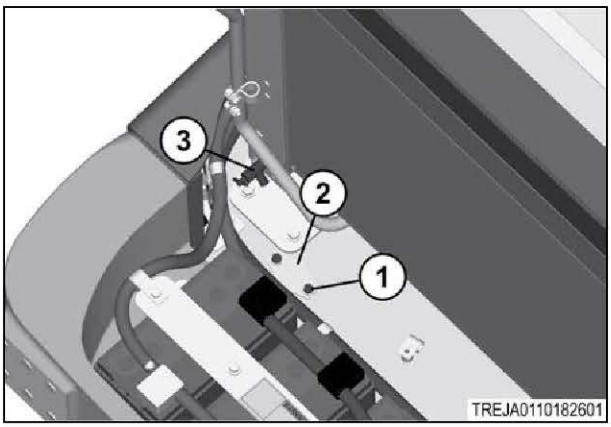


Fig. 154

9. Remove the hardware (1, 3) and the right fan guard (2).

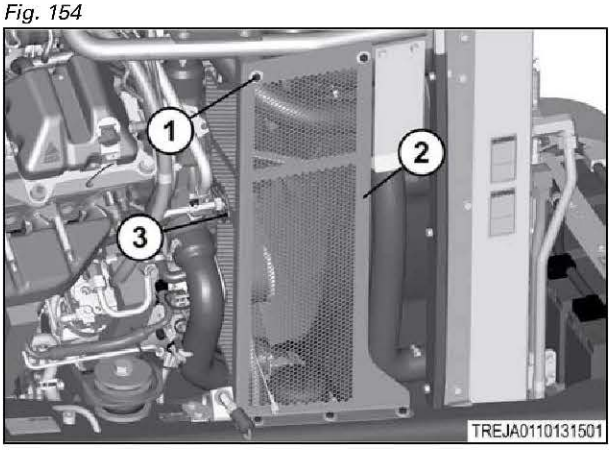


Fig. 155

10. Remove the hardware (1) and the left fan guard (2).

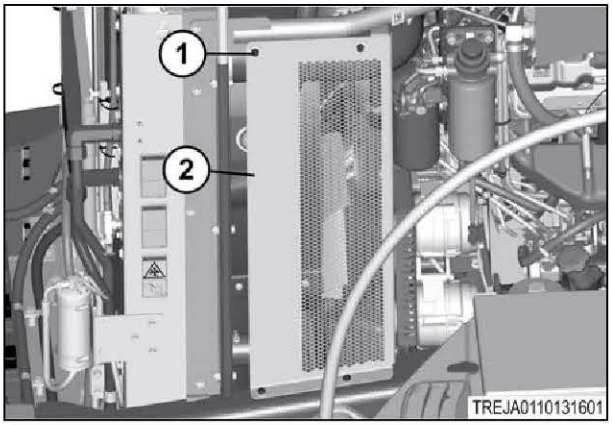


Fig. 156

11. Loosen the hose clamps (1) and disconnect the left charge air cooler hose (2).

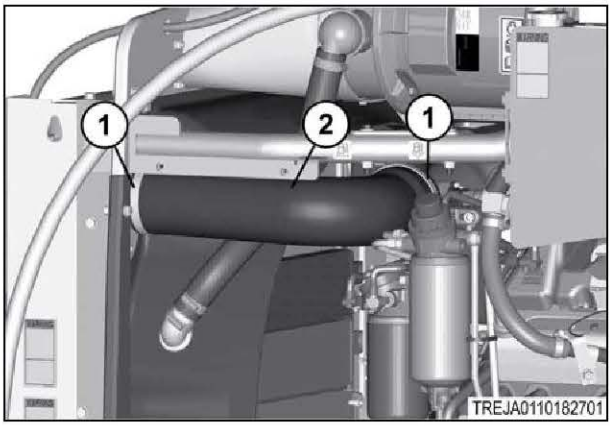


Fig. 157

12. Loosen the hose clamp (1) and disconnect the right charge air cooler hose (2).

13. Remove the hardware (3) and the hose clamp (4).

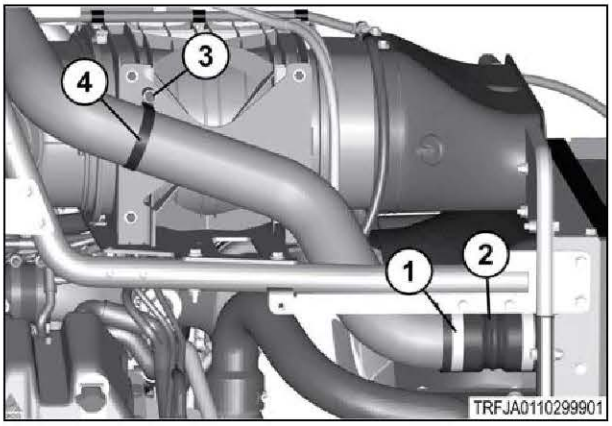


Fig. 158

14. Disconnect the two wire harnesses (1) from the air filter assembly.

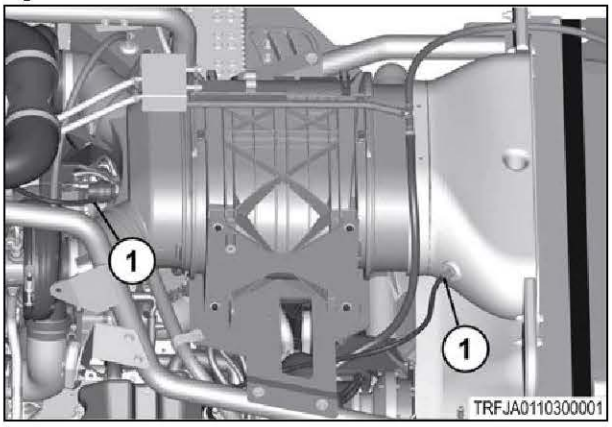


Fig. 159

15. Loosen the hose clamps (1) and disconnect the turbocharger inlet tubes (2).

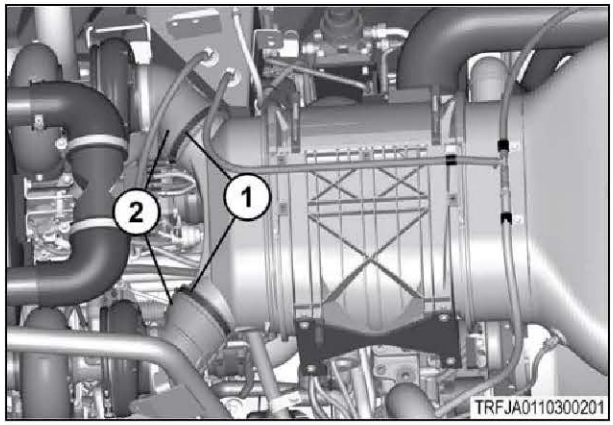


Fig. 160

16. Loosen the two hose clamps (1) and disconnect the two hoses (2).

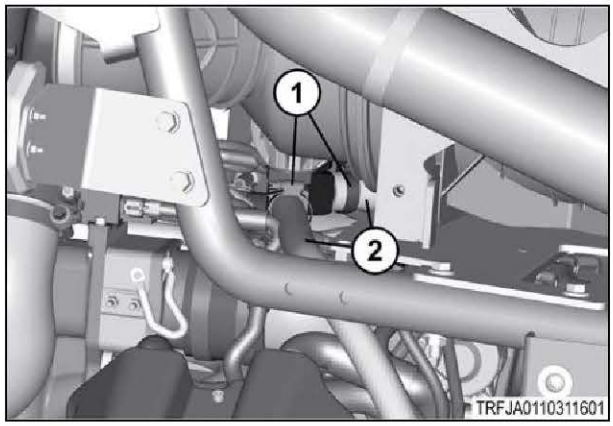


Fig. 161

17. Remove the hardware (1), the hose clips (2), and the doser expansion tank bracket (3).

18. Loloosen the two hose clamps (4), and disconnect the two hoses.

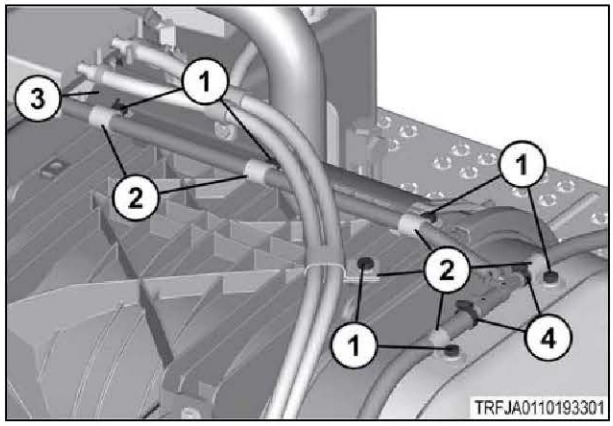


Fig. 162

19. Remove the hardware (1), and the air filter nozzle (2).

20. Remove the hardware (3), and the plastic seals (4).

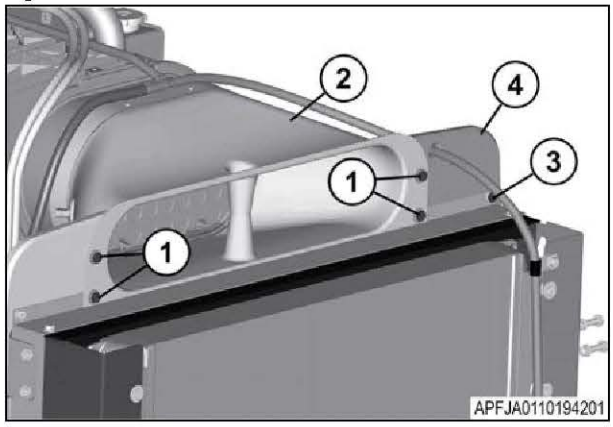


Fig. 163

21. Loosen the hose clamp (1) and disconnect the dust ejector tube (2).

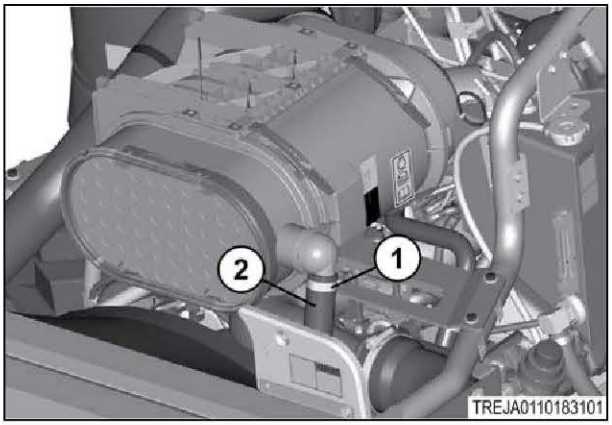


Fig. 164

22. Remove the hardware (1) and the air filter assembly (2).

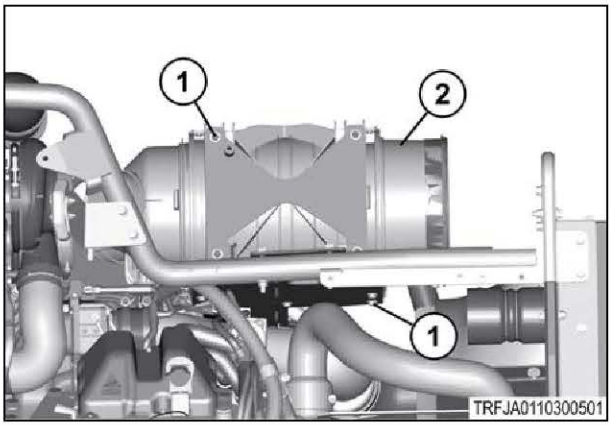


Fig. 165

23. Remove the hardware (1), and the hose clips (2).

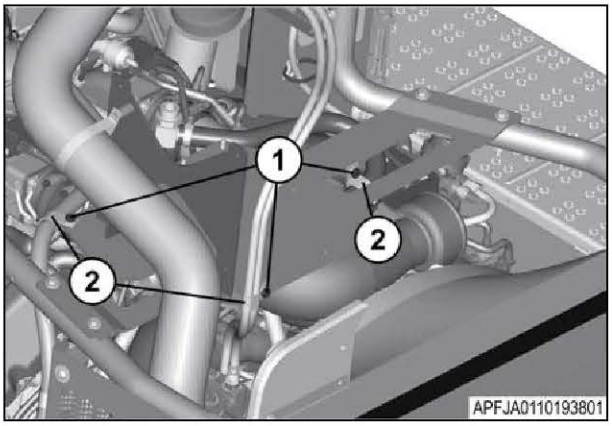


Fig. 166

24. Remove the hardware (1) and the air filter bracket (2).

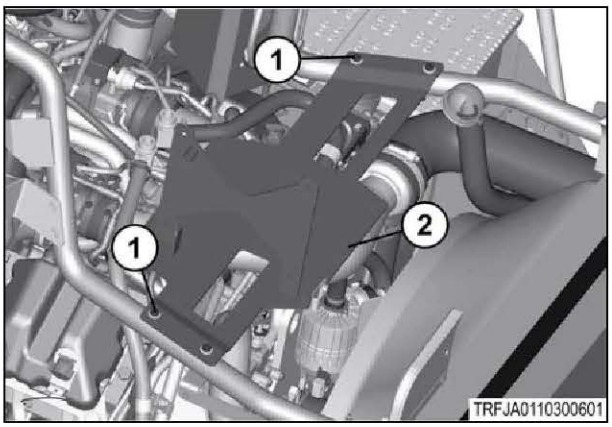


Fig. 167

25. Remove the hardware (1), the hose clamp (2), and the bracket (3).

26. Loosen the hose clamps (4) and disconnect the inlet radiator hose (5).

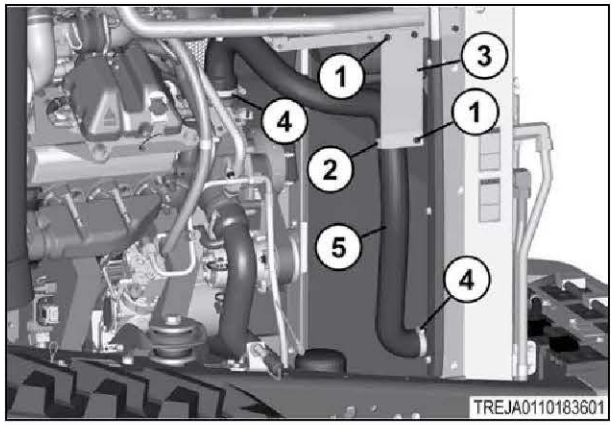


Fig. 168

27. Remove the hardware (1) and the hose clamp (2).

28. Loosen the hose clamps (3) and disconnect the outlet radiator hose (4).

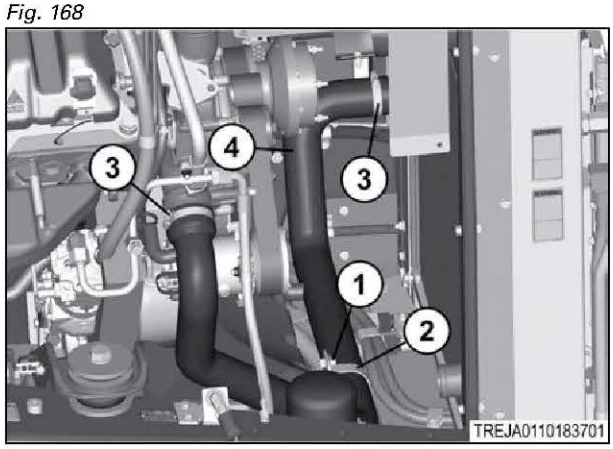


Fig. 169

29. Remove the hardware (1) and the right support bracket (2).

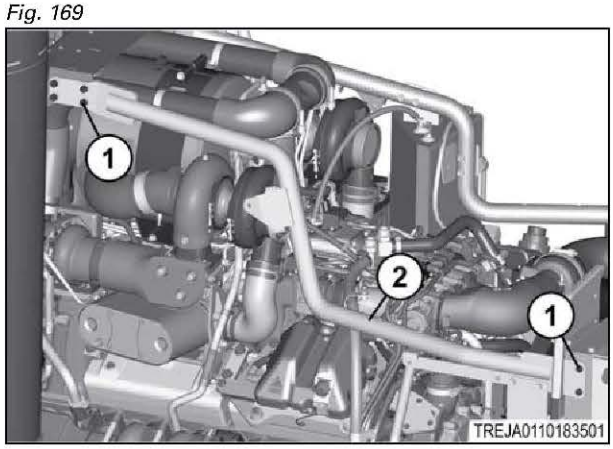


Fig. 170

30. Loosen the hose clamps (1) and disconnect the hoses (2) from the expansion tank.

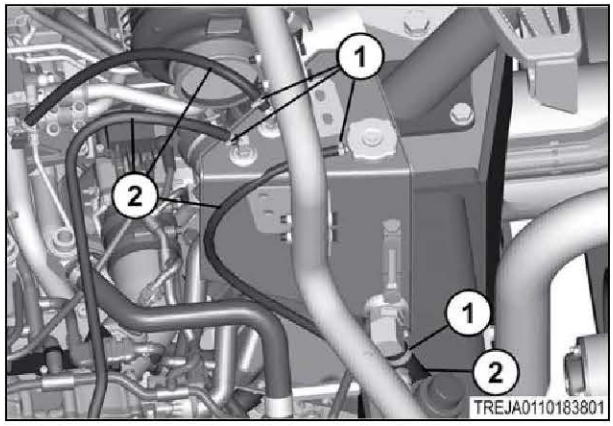


Fig. 171

31. Remove the hardware (1) and the expansion tank (2).

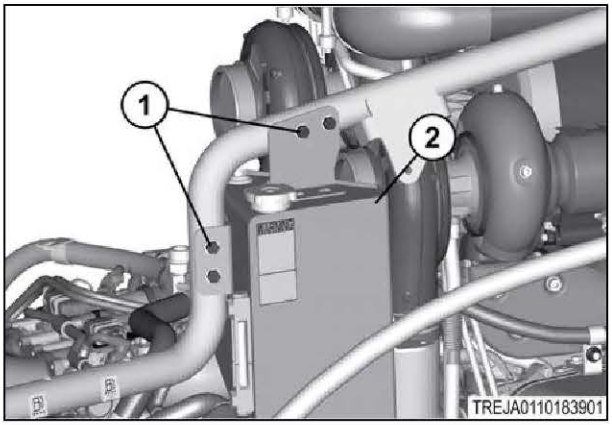


Fig. 172

32. Remove the hardware (1) and the left support bracket (2).

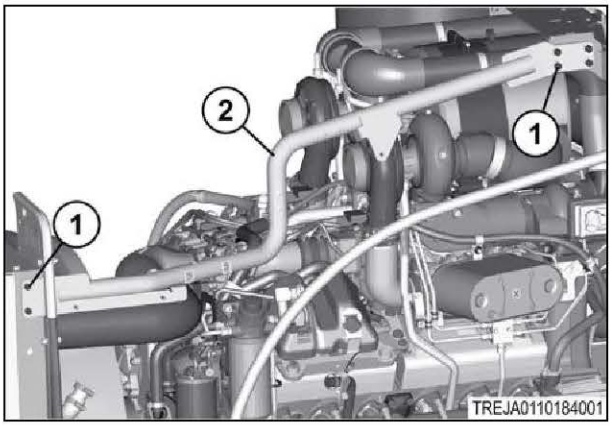


Fig. 173

33. Remove the batteries (1).

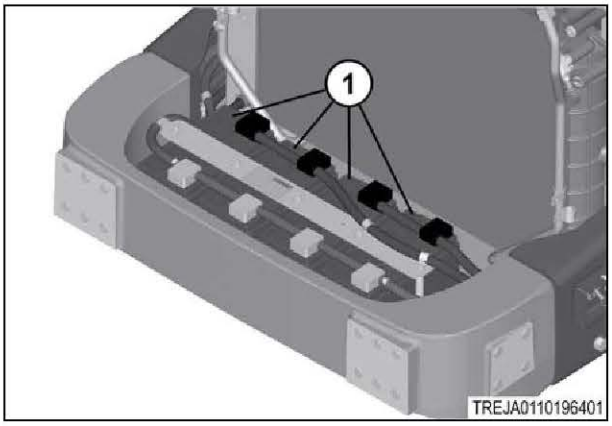


Fig. 174

34. Remove the hardware (1) and the two side seal brackets (2) with seals.

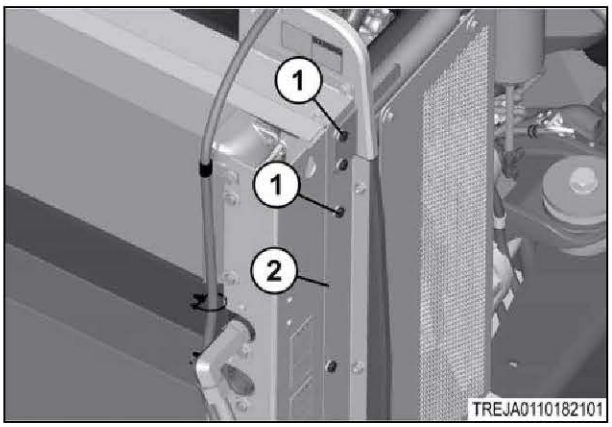


Fig. 175

35. Remove the hardware (1) and the top seal bracket (2) with seal.

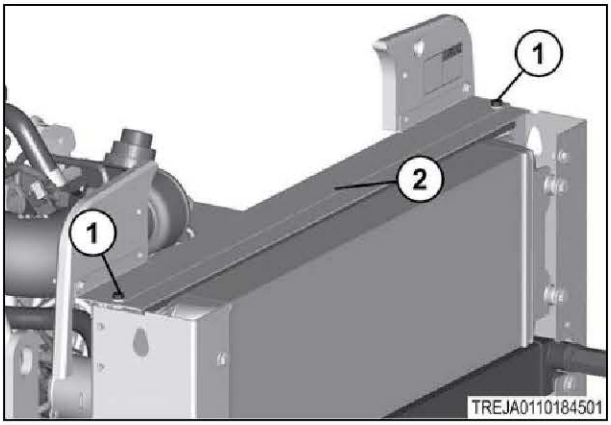


Fig. 176

36. Remove the hardware (1) and the air conditioning receiver-dryer bracket (2).

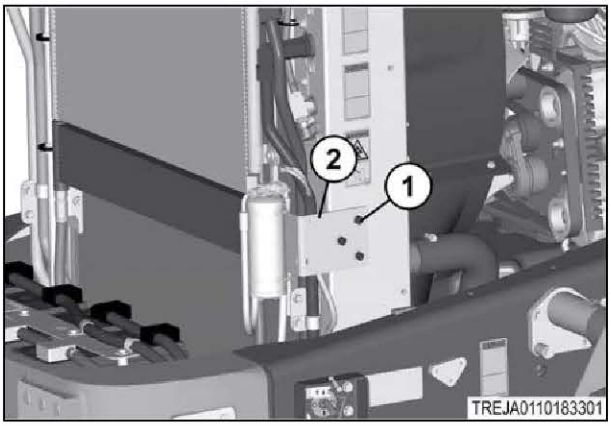


Fig. 177

37. Remove the hardware (2) and put the air conditioning condenser/fuel cooler assembly (3) to the side.

38. Disconnect the hydraulic hoses (1).

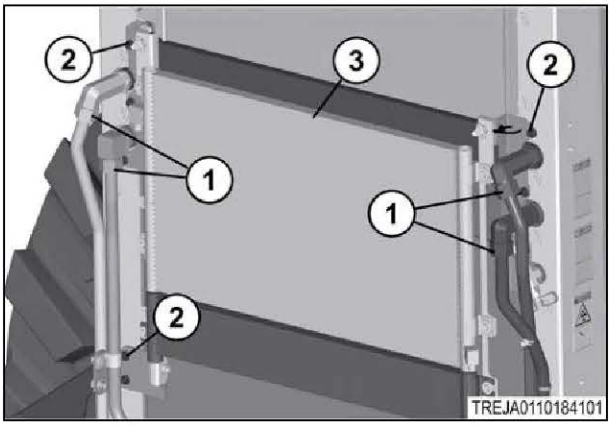


Fig. 178

39. Remove the hardware (1) and the fan shroud (2).

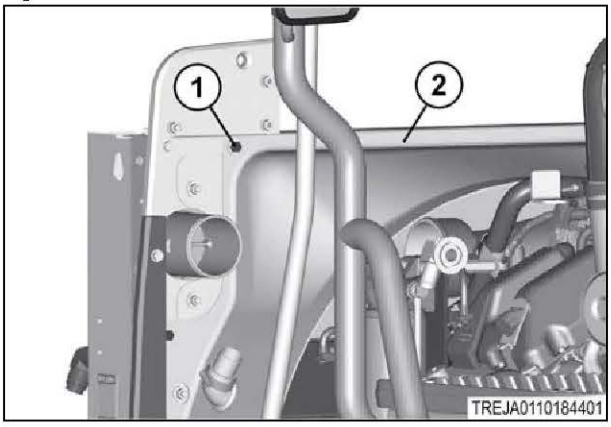


Fig. 179

40. Connect the correct lift equipment (1) to the cooling package.

IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

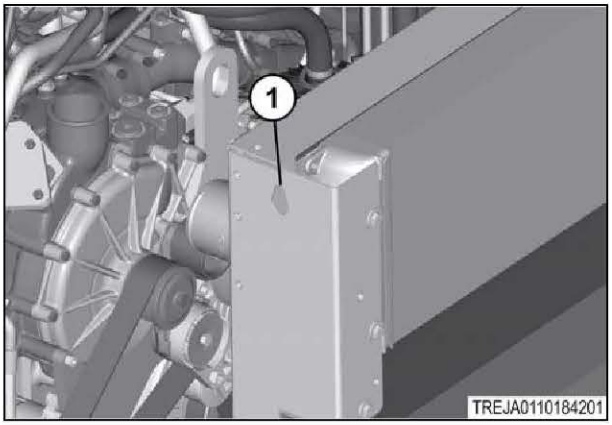


Fig. 180

41. Remove the hardware (1) and the cooling package (2).

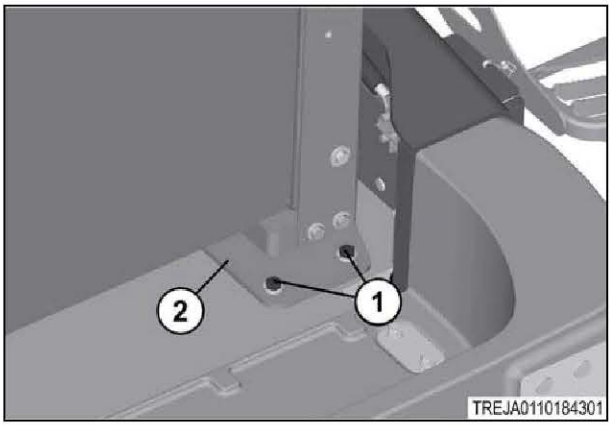


Fig. 181

42. Remove the hardware (1) and the bottom and top cross members (2).

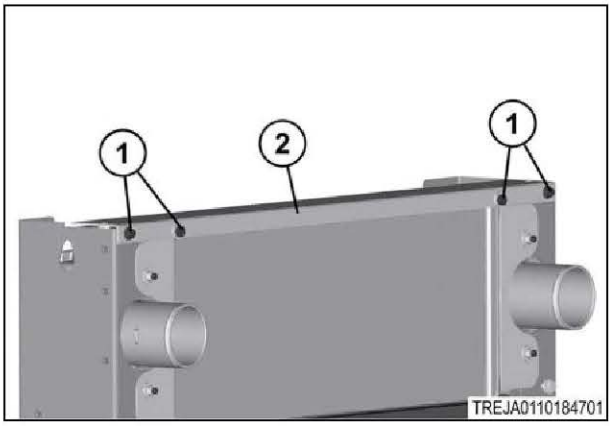


Fig. 182

43. Remove the hardware (1) and the two side channels (2).

44. Remove the implement oil cooler (3).

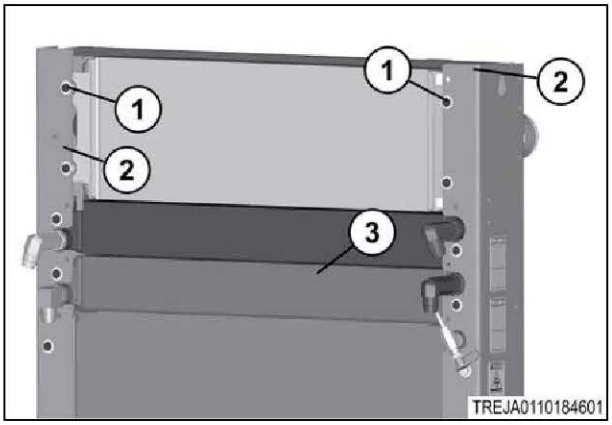


Fig. 183

Related Links

Remove the engine cover page 13-3
Remove the batteries page 10-22

2.2.12 Install the implement oil cooler

Procedure

1. Use the hardware (1), to install the foam seals and the implement oil cooler (3), to the two side channels (2).

   NOTE: *Make sure the foam seals are in the correct location. Replace if worn.*

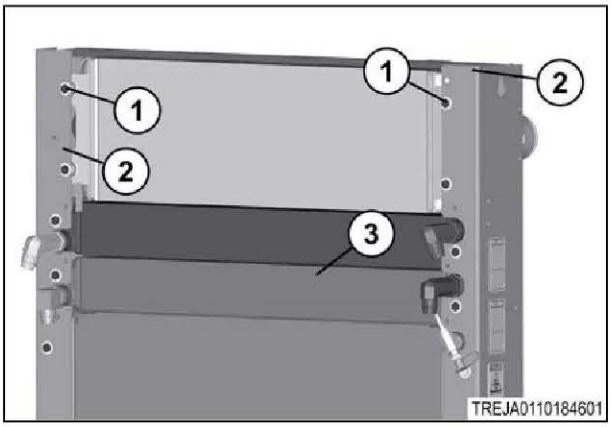


Fig. 184

2. Use the hardware (1) to install the bottom and the top cross members (2).

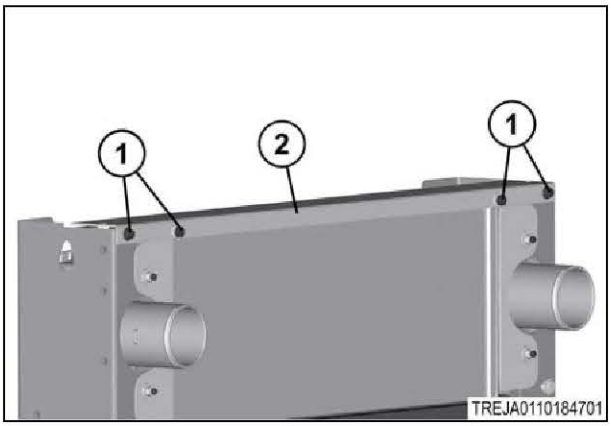


Fig. 185

3. Connect the correct lift equipment (1) to the cooling package.

   IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

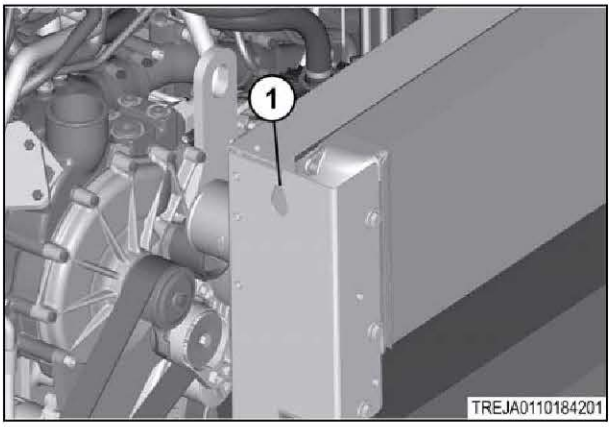


Fig. 186

4. Use the hardware (1) to install the cooling package (2).

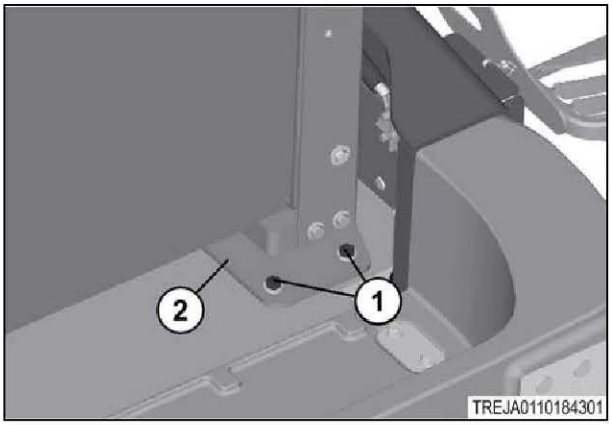


Fig. 187

5. Use the hardware (1) to install the fan shroud (2).

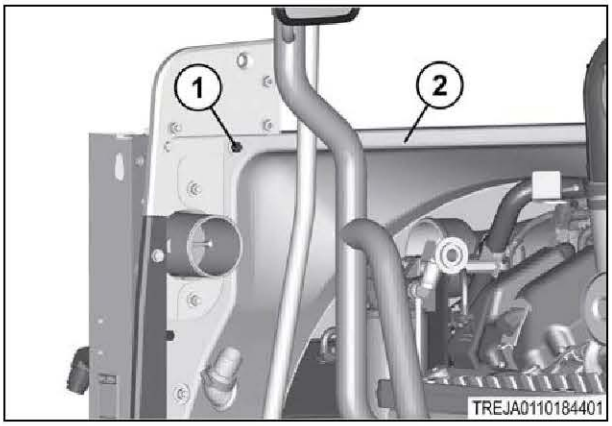


Fig. 188

6. Use the hardware (2) to install the air conditioning condenser/fuel cooler assembly (3).

7. Connect the hydraulic hoses (1).

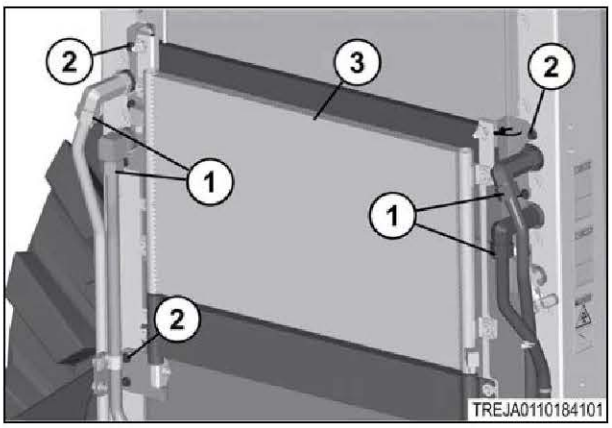


Fig. 189

8. Use the hardware (1) to install the air conditioning receiver-dryer bracket (2).

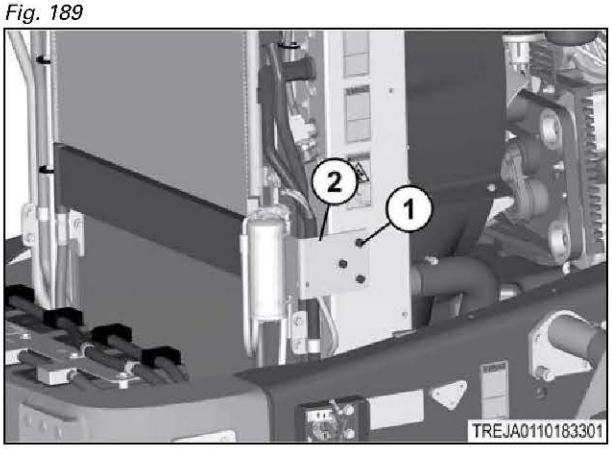


Fig. 190

9. Use the hardware (1) to install the seal, and the top seal bracket (2).

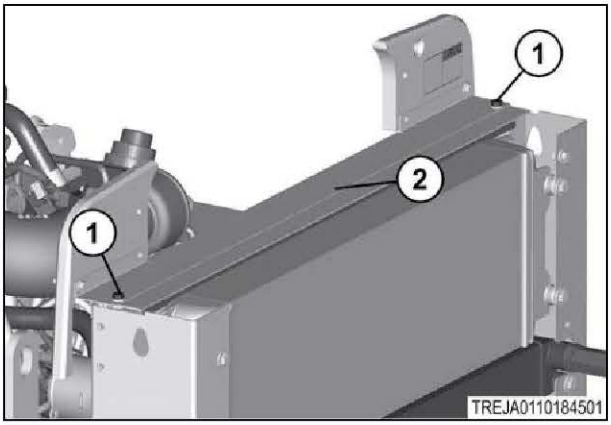


Fig. 191

10. Use the hardware (1) to install the seals, and the two side seal brackets (2).

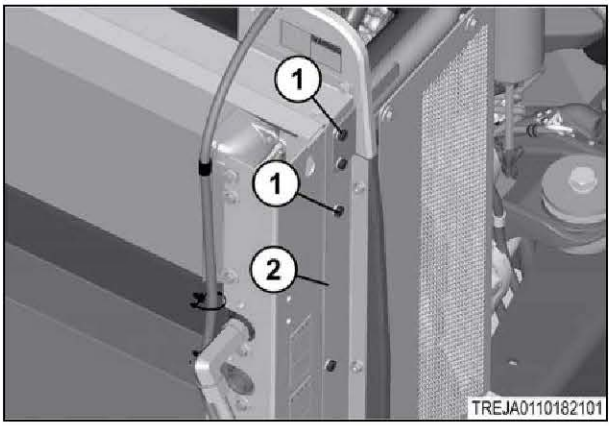


Fig. 192

11. Install the batteries (1).

See the information for installing the batteries.

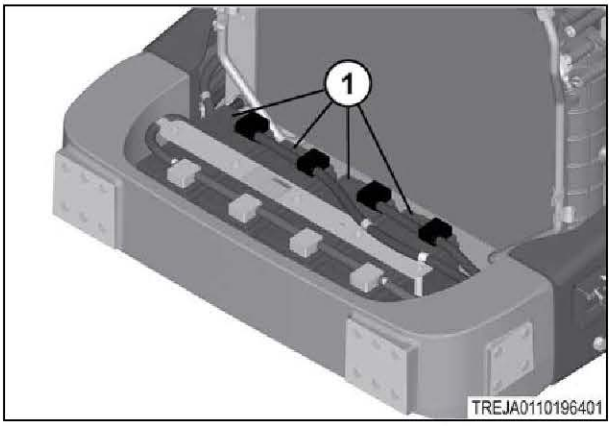


Fig. 193

12. Use the hardware (1) to install the left support bracket (2).

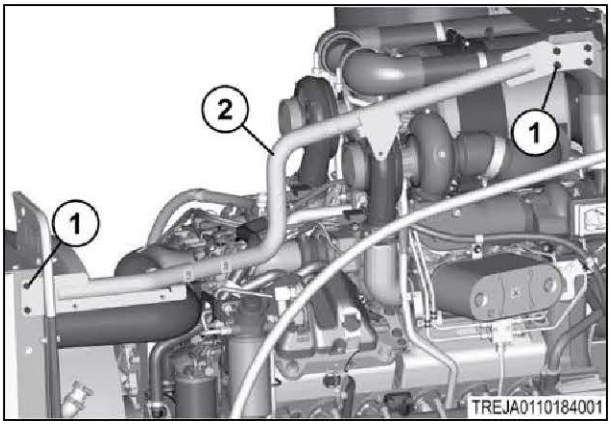


Fig. 194

13. Use the hardware (1) to install the expansion tank (2).

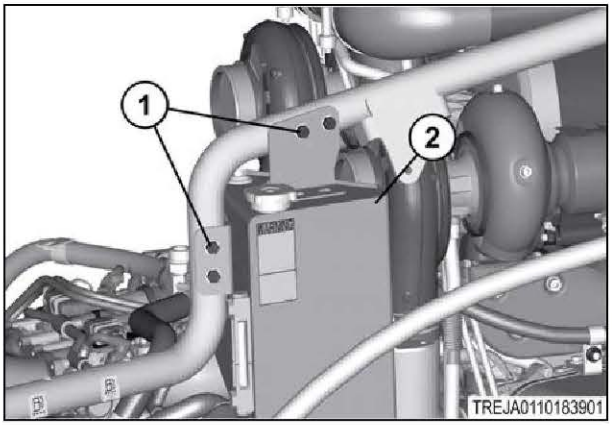


Fig. 195

14. Use the hose clamps (1) to connect the hoses (2) to the expansion tank.

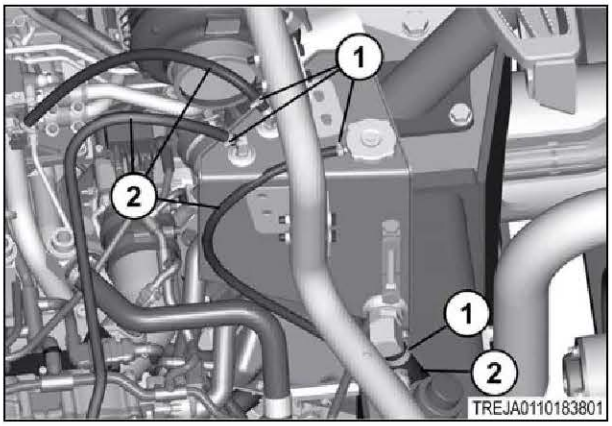


Fig. 196

15. Use the hardware (1) to install the right support bracket (2).

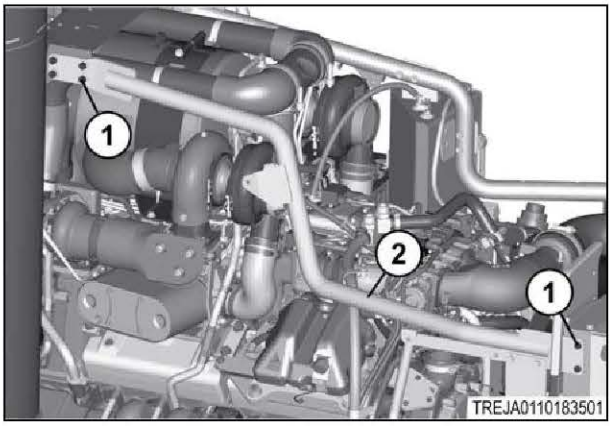


Fig. 197

16. Use the hose clamps (3) to connect the outlet radiator hose (4).

17. Use the hardware (1) to install the hose clamp (2).

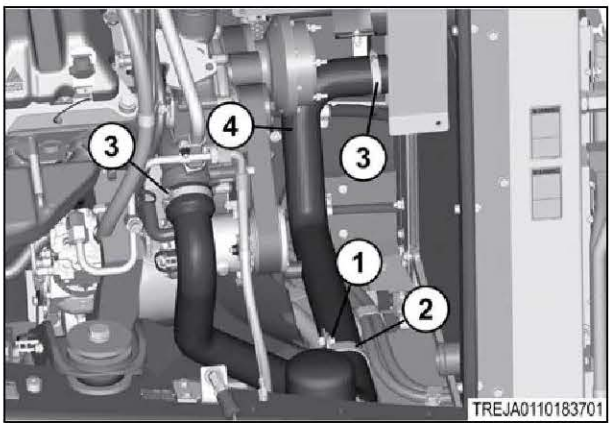


Fig. 198

18. Use the hose clamps (4) to connect the inlet radiator hose (5).

19. Use the hardware (1) to install the bracket (3) and the hose clamp (2).

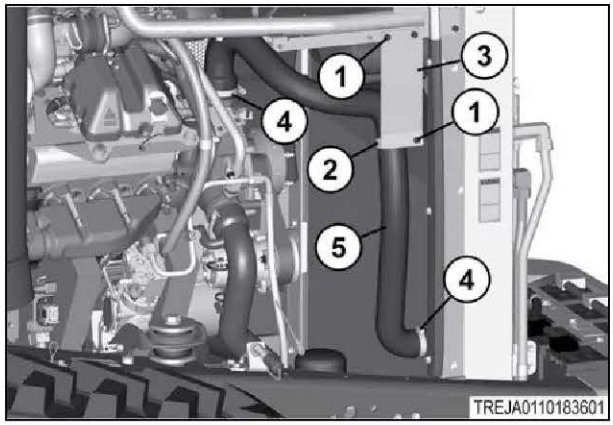


Fig. 199

20. Use the hardware (1) to install the air filter assembly mount (2).

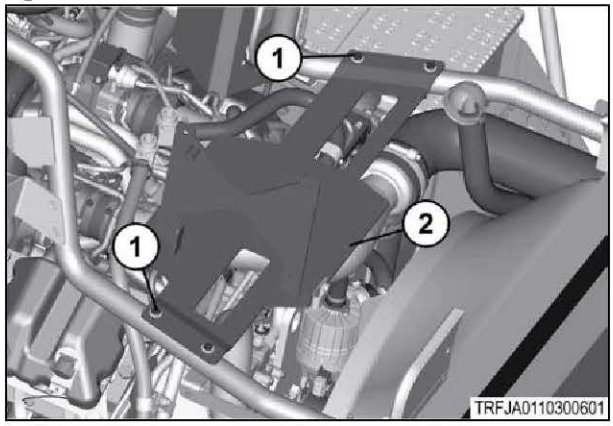


Fig. 200

21. Use the hardware (1), to install the hose clips (2).

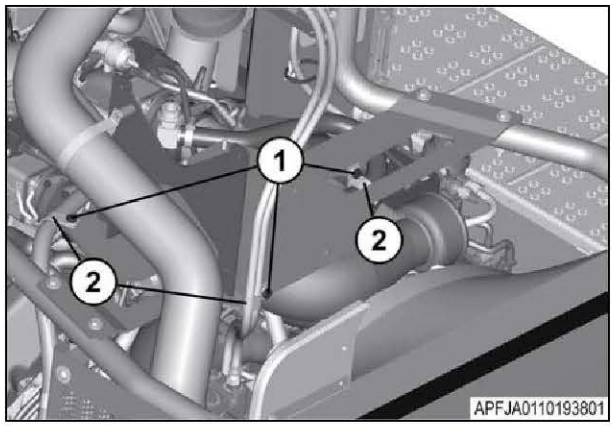


Fig. 201

22. Use the hardware (1) to install the air filter assembly (2).

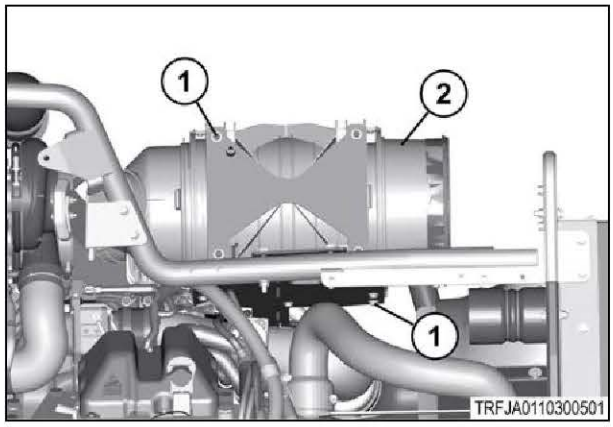


Fig. 202

23. Use the hose clamp (1) to connect the dust ejector tube (2).

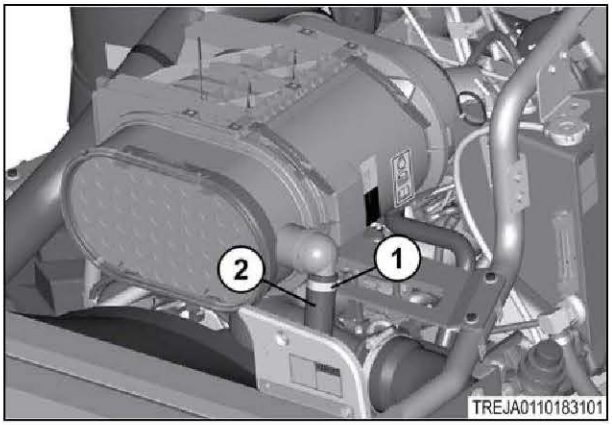


Fig. 203

24. Use the hose clamps (1) to connect the turbocharger inlet tubes (2).

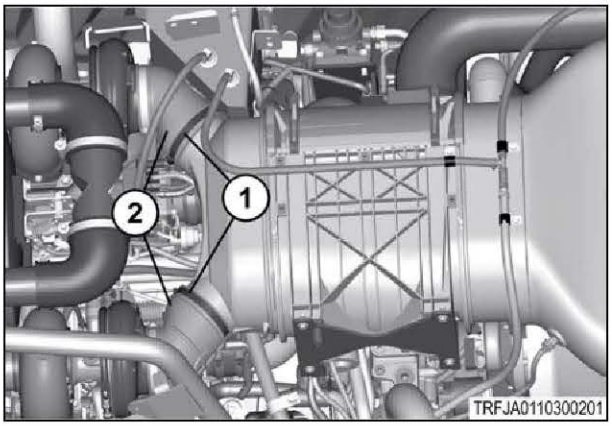


Fig. 204

25. Connect the two wire harnesses (1) to the air filter.

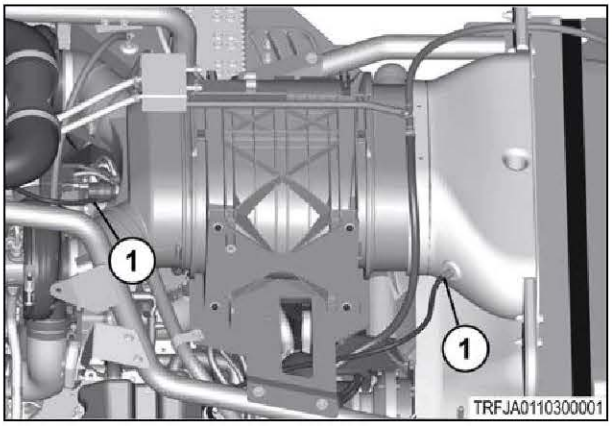


Fig. 205

26. Use the hardware (1), to install the hose clips (2), and the doser expansion tank bracket (3).

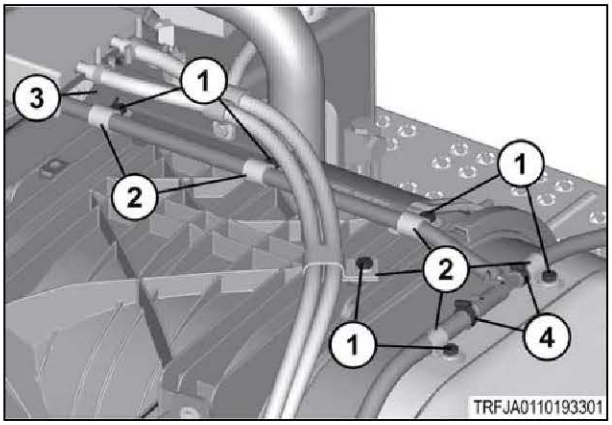


Fig. 206

27. Use the hardware (1) to install the air filter nozzle (2).

28. Use the hardware (3), to install the plastic seals (4).

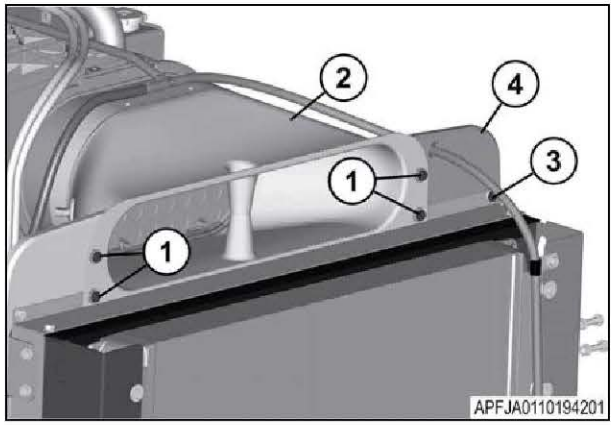


Fig. 207

29. Use the tube clamps (1) to install the right charge air cooler tube (2).

30. Use the hardware (3) to install the clamp (4).

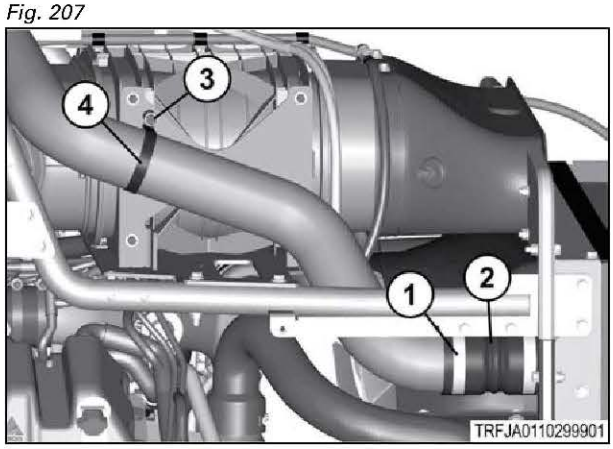


Fig. 208

31. Use the tube clamps (1) to install the left charge air cooler tube (2).

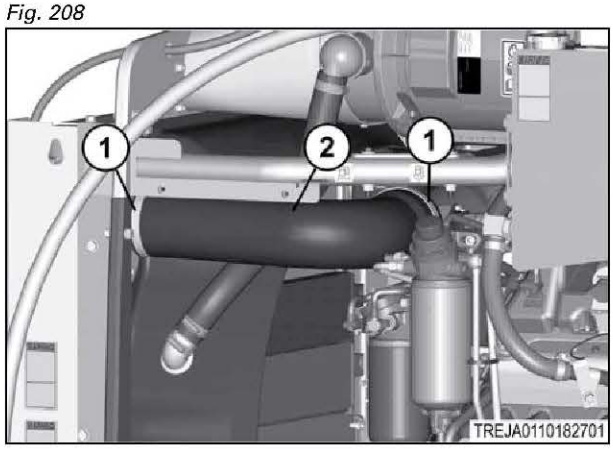


Fig. 209

32. Use the hardware (1) to install the left fan guard (2).

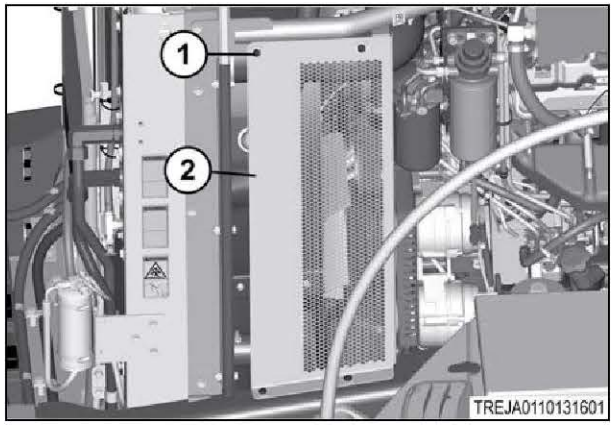


Fig. 210

33. Use the hardware (1, 3) to install the right fan guard (2).

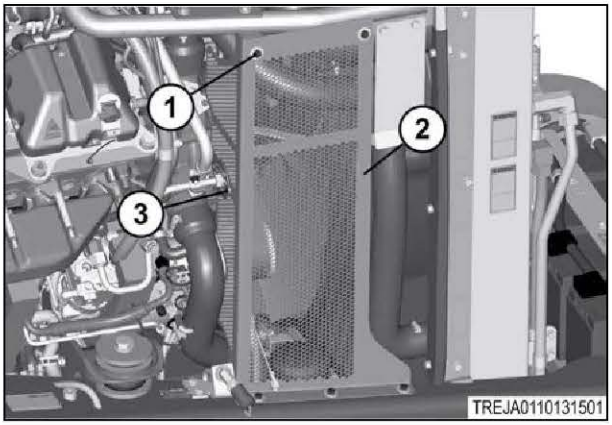


Fig. 211

34. Remove the drain hose and tighten the drain valve (3).

35. Use the hardware (1) to install the cover plate (2).

36. Fill the radiator with the correct type and quantity of engine coolant.

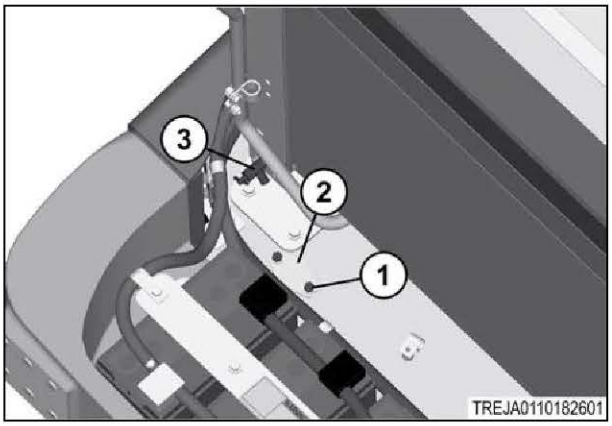


Fig. 212

37. Install the engine cover.

38. Install the battery disconnect switch key.

39. Turn on the battery disconnect switch (1).

Related Links

Install the engine cover (MY2015 and earlier) page 13-16
Fill capacities page 1-18
Coolant quality requirements page 2-239
Install the batteries page 10-23
Refill the cooling system page 2-149

2.2.13 Remove the transmission cooler

Before starting the procedure

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.

WARNING: Pressurized gases or fluids can be hazards.

Personal injury can result.

Relieve the pressure from the system or component before disconnecting components.

NOTE: *Before removal, put identification tags on the components for correct installation at assembly. Put covers and plugs on all hoses, fittings, and ports to prevent contamination from the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all parts to keep contamination from the system. Contamination can damage the precision parts. Complete the disassembly steps on a clean surface. Put clean material on top of the parts.*

NOTE: *Use only certified technicians and equipment to service the air conditioning system.*

NOTE: *When opening the air conditioning system, replace the receiver-dryer. See the information for removing/installing the receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn off the battery disconnect switch.
4. Remove the battery disconnect switch key.
5. Remove the engine cover.
6. Remove the hardware (1) and the cover plate (2).
7. Install a hose to the radiator drain valve (3) and put through the access hole.
8. Set a correct container under the radiator drain hose.
9. Loosen the radiator drain valve (3) and drain the engine coolant.

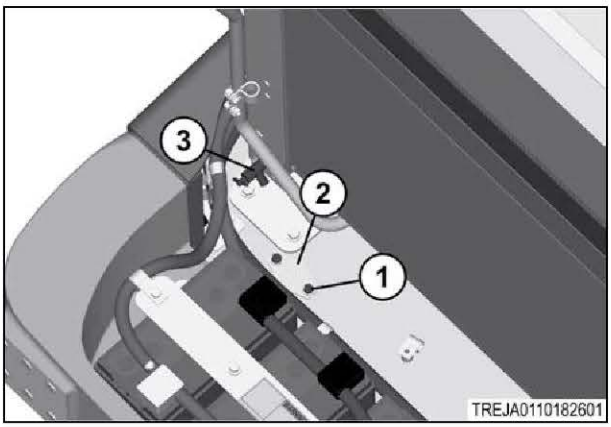


Fig. 213

10. Remove the hardware (1, 3) and the right fan guard (2).

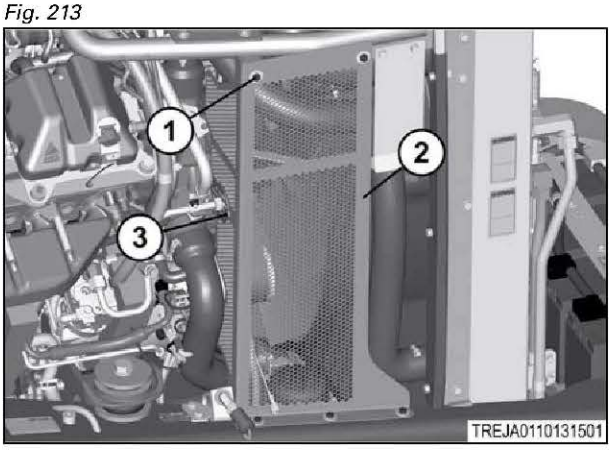


Fig. 214

11. Remove the hardware (1) and the left fan guard (2).

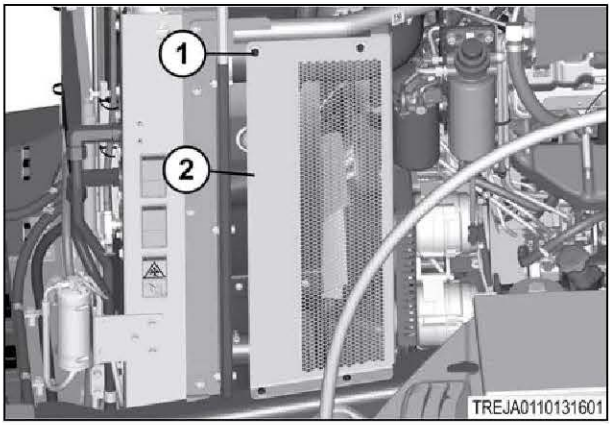


Fig. 215

12. Loosen the hose clamps (1) and disconnect the left charge air cooler hose (2).

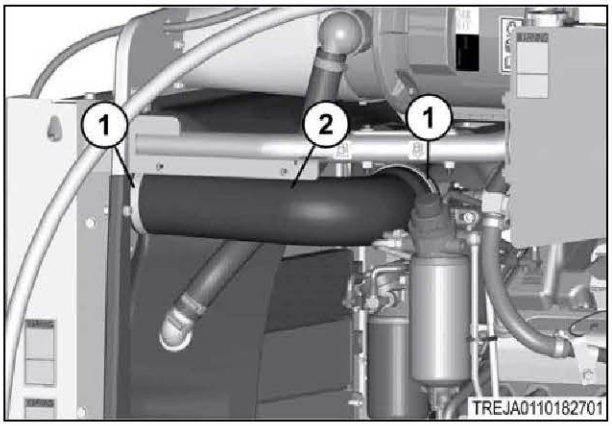


Fig. 216

13. Loosen the hose clamp (1) and disconnect the right charge air cooler hose (2).

14. Remove the hardware (3) and the hose clamp (4).

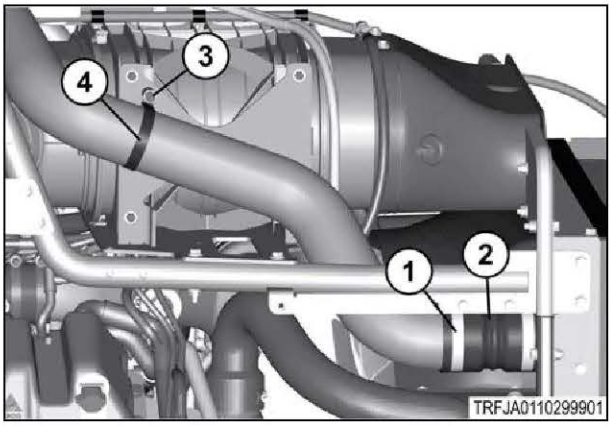


Fig. 217

15. Disconnect the two wire harnesses (1) from the air filter assembly.

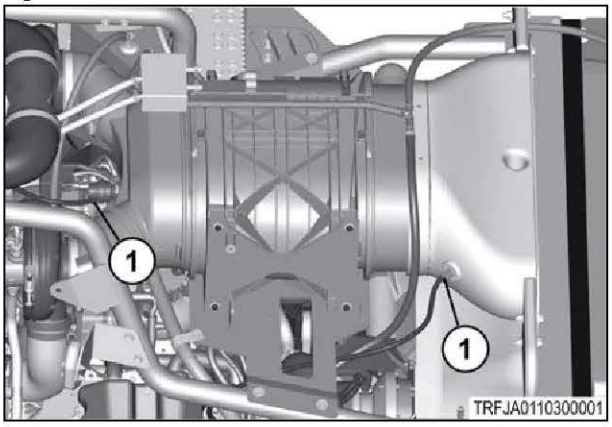


Fig. 218

16. Loosen the hose clamps (1) and disconnect the turbocharger inlet tubes (2).

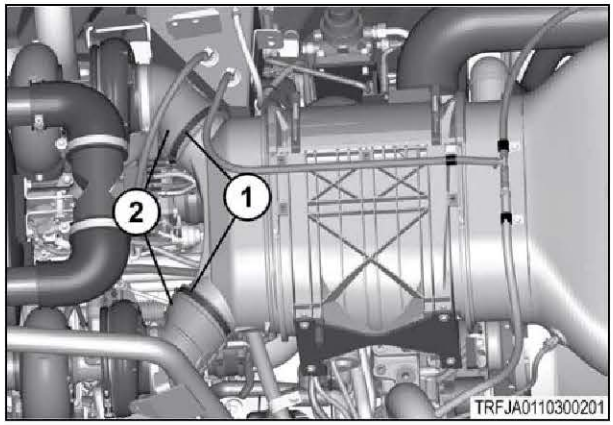


Fig. 219

17. Loosen the two hose clamps (1) and disconnect the two hoses (2).

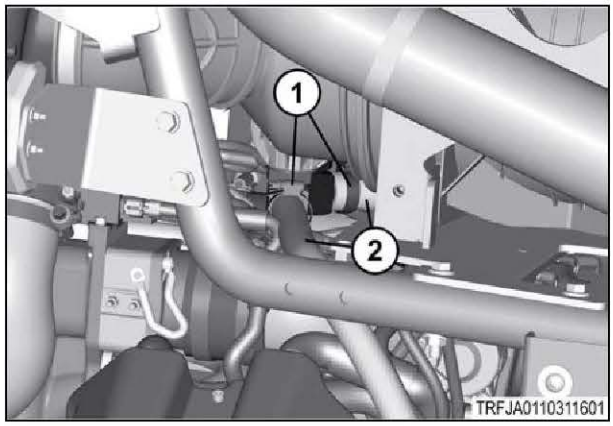


Fig. 220

18. Remove the hardware (1), the hose clips (2), and the doser expansion tank bracket (3).

19. Loosen the two hose clamps (4), and disconnect the two hoses.

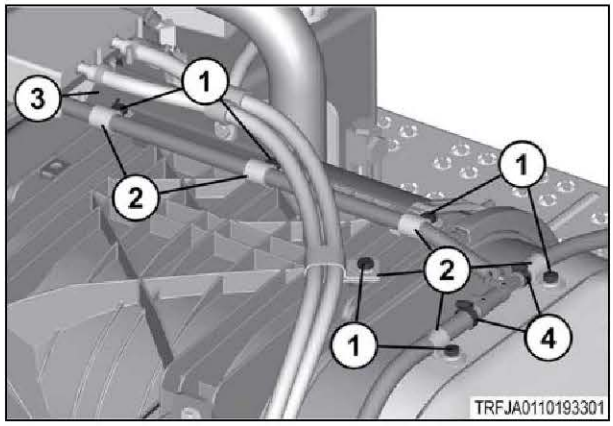


Fig. 221

20. Remove the hardware (1), and the air filter nozzle (2).

21. Remove the hardware (3), and the plastic seals (4).

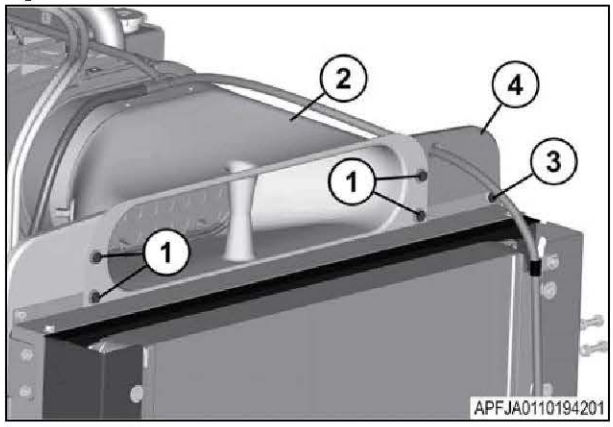


Fig. 222

22. Loosen the hose clamp (1) and disconnect the dust ejector tube (2).

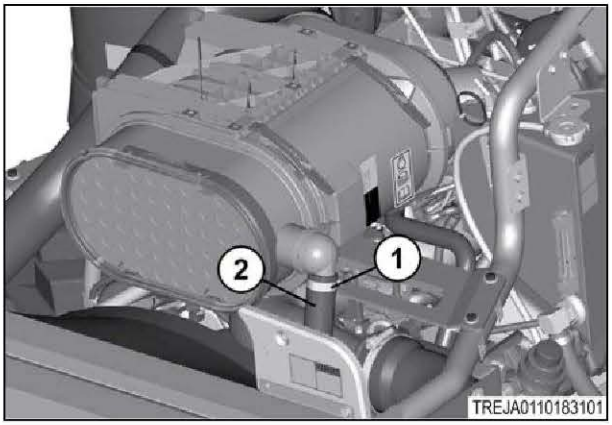


Fig. 223

23. Remove the hardware (1) and the air filter assembly (2).

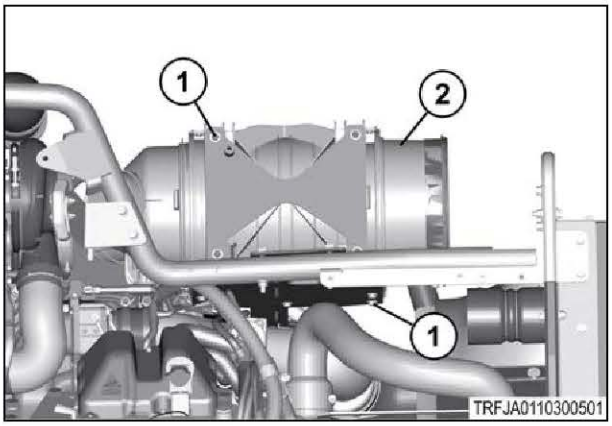


Fig. 224

24. Remove the hardware (1), and the hose clips (2).

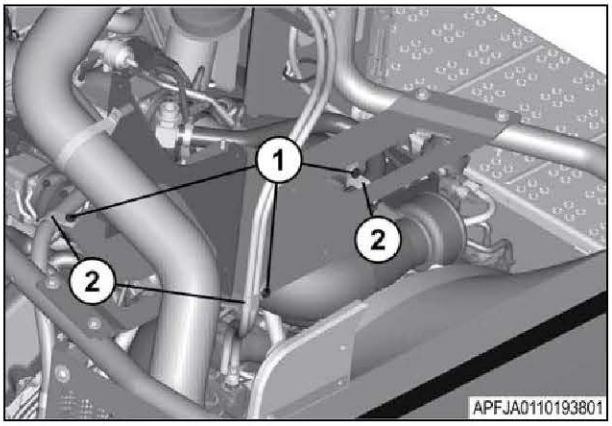


Fig. 225

25. Remove the hardware (1) and the air filter bracket (2).

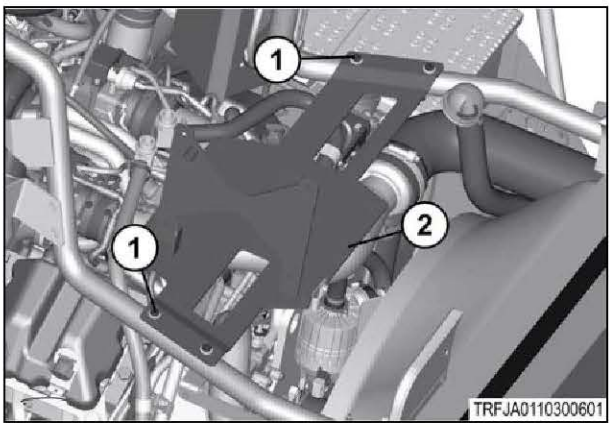


Fig. 226

26. Remove the hardware (1), the hose clamp (2), and the bracket (3).

27. Loosen the hose clamps (4) and disconnect the inlet radiator hose (5).

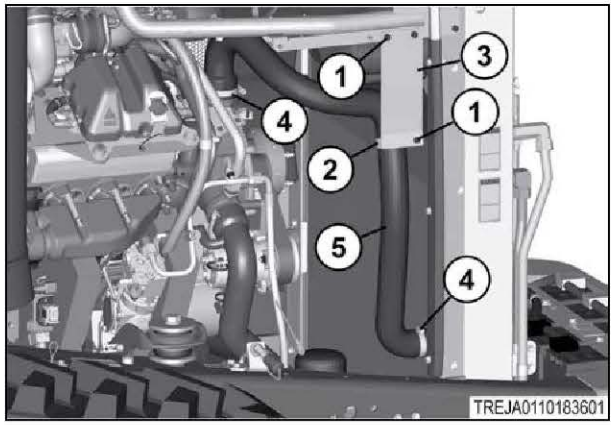


Fig. 227

28. Remove the hardware (1) and the hose clamp (2).

29. Loosen the hose clamps (3) and disconnect the outlet radiator hose (4).

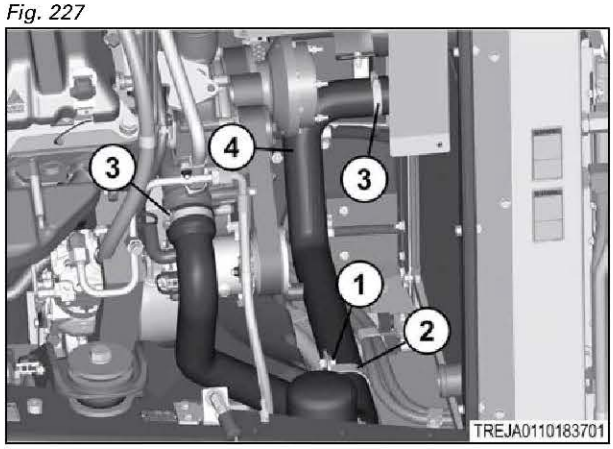


Fig. 228

30. Remove the hardware (1) and the right support bracket (2).

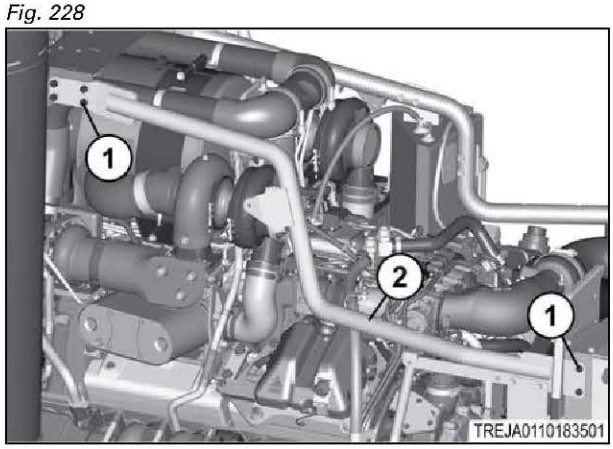


Fig. 229

31. Loosen the hose clamps (1) and disconnect the hoses (2) from the expansion tank.

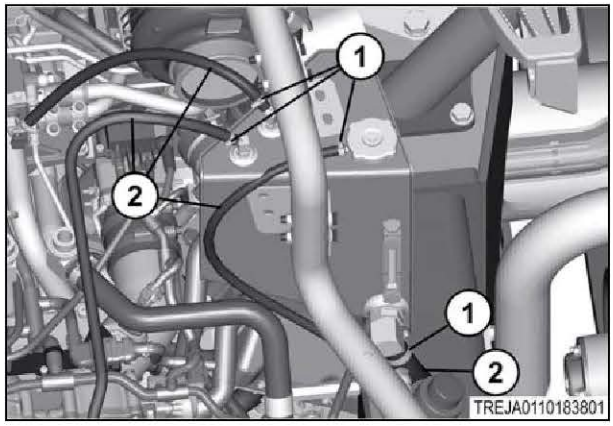


Fig. 230

32. Remove the hardware (1) and the expansion tank (2).

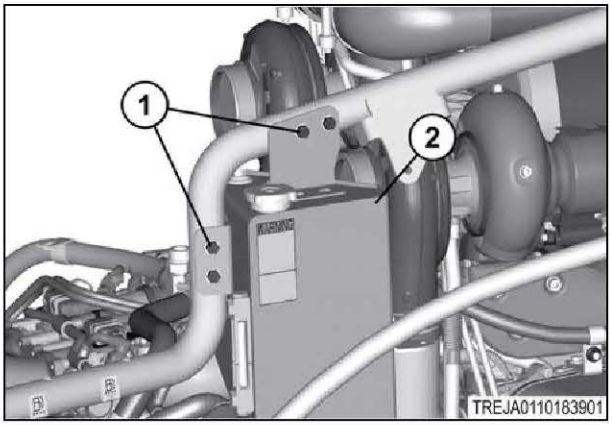


Fig. 231

33. Remove the hardware (1) and the left support bracket (2).

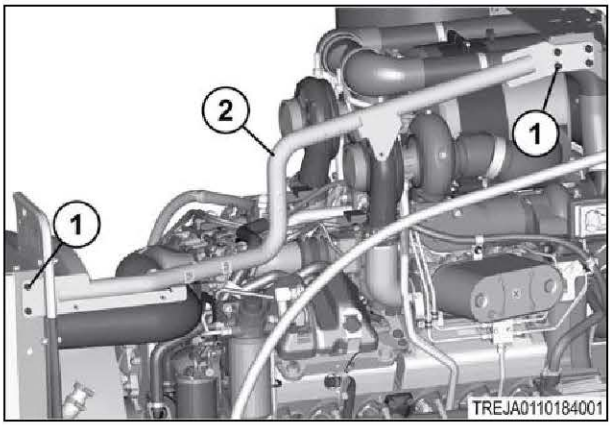


Fig. 232

34. Remove the batteries (1).

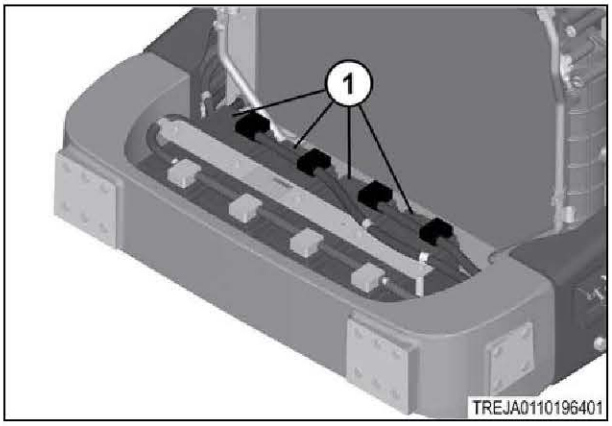


Fig. 233

35. Remove the hardware (1) and the two side seal brackets (2) with seals.

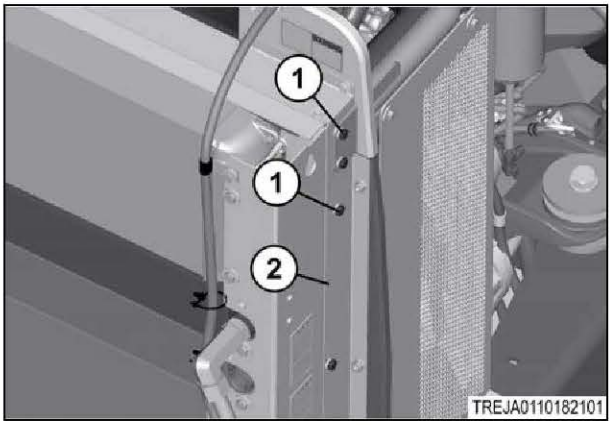


Fig. 234

36. Remove the hardware (1) and the top seal bracket (2) with seal.

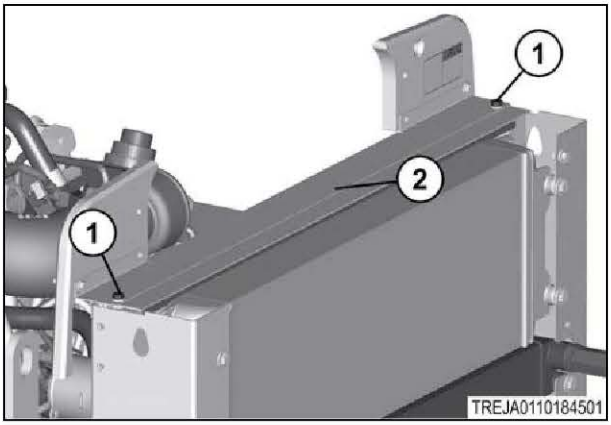


Fig. 235

37. Remove the hardware (1) and the air conditioning receiver-dryer bracket (2).

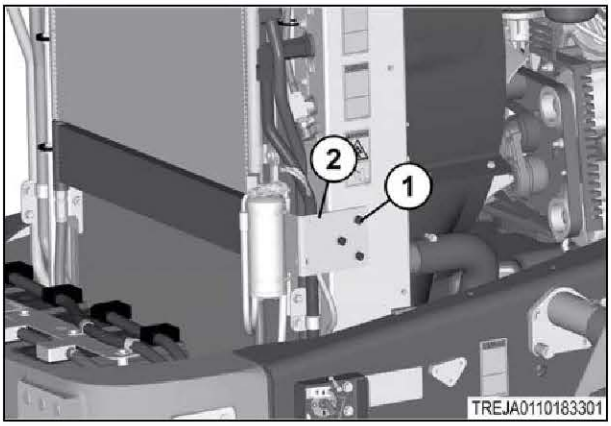


Fig. 236

38. Remove the hardware (2) and put the air conditioning condenser/fuel cooler assembly (3) to the side.

39. Disconnect the hydraulic hoses (1).

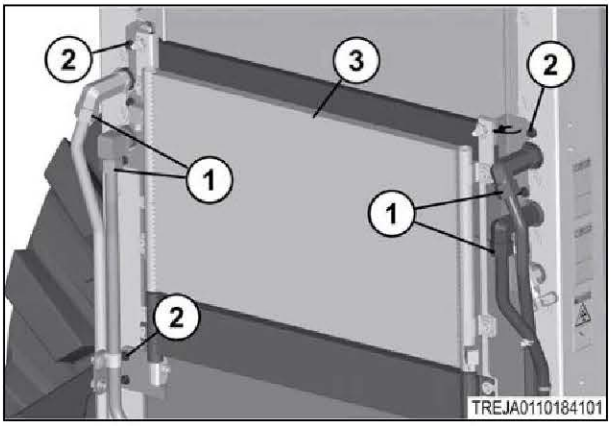


Fig. 237

40. Remove the hardware (1) and the fan shroud (2).

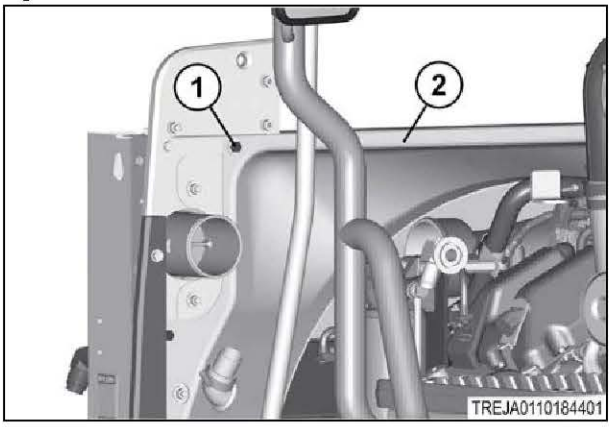


Fig. 238

41. Connect the correct lift equipment (1) to the cooling package.

IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

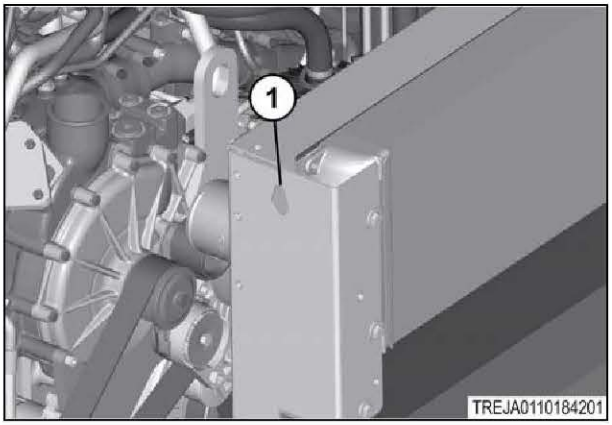


Fig. 239

42. Remove the hardware (1) and the cooling package (2).

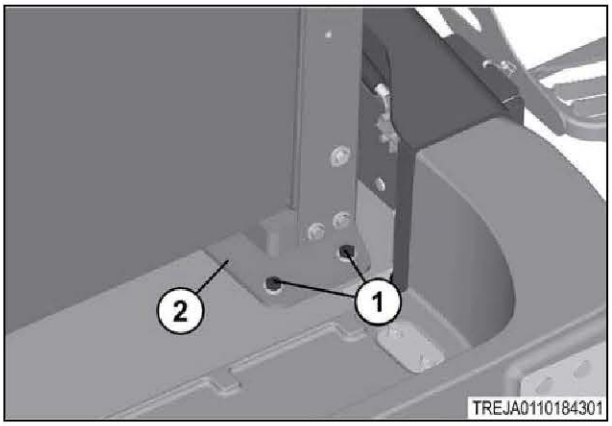


Fig. 240

43. Remove the hardware (1) and the bottom and top cross members (2).

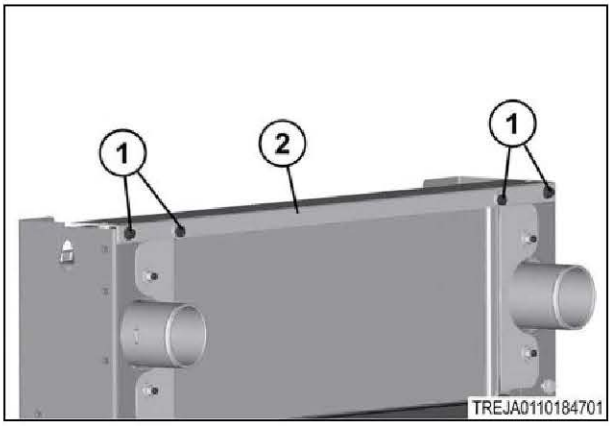


Fig. 241

44. Remove the hardware (1) and the two side channels (2).

45. Remove the transmission cooler (3) and seals.

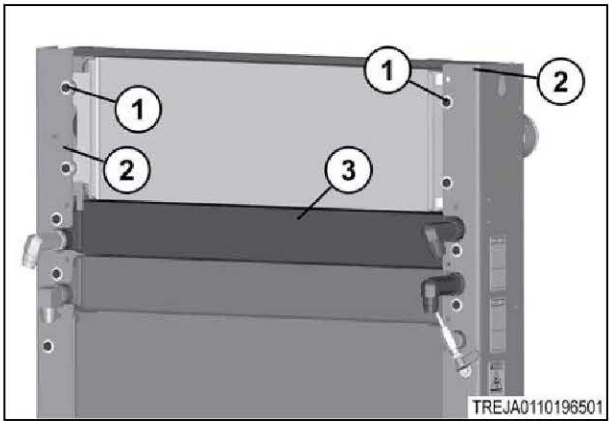


Fig. 242

Related Links

Remove the engine cover page 13-3
Remove the batteries page 10-22

2.2.14 Install the transmission cooler

Procedure

1. Use the hardware (1), to install the foam seals and the transmission cooler (3), to the two side channels (2).

   NOTE: *Make sure the foam seals are in the correct location. Replace if worn.*

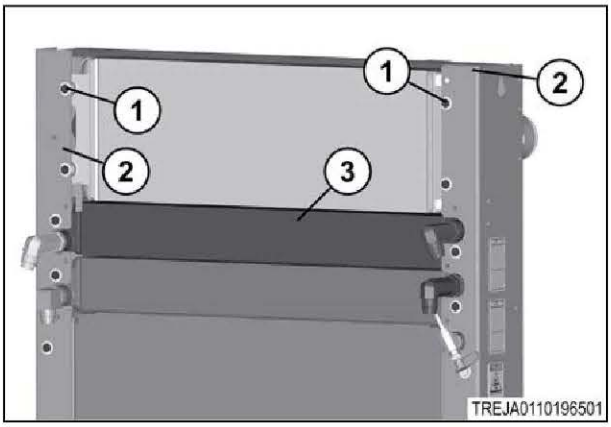


Fig. 243

2. Use the hardware (1) to install the bottom and the top cross members (2).

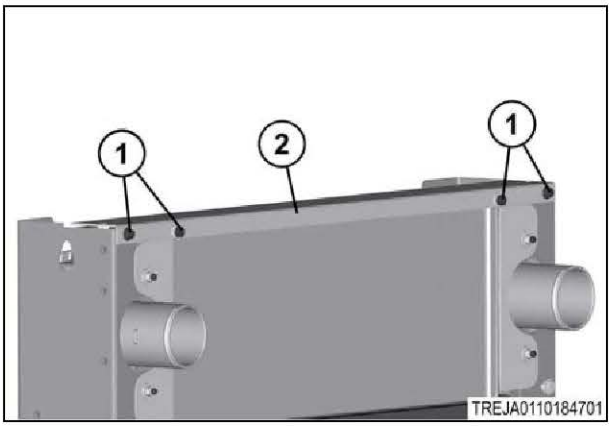


Fig. 244

3. Attach the correct lift equipment (1) to the cooling package.

   IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

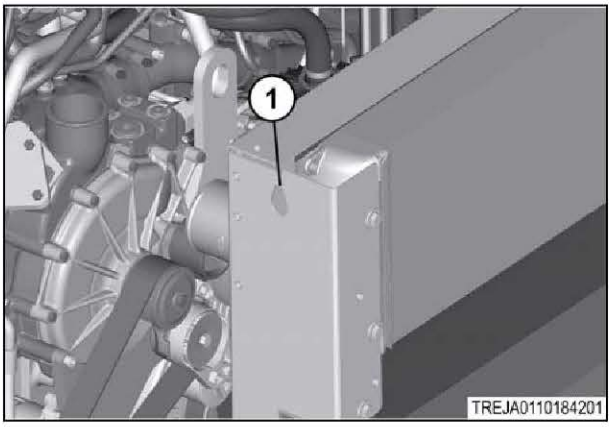


Fig. 245

4. Use the hardware (1) to install the cooling package (2).

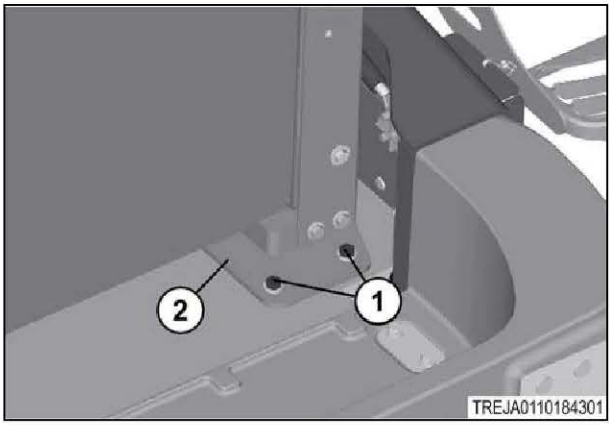


Fig. 246

5. Use the hardware (1) to install the fan shroud (2).

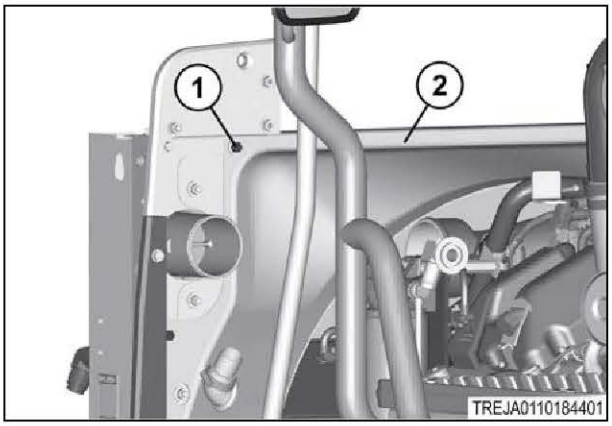


Fig. 247

6. Use the hardware (2) to install the air conditioning condenser/fuel cooler assembly (3).

7. Connect the hydraulic hoses (1).

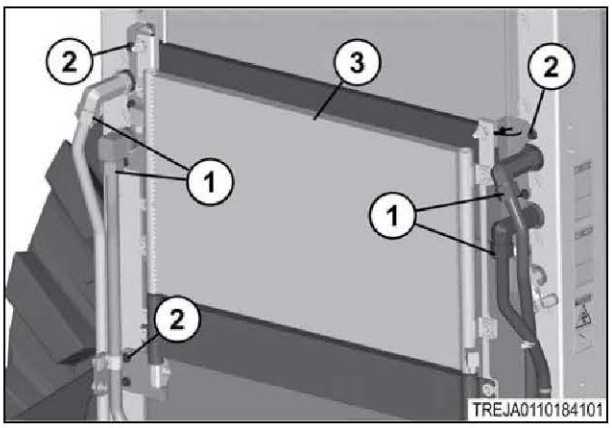


Fig. 248

8. Use the hardware (1) to install the air conditioning receiver-dryer bracket (2).

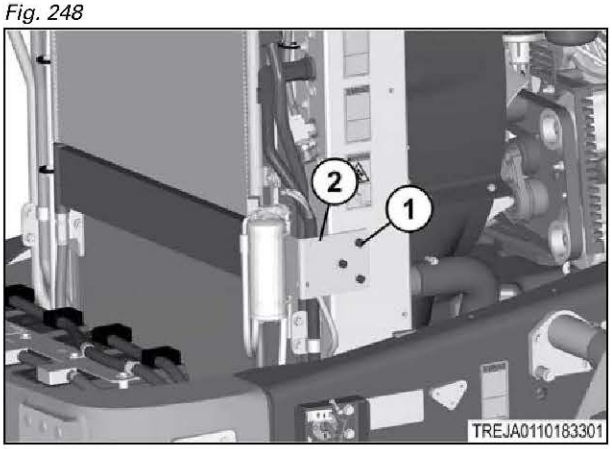


Fig. 249

9. Use the hardware (1) to install the seal, and the top seal bracket (2).

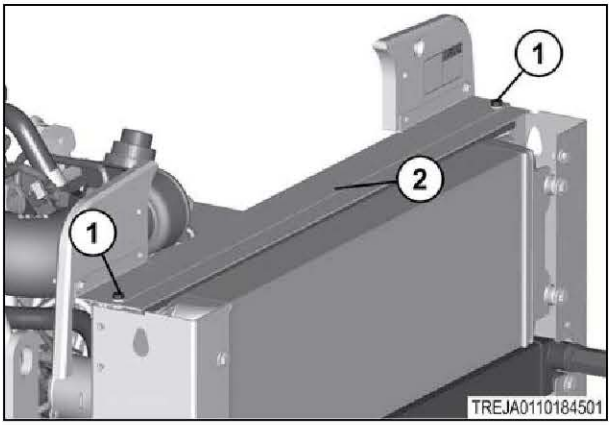


Fig. 250

10. Use the hardware (1) to install the seals, and the two side seal brackets (2).

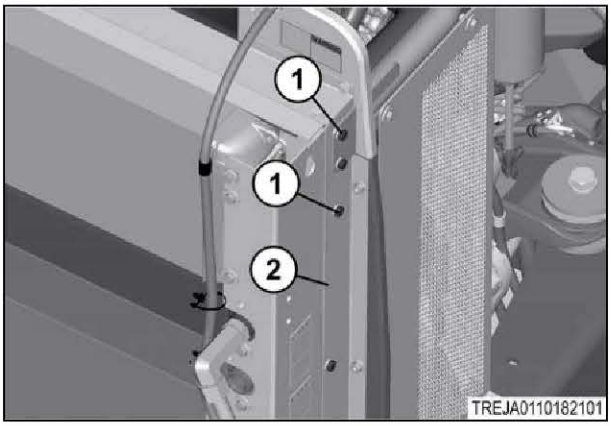


Fig. 251

11. Install the batteries (1).

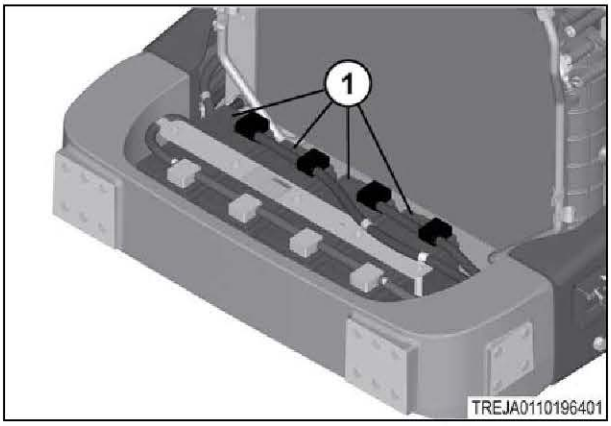


Fig. 252

12. Use the hardware (1) to install the left support bracket (2).

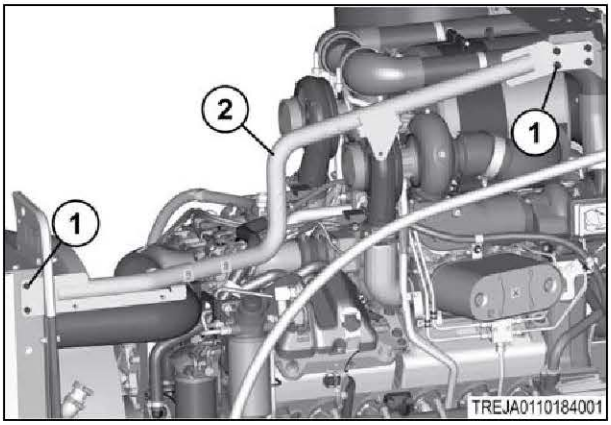


Fig. 253

13. Use the hardware (1) to install the expansion tank (2).

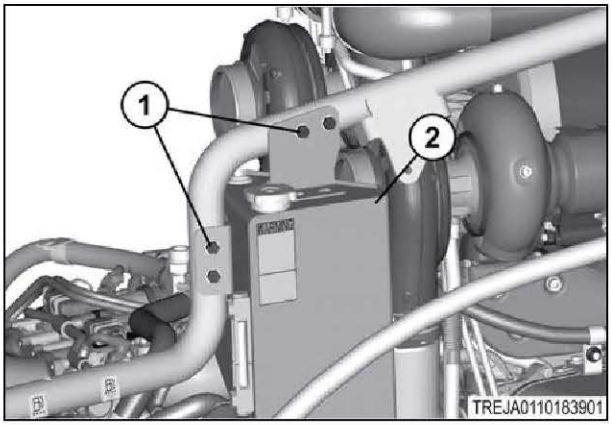


Fig. 254

14. Use the hose clamps (1) to connect the hoses (2) to the expansion tank.

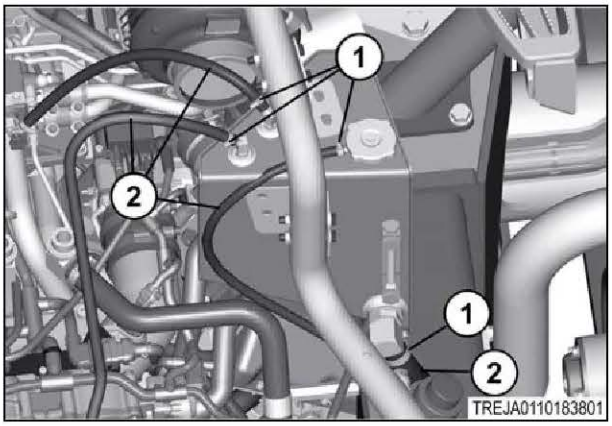


Fig. 255

15. Use the hardware (1) to install the right support bracket (2).

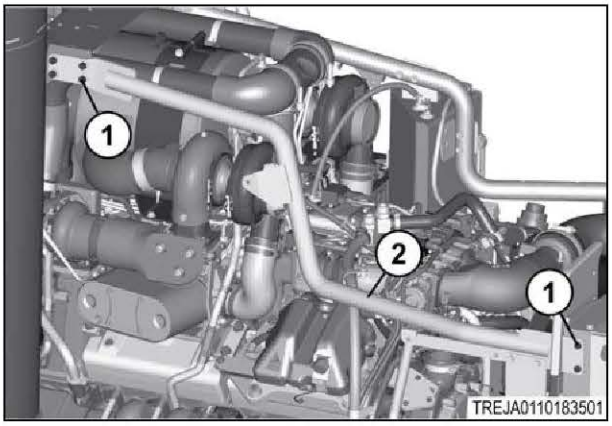


Fig. 256

16. Use the hose clamps (3) to connect the outlet radiator hose (4).

17. Use the hardware (1) to install the hose clamp (2).

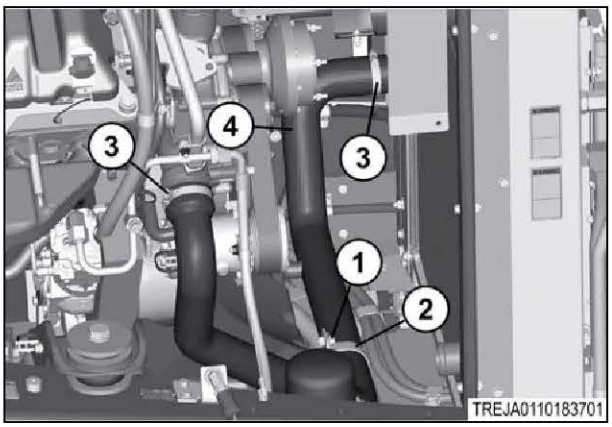


Fig. 257

18. Use the hose clamps (4) to connect the inlet radiator hose (5).

19. Use the hardware (1) to install the bracket (3) and the hose clamp (2).

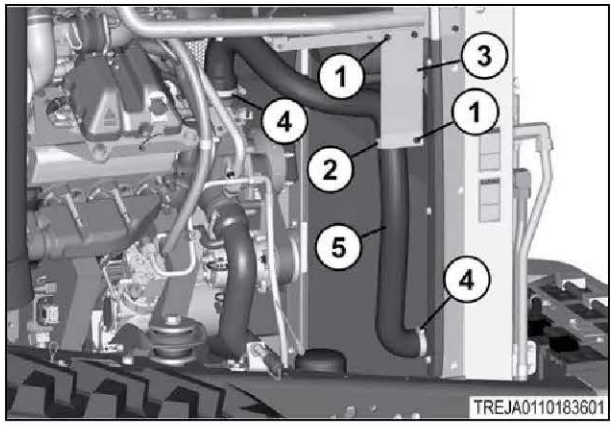


Fig. 258

20. Use the hardware (1) to install the air filter assembly mount (2).

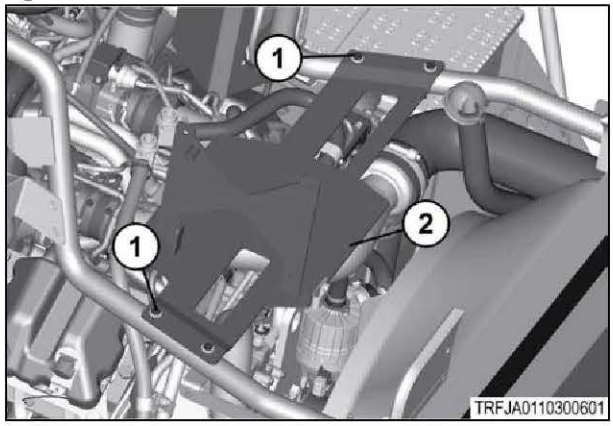


Fig. 259

21. Use the hardware (1), to install the hose clips (2).

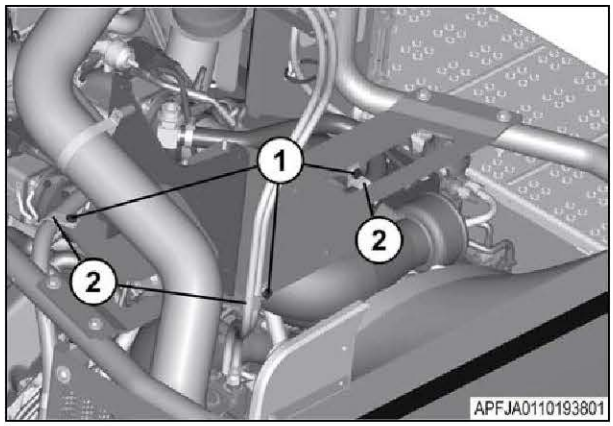


Fig. 260

22. Use the hardware (1) to install the air filter assembly (2).

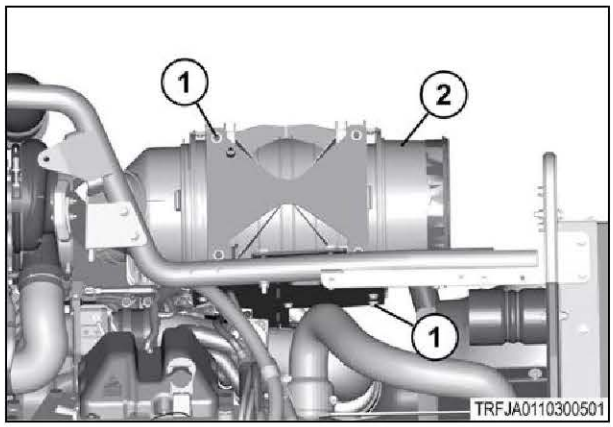


Fig. 261

23. Use the hose clamp (1) to connect the dust ejector tube (2).

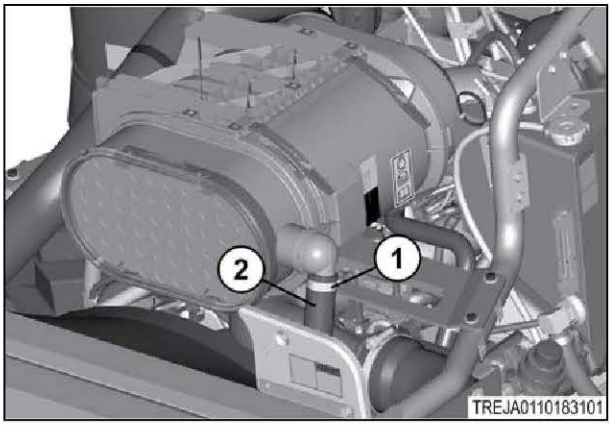


Fig. 262

24. Use the hose clamps (1) to connect the turbocharger inlet tubes (2).

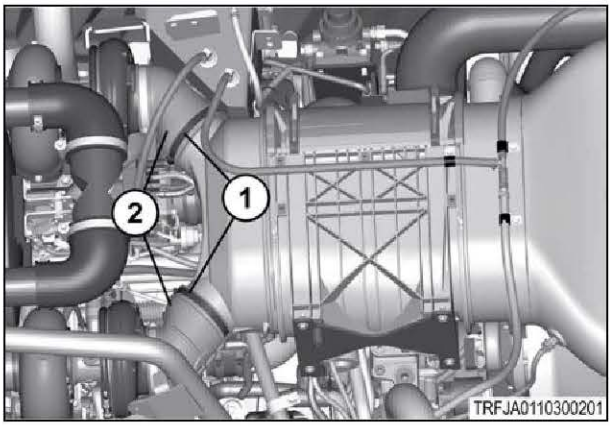


Fig. 263

25. Connect the two wire harnesses (1) to the air filter.

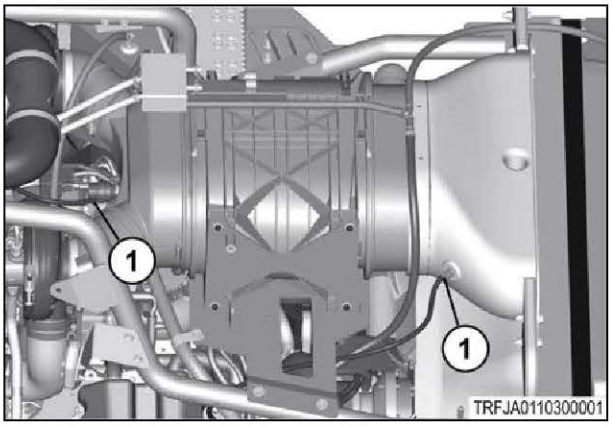


Fig. 264

26. Use the hardware (1), to install the hose clips (2), and the doser expansion tank bracket (3).

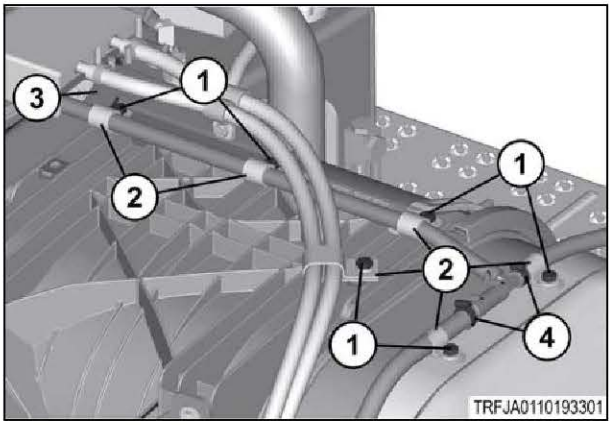


Fig. 265

27. Use the hardware (1) to install the air filter nozzle (2).

28. Use the hardware (3), to install the plastic seals (4).

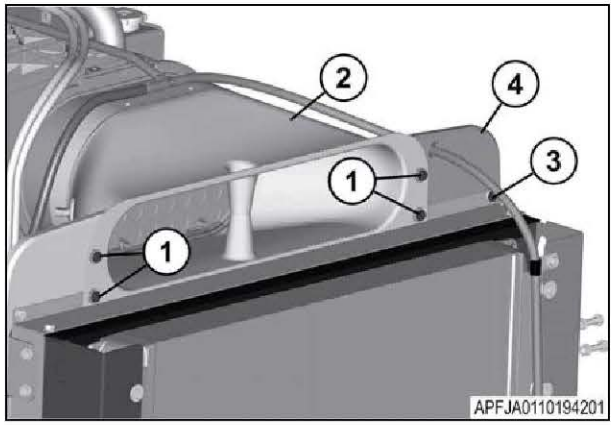


Fig. 266

29. Use the tube clamps (1) to install the right charge air cooler tube (2).

30. Use the hardware (3) to install the clamp (4).

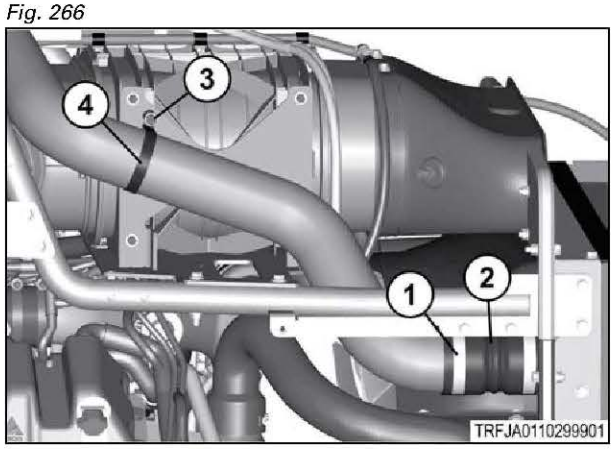


Fig. 267

31. Use the tube clamps (1) to install the left charge air cooler tube (2).

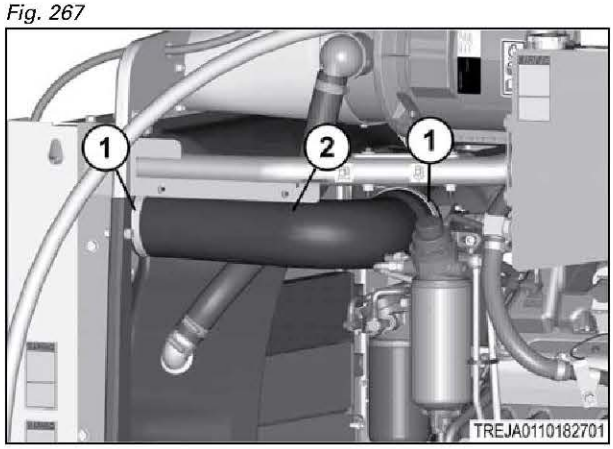


Fig. 268

32. Use the hardware (1) to install the left fan guard (2).

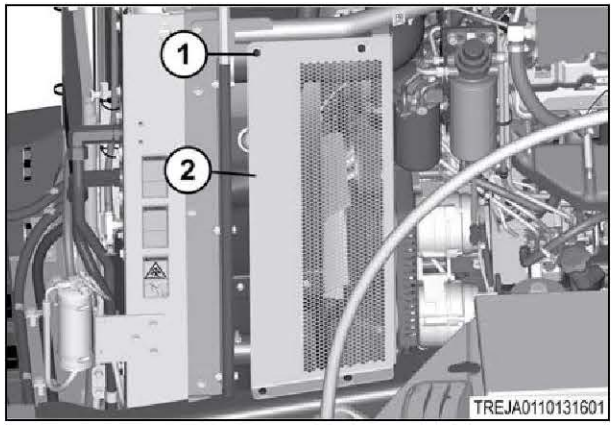


Fig. 269

33. Use the hardware (1, 3) to install the right fan guard (2).

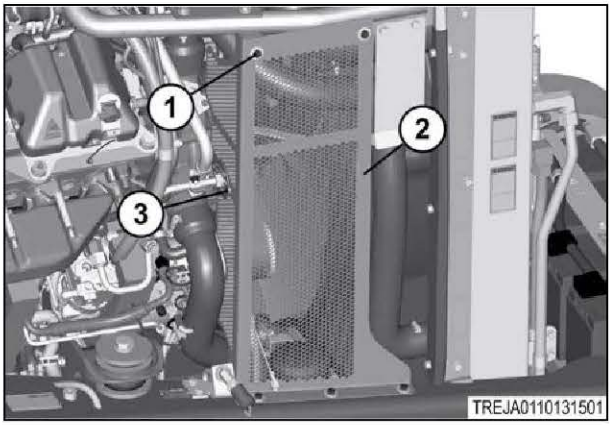


Fig. 270

34. Remove the drain hose and tighten the drain valve (3).

35. Use the hardware (1), to install the cover plate (2).

36. Fill the radiator with the correct type and quantity of engine coolant.

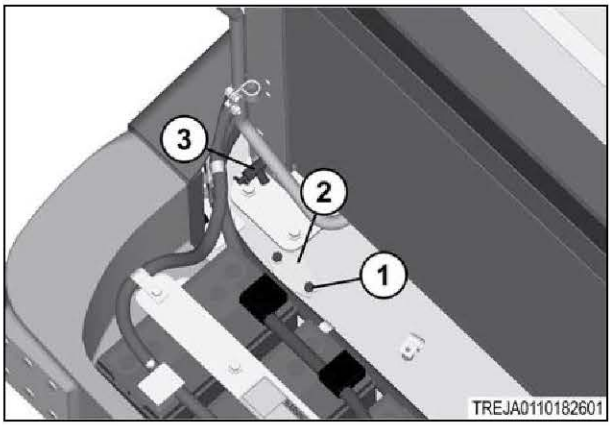


Fig. 271

37. Install the engine cover.

38. Install the battery disconnect switch key.

39. Turn on the battery disconnect switch.

Related Links

Install the engine cover (MY2015 and earlier) page 13-16
Fill capacities page 1-18
Coolant quality requirements page 2-239
Install the batteries page 10-23
Refill the cooling system page 2-149

2.2.15 Remove the air conditioning condenser

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.

NOTE:
Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.

NOTE:
Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.

NOTE:
Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.

NOTE:
Use only certified technicians and equipment to service the air conditioning systems.

NOTE:
When opening the air conditioning system, replace the air conditioning receiver-dryer. See the information for removing/installing the air conditioning receiver-dryer.

Procedure

1. Park the machine on a solid level surface. Stop the engine, apply the parking brake, and take the key with you.

2. Turn the battery disconnect switch key (1) counterclockwise to disconnect the battery power.

   NOTE:
   The battery disconnect switch is shown in the off position.

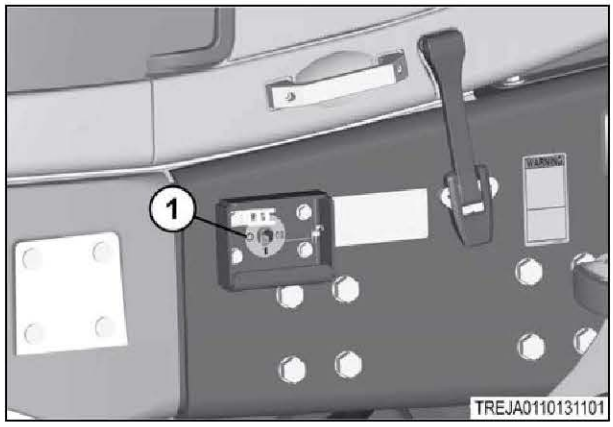


Fig. 272

3. Remove the battery disconnect switch key (1).

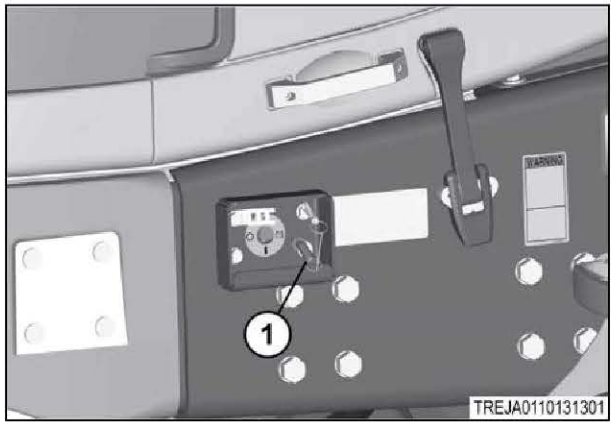


Fig. 273

4. **CAUTION:**
Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

Release the two latches (1) and open the engine cover (2) all the way.

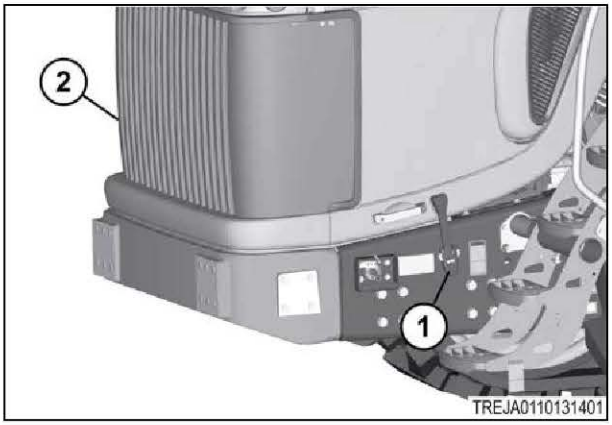


Fig. 274

5. Disconnect the two air conditioning condenser hoses (1).

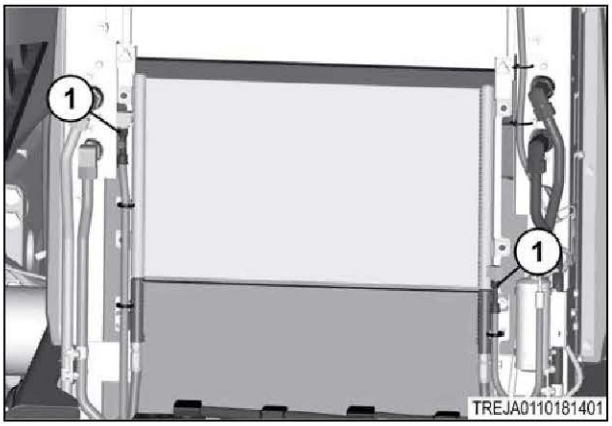


Fig. 275

6. Remove the hardware (1) and the air conditioning condenser (2).

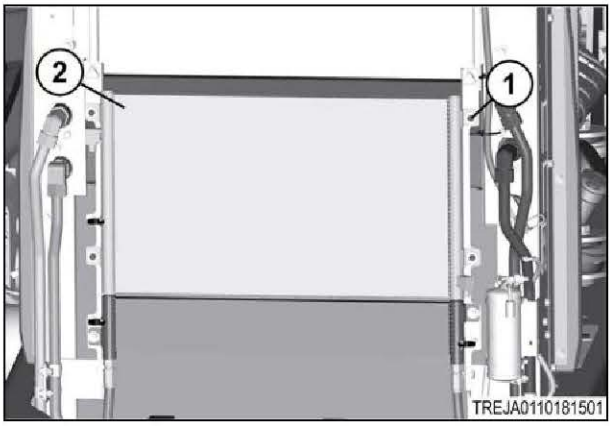


Fig. 276

2.2.16 Install the air conditioning condenser

Procedure

1. Install the air conditioning condenser (2) with the hardware (1).

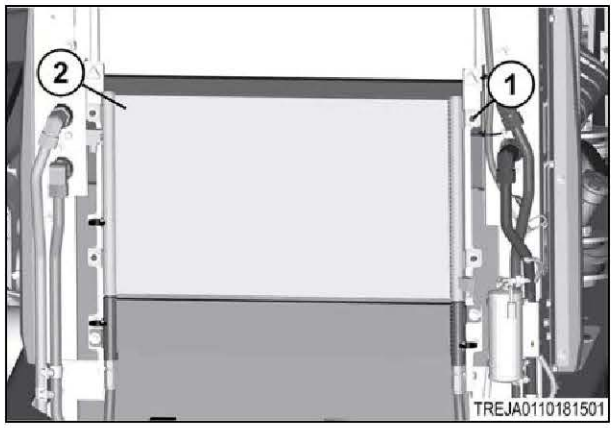


Fig. 277

2. Connect the two air conditioning condenser hoses (1) to the fuel cooler.

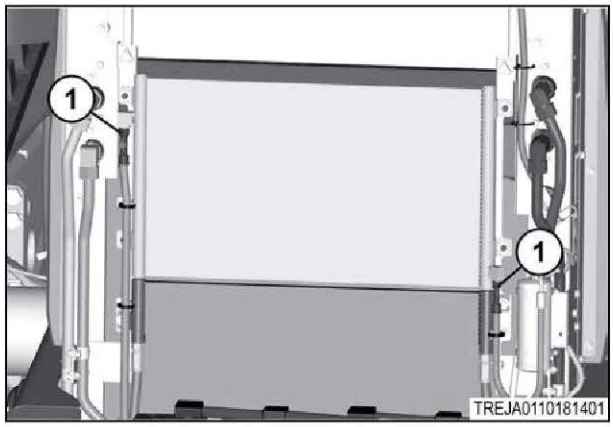


Fig. 278

3. Close the engine cover (2) and connect the two latches (1).

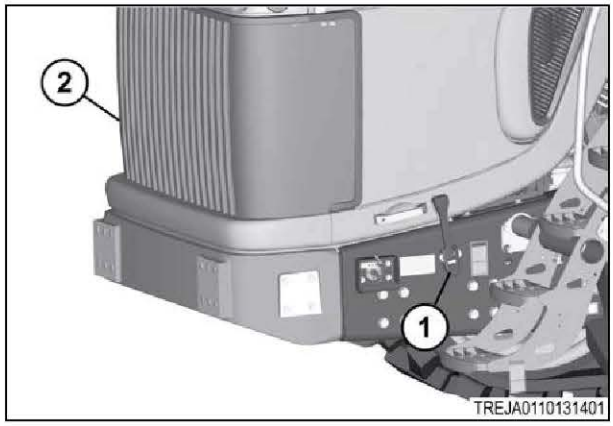


Fig. 279

4. Install the battery disconnect switch key (1).

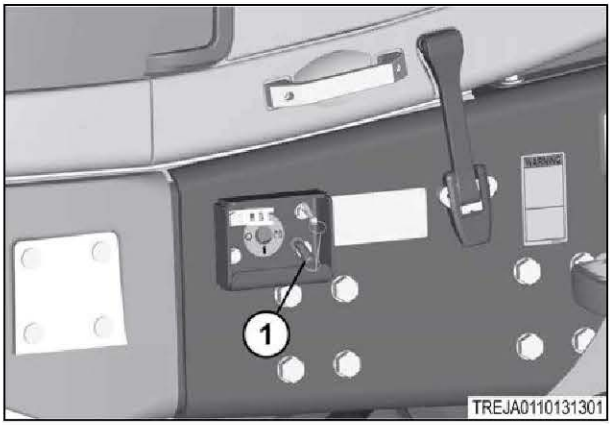


Fig. 280

5. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

   NOTE:
   The battery disconnect switch is shown in the on position.

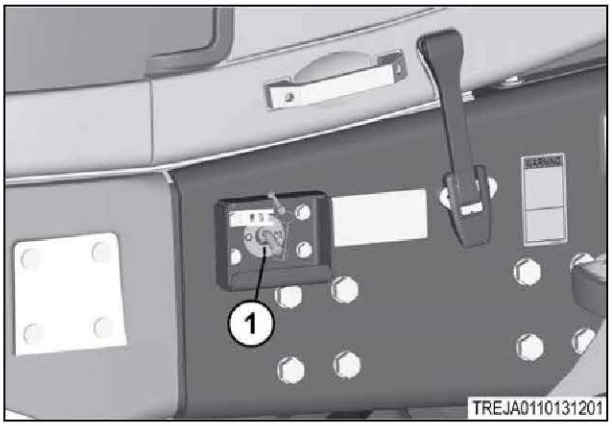


Fig. 281

2.2.17 Remove the fuel cooler

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

NOTE: *Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn off the battery disconnect switch.
4. Remove the battery disconnect switch key.
5. Release the two latches (1), open the engine cover (2) all the way and connect the engine cover support arm.

CAUTION:
Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

6. Close the fuel valve (1).

NOTE: *The valve is shown in the open position.*

7. Clamp off the fuel return hose.

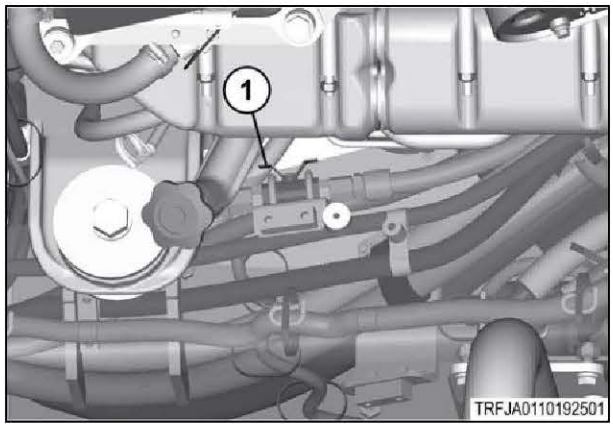


Fig. 282

8. Disconnect the two fuel hoses (1).

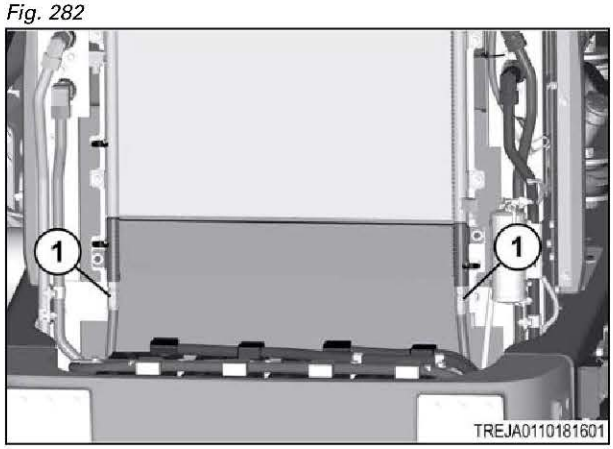


Fig. 283

9. Remove the hardware (1) and the fuel cooler (2).

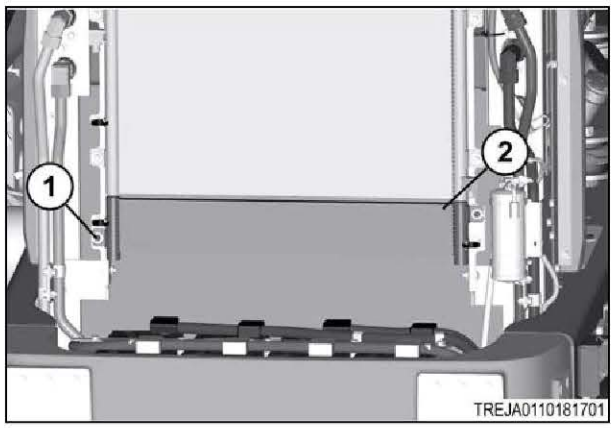


Fig. 284

2.2.18 Install the fuel cooler

Procedure

1. Use the hardware (1), to install the fuel cooler (2).

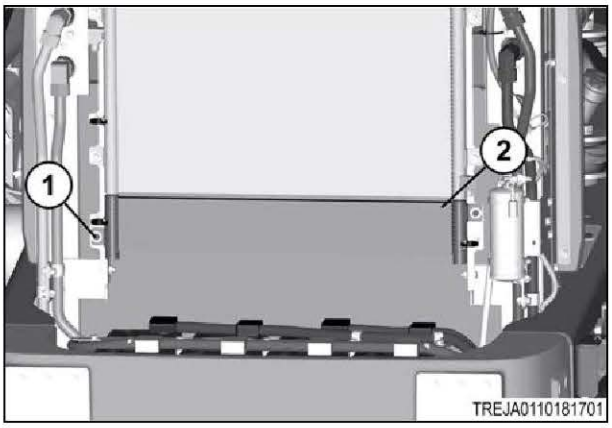


Fig. 285

2. Connect the two fuel hoses (1).
3. Remove the clamp from the fuel return hose.

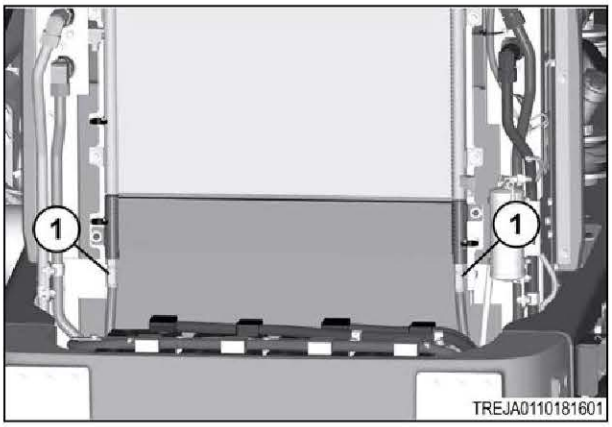


Fig. 286

4. Open the fuel valve (1).

   NOTE: *The fuel valve is shown in the open position.*

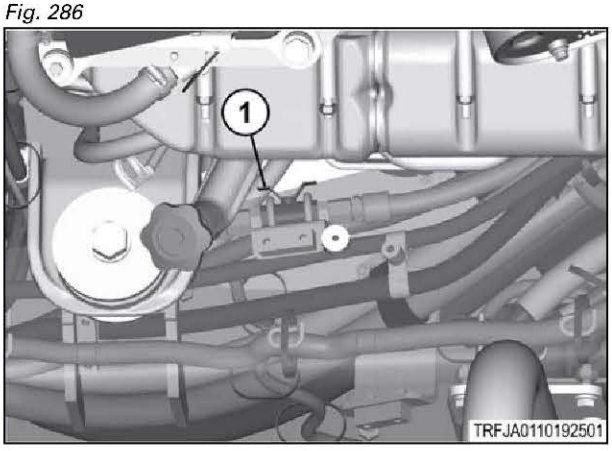


Fig. 287

5. Disconnect the engine cover support arm, close the engine cover (2) and connect the two latches (1).
6. Install the battery disconnect switch key (1).
7. Turn on the battery disconnect switch (1).

2.2.19 Remove the charge air cooler

Before starting the procedure



WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.



WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.



WARNING: Pressurized gases or fluids can be hazards.

Personal injury can result.

Relieve the pressure from the system or component before disconnecting components.

NOTE: *Before removal, put identification tags on the components for correct installation at assembly. Put covers and plugs on all hoses, fittings, and ports to prevent contamination from the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all parts to keep contamination from the system. Contamination can damage the precision parts. Complete the disassembly steps on a clean surface. Put clean material on top of the parts.*

NOTE: *Use only certified technicians and equipment to service the air conditioning system.*

NOTE: *When opening the air conditioning system, replace the receiver-dryer. See the information for removing/installing the receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn off the battery disconnect switch.
4. Remove the battery disconnect switch key.
5. Remove the engine cover.

6. Remove the hardware (1) and the cover plate (2).

7. Install a temporary hose to the radiator drain valve (3) and put through the access hole.

8. Set a correct container under the temporary hose.

9. Loosen the radiator drain valve (3) and drain the engine coolant.

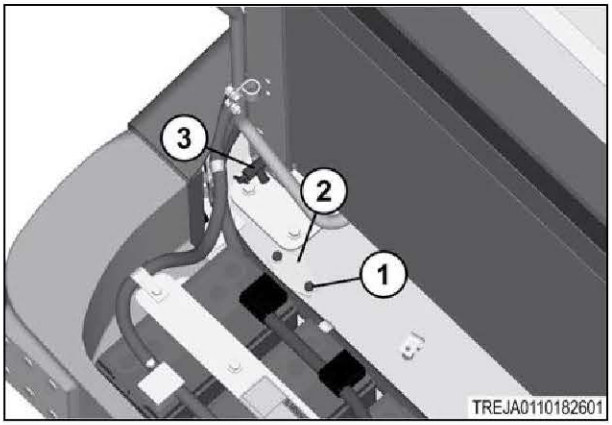


Fig. 288

10. Remove the hardware (1, 3) and the right fan guard (2).

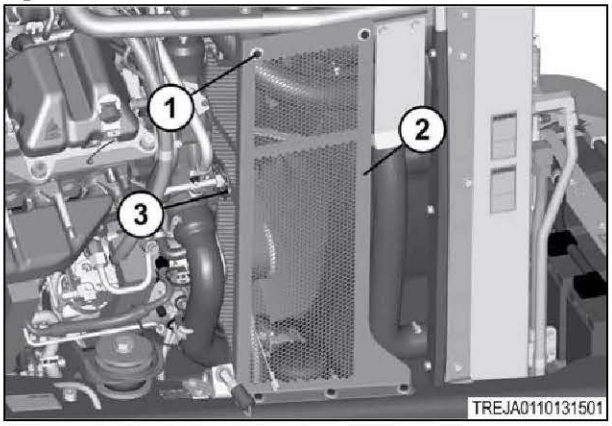


Fig. 289

11. Remove the hardware (1) and the left fan guard (2).

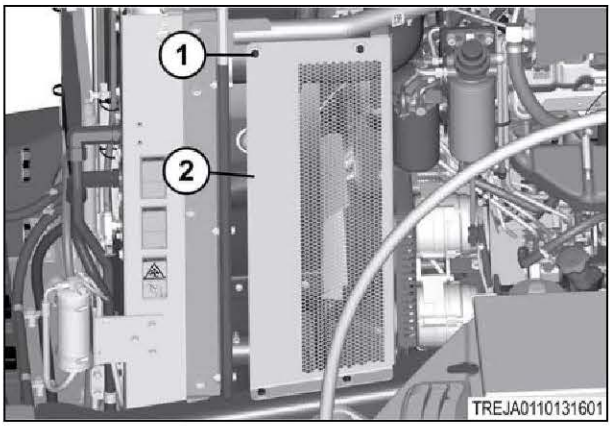


Fig. 290

12. Loosen the hose clamps (1) and disconnect the left charge air cooler hose (2).

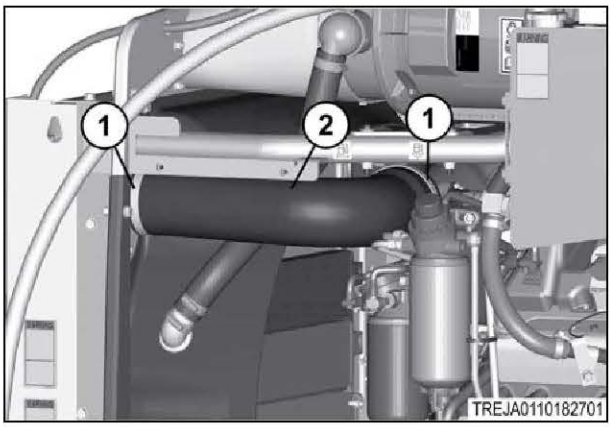


Fig. 291

13. Loosen the hose clamp (1) and disconnect the right charge air cooler hose (2).

14. Remove the hardware (3) and the hose clamp (4).

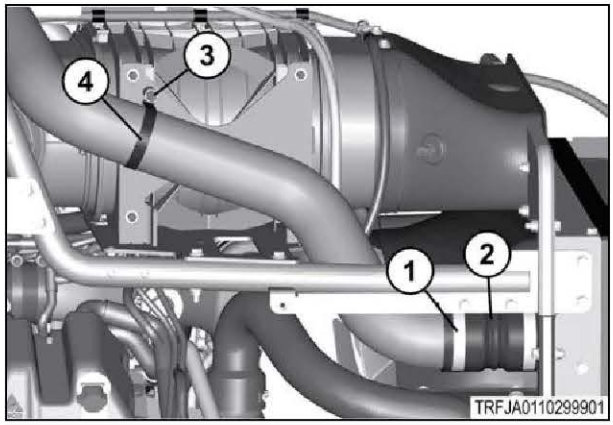


Fig. 292

15. Disconnect the two wire harnesses (1) from the air filter assembly.

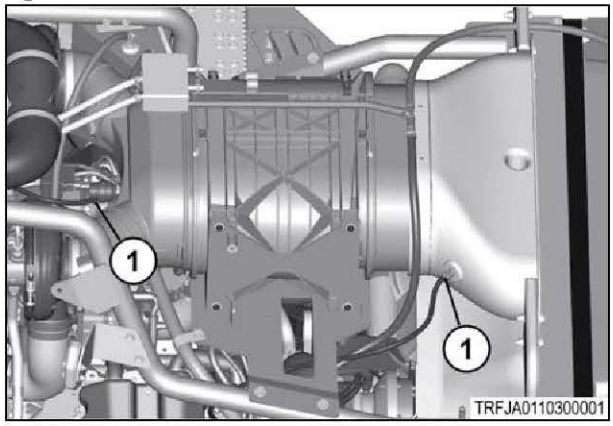


Fig. 293

16. Loosen the hose clamps (1) and disconnect the turbocharger inlet tubes (2).

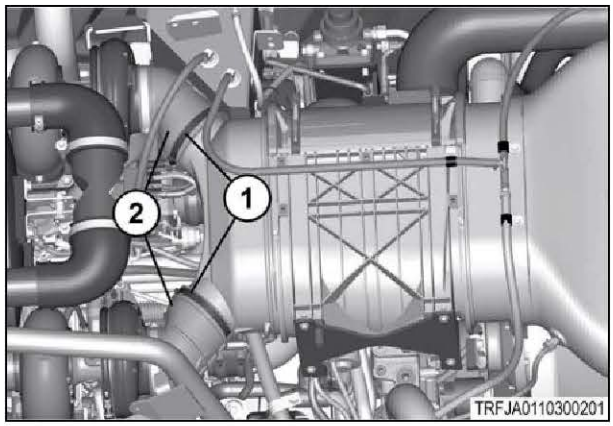


Fig. 294

17. Loosen the two hose clamps (1) and disconnect the two hoses (2).

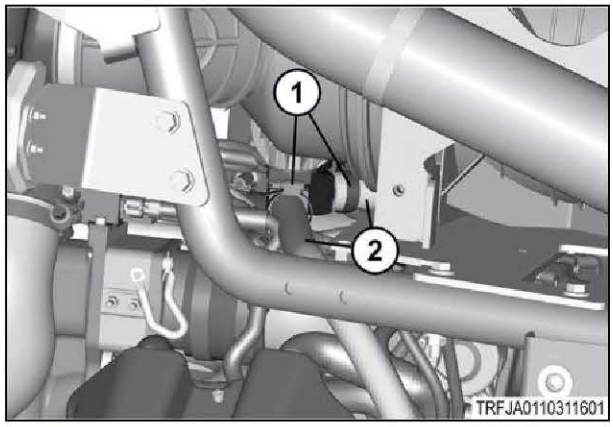


Fig. 295

18. Remove the hardware (1), the hose clips (2), and the doser expansion tank bracket (3).

19. Loosen the two hose clamps (4), and disconnect the two hoses.

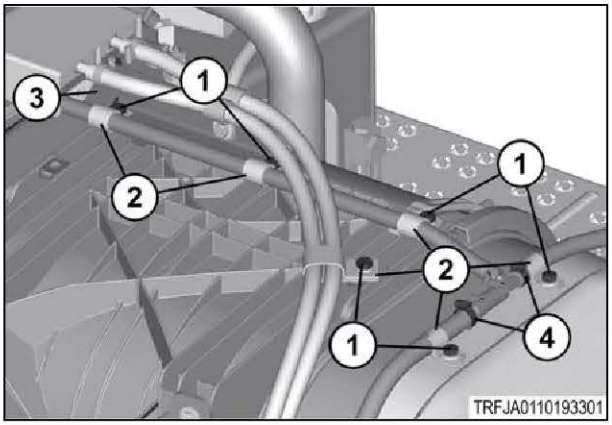


Fig. 296

20. Remove the hardware (1), and the air filter nozzle (2).

21. Remove the hardware (3), and the plastic seals (4).

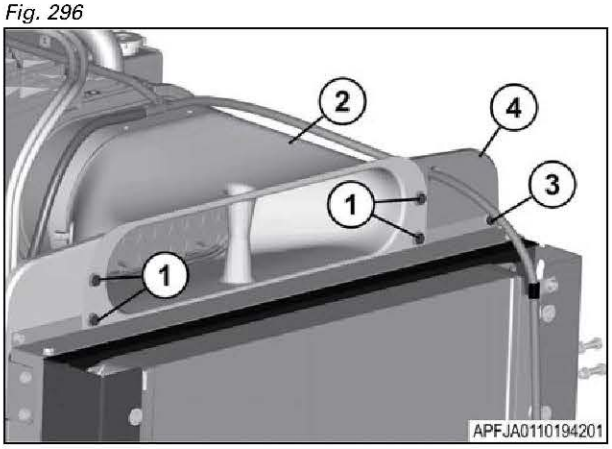


Fig. 297

22. Loosen the hose clamp (1) and disconnect the dust ejector tube (2).

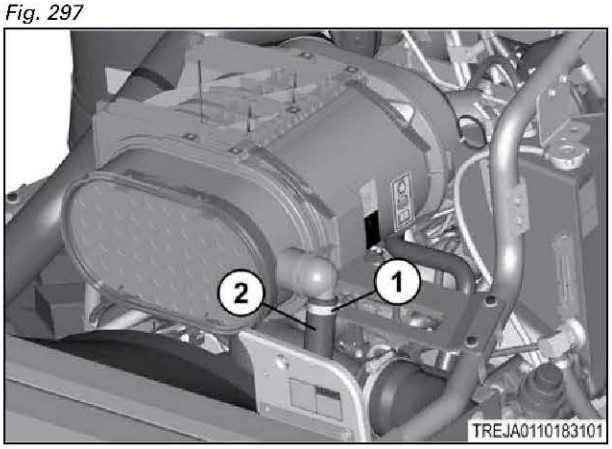


Fig. 298

23. Remove the hardware (1) and the air filter assembly (2).

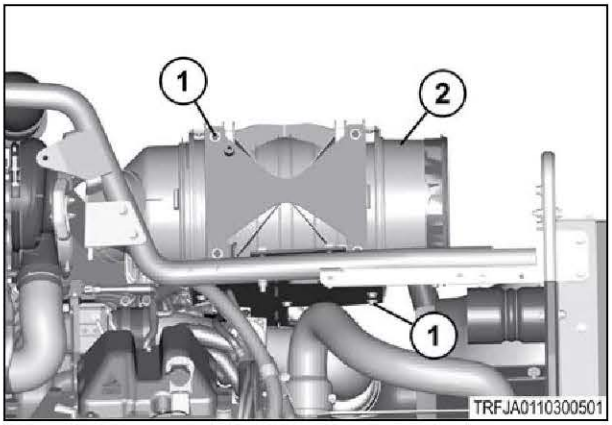


Fig. 299

24. Remove the hardware (1), and the hose clips (2).

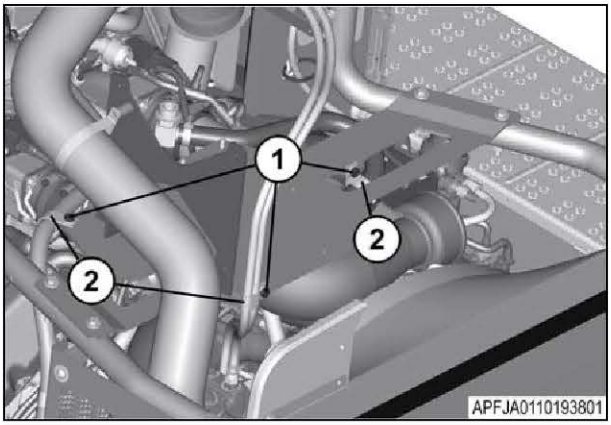


Fig. 300

25. Remove the hardware (1) and the air filter bracket (2).

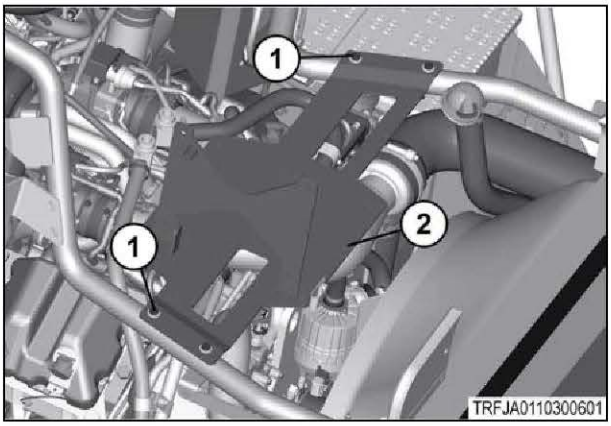


Fig. 301

26. Remove the hardware (1), the hose clamp (2), and the bracket (3).

27. Loosen the hose clamps (4) and disconnect the inlet radiator hose (5).

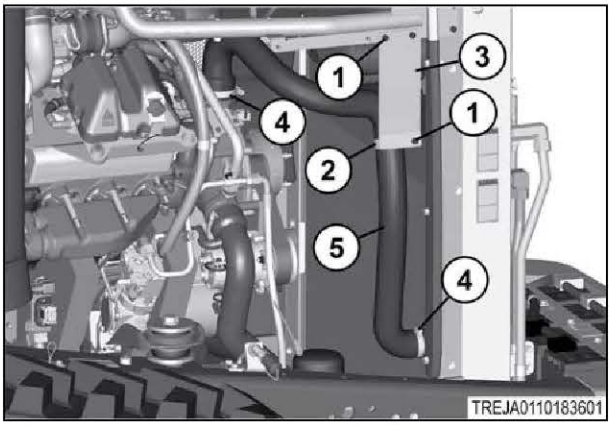


Fig. 302

28. Remove the hardware (1) and the hose clamp (2).

29. Loosen the hose clamps (3) and disconnect the outlet radiator hose (4).

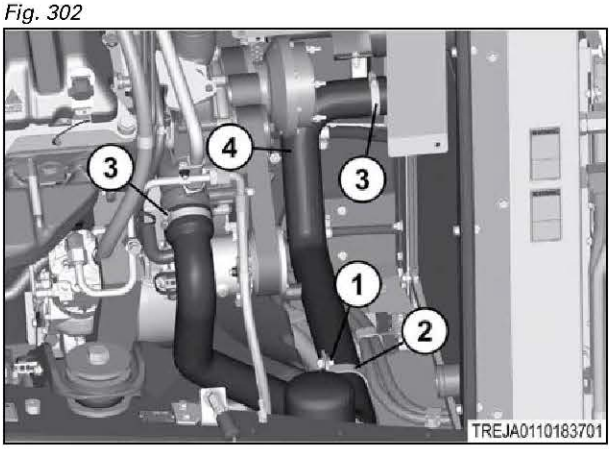


Fig. 303

30. Remove the hardware (1) and the right support bracket (2).

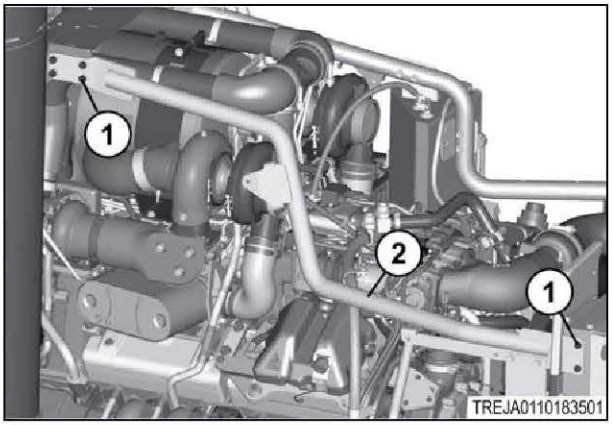


Fig. 304

31. Loosen the hose clamps (1) and disconnect the hoses (2) from the expansion tank.

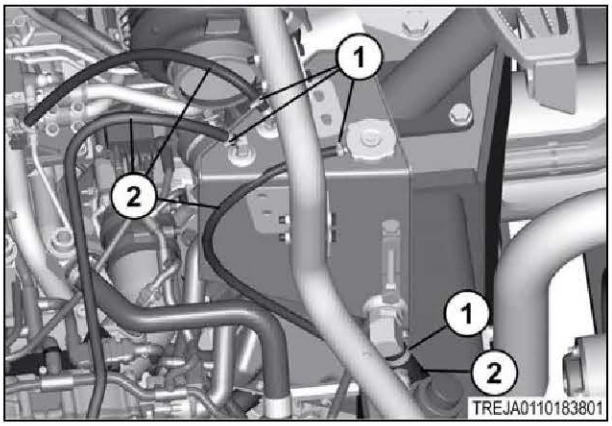


Fig. 305

32. Remove the hardware (1) and the expansion tank (2).

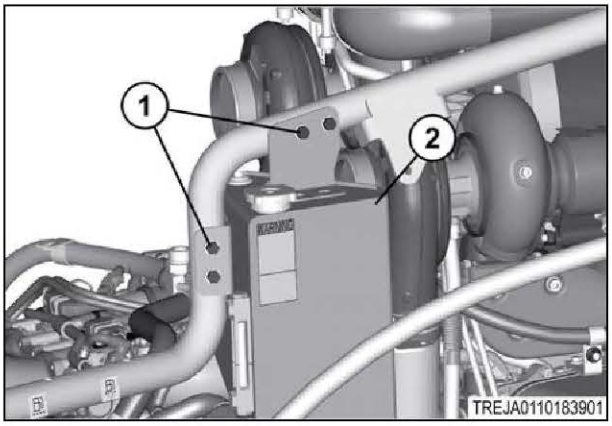


Fig. 306

33. Remove the hardware (1) and the left support bracket (2).

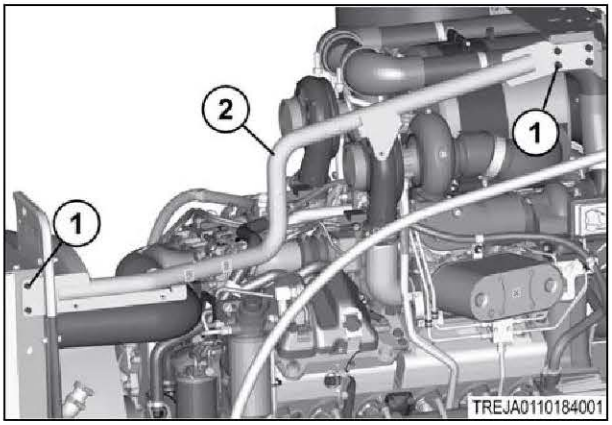


Fig. 307

34. Remove the batteries (1).

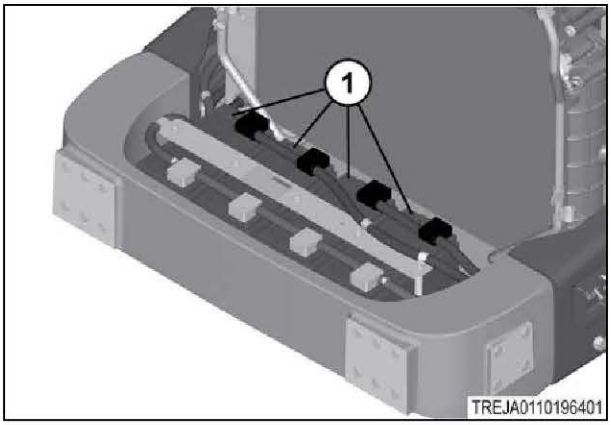


Fig. 308

35. Remove the hardware (1) and the two side seal brackets (2).

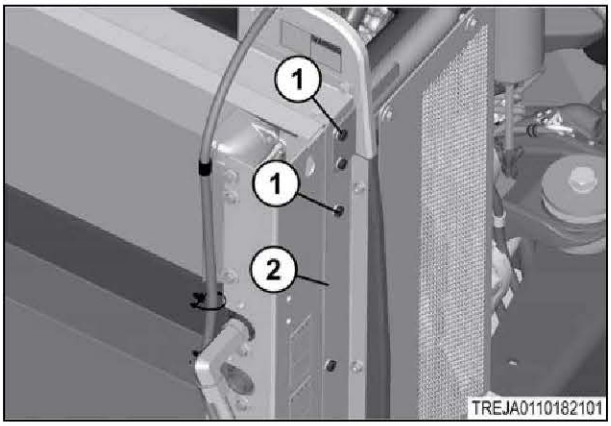


Fig. 309

36. Remove the hardware (1), the top seal bracket (2), and the seal.

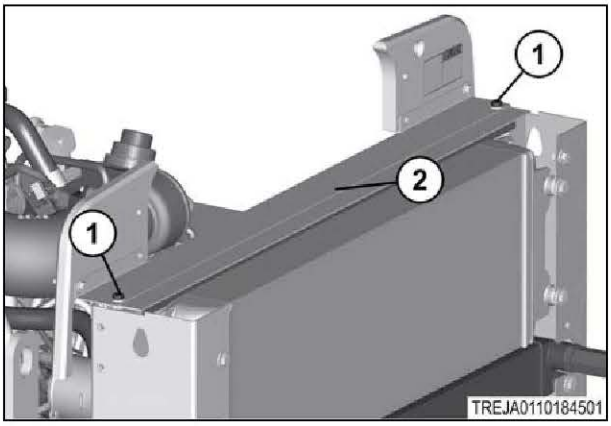


Fig. 310

37. Remove the hardware (1) and the air conditioning receiver-dryer bracket (2).

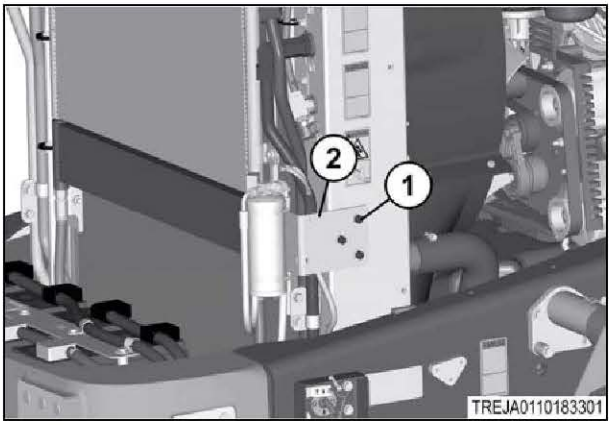


Fig. 311

38. Remove the hardware (2) and put the air conditioning condenser/fuel cooler assembly (3) to the side.

39. Disconnect the hydraulic hoses (1).

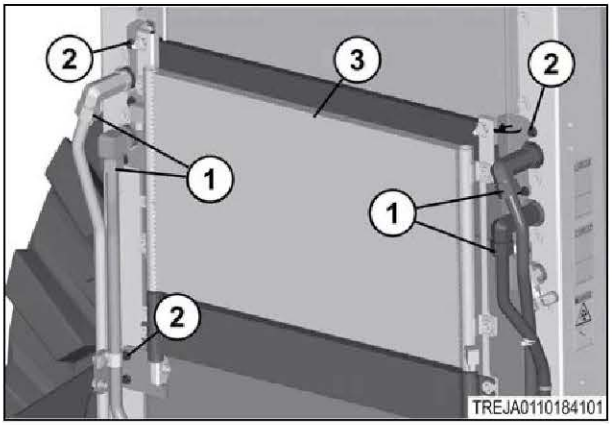


Fig. 312

40. Remove the hardware (1) and the fan shroud (2).

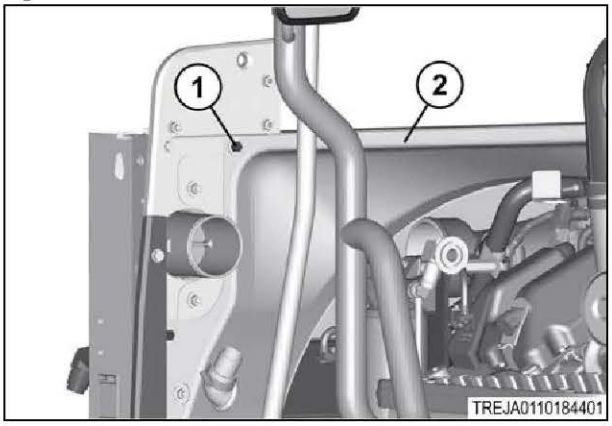


Fig. 313

41. Attach the correct lift equipment (1) to the cooling package.

IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

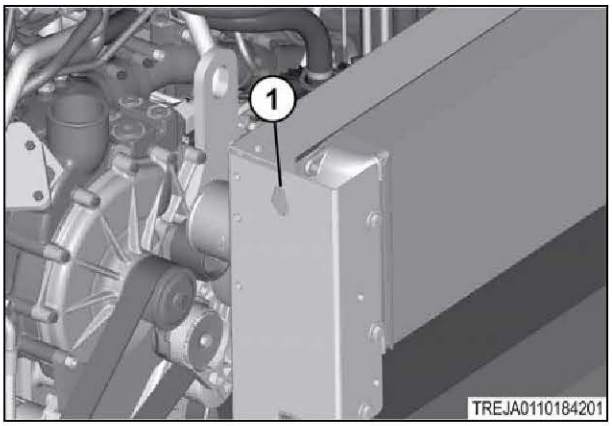


Fig. 314

42. Remove the hardware (1) and the cooling package (2).

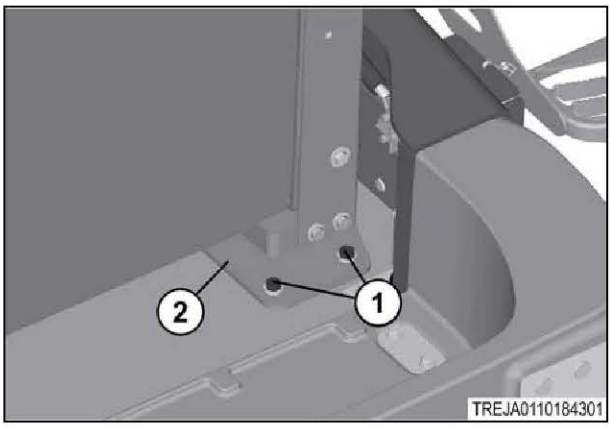


Fig. 315

43. Remove the hardware (1) and the bottom and top cross members (2).

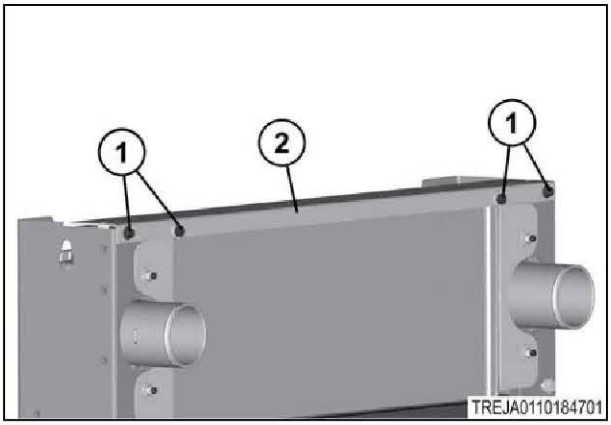


Fig. 316

44. Remove the hardware (1) and the two side channels (2).

45. Remove the charge air cooler (3).

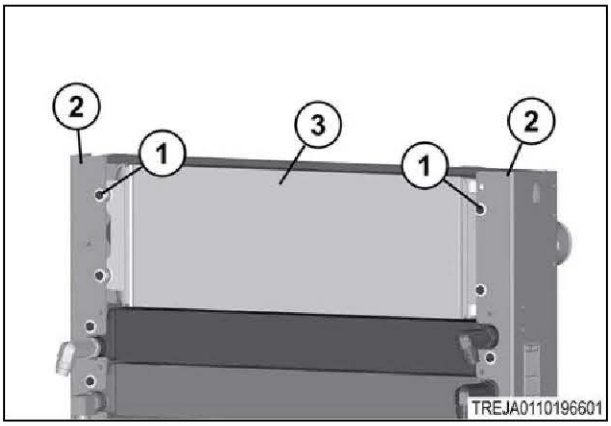


Fig. 317

Related Links

Remove the engine cover page 13-3
Remove the batteries page 10-22

2.2.20 Install the charge air cooler

Procedure

1. Use the hardware (1), to install the foam seals and the charge air cooler (3), to the two side channels (2).

NOTE: *Make sure the foam seals are in the correct location. Replace if worn.*

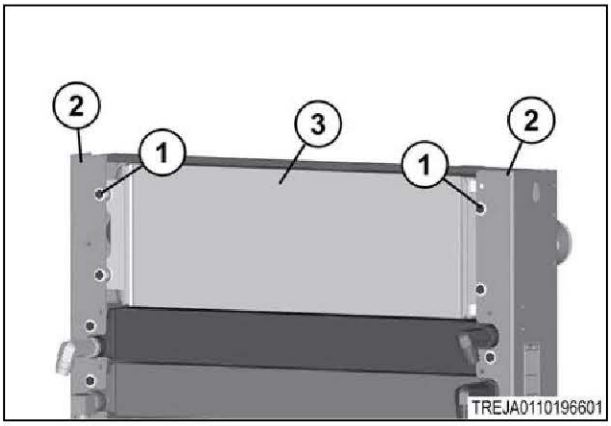


Fig. 318

2. Use the hardware (1) to install the bottom and the top cross members (2).

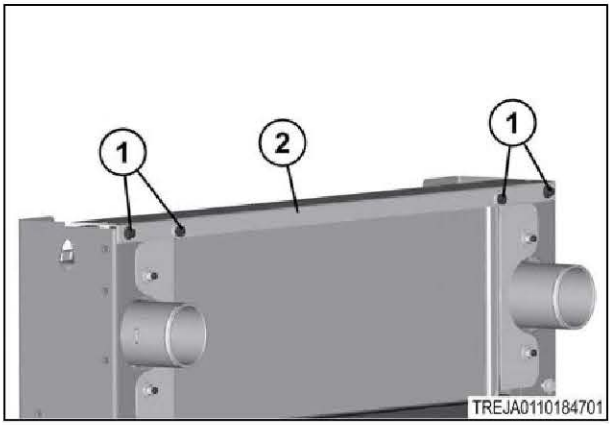


Fig. 319

3. Attach the correct lift equipment (1) to the cooling package.

   IMPORTANT: *The weight of the cooling package is approximately 179 kg (395 lb).*

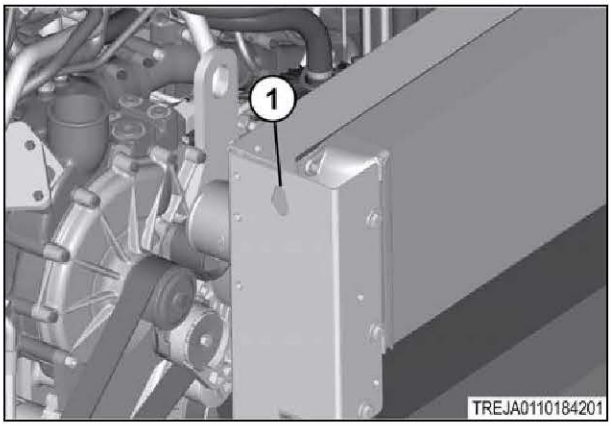


Fig. 320

4. Use the hardware (1) to install the cooling package (2).

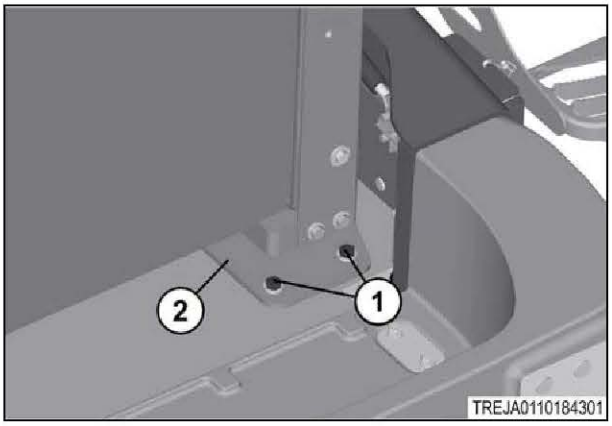


Fig. 321

5. Use the hardware (1) to install the fan shroud (2).

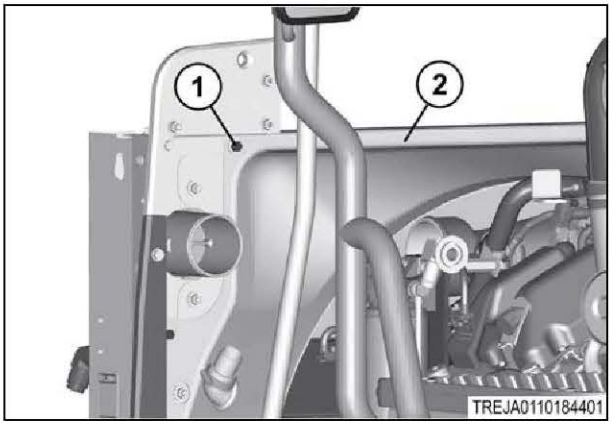


Fig. 322

6. Use the hardware (2) to install the air conditioning condenser/fuel cooler assembly (3).

7. Connect the hydraulic hoses (1).

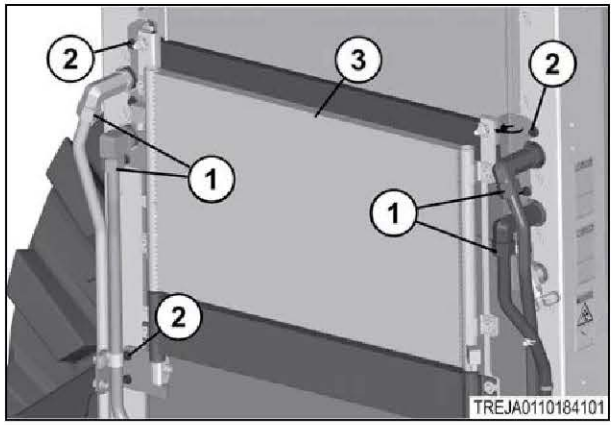


Fig. 323

8. Use the hardware (1) to install the air conditioning receiver-dryer bracket (2).

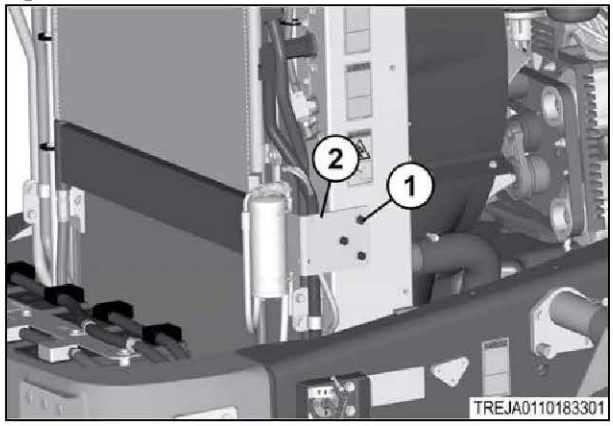


Fig. 324

9. Use the hardware (1) to install the seal, and the top seal bracket (2).

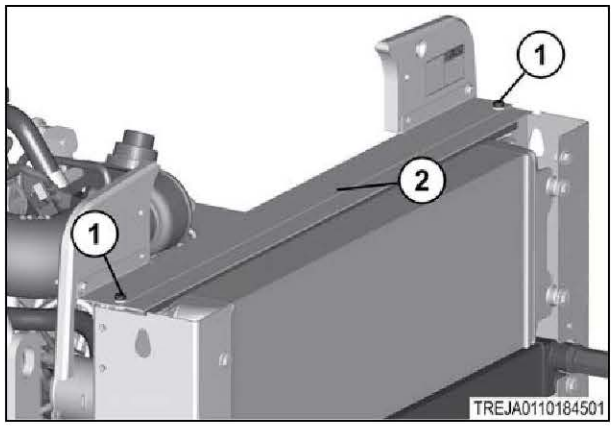


Fig. 325

10. Use the hardware (1) to install the seals, and the two side seal brackets (2).

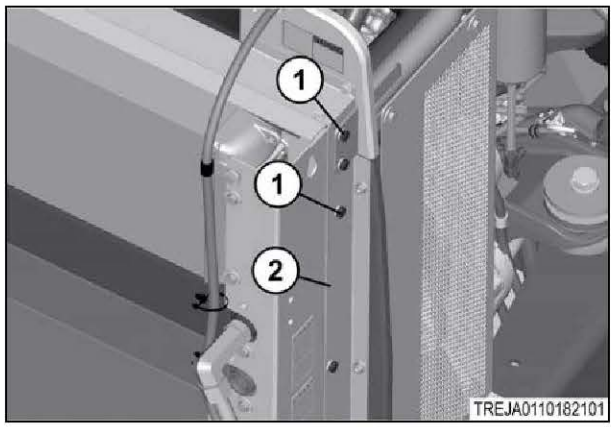


Fig. 326

11. Install the batteries (1).

See the information for installing the batteries.

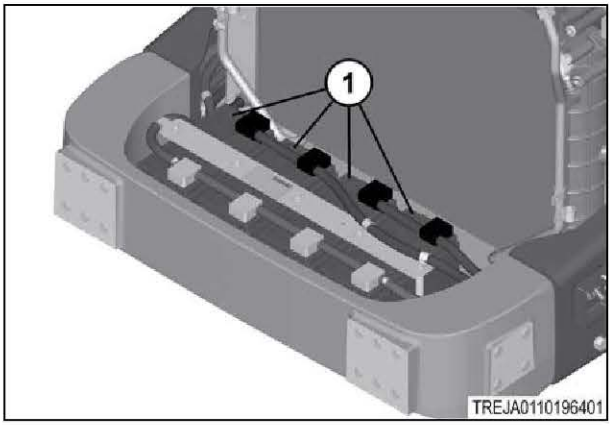


Fig. 327

12. Use the hardware (1) to install the left support bracket (2).

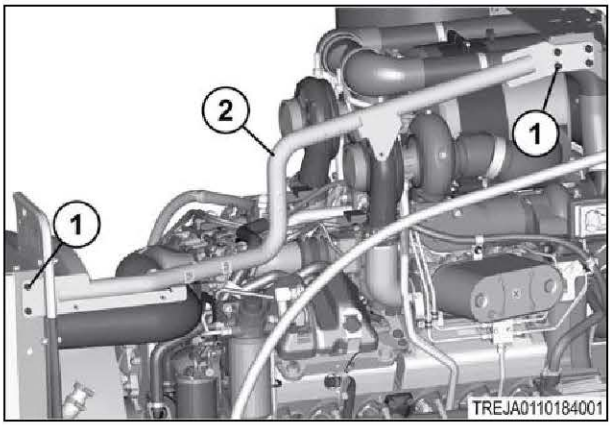


Fig. 328

13. Use the hardware (1) to install the expansion tank (2).

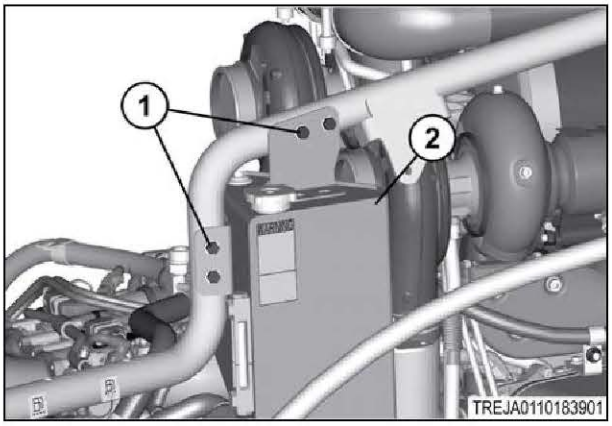


Fig. 329

14. Use the hose clamps (1) to connect the hoses (2) to the expansion tank.

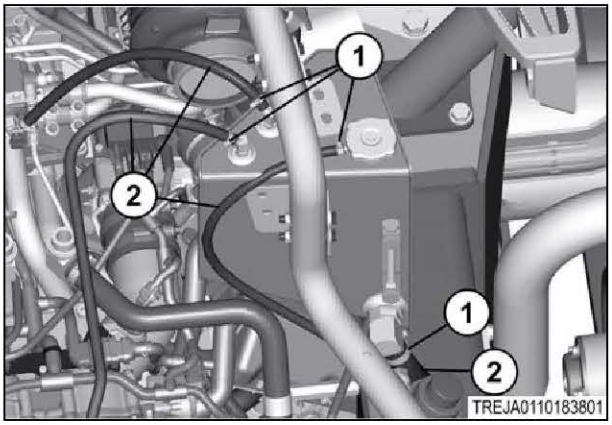


Fig. 330

15. Use the hardware (1) to install the right support bracket (2).

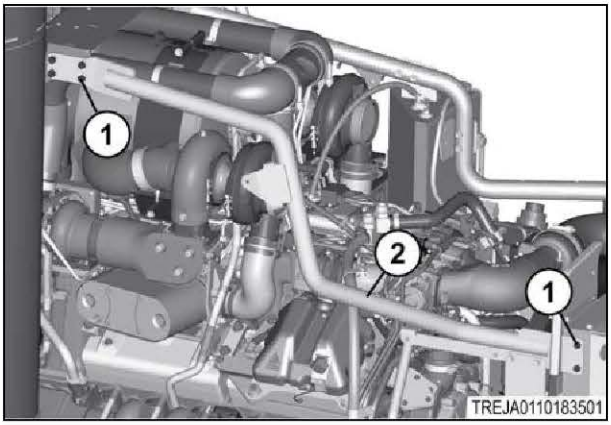


Fig. 331

16. Use the hose clamps (3) to connect the outlet radiator hose (4).

17. Use the hardware (1) to install the hose clamp (2).

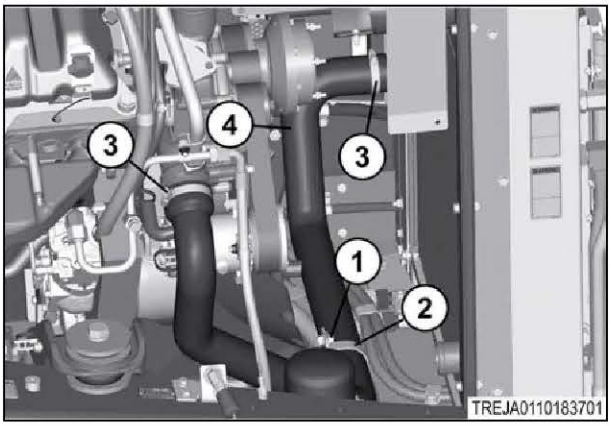


Fig. 332

18. Use the hose clamps (4) to connect the inlet radiator hose (5).

19. Use the hardware (1) to install the bracket (3) and the hose clamp (2).

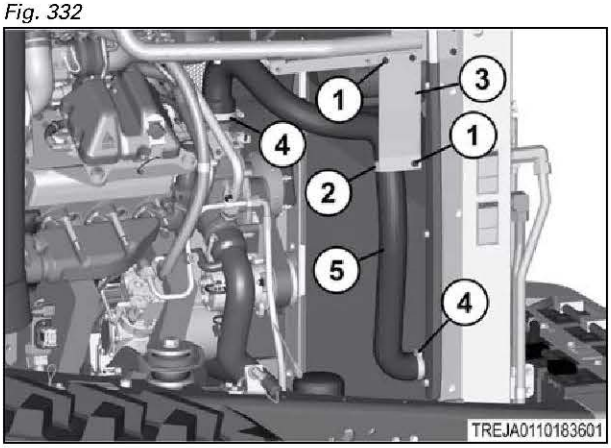


Fig. 333

20. Use the hardware (1) to install the air filter assembly mount (2).

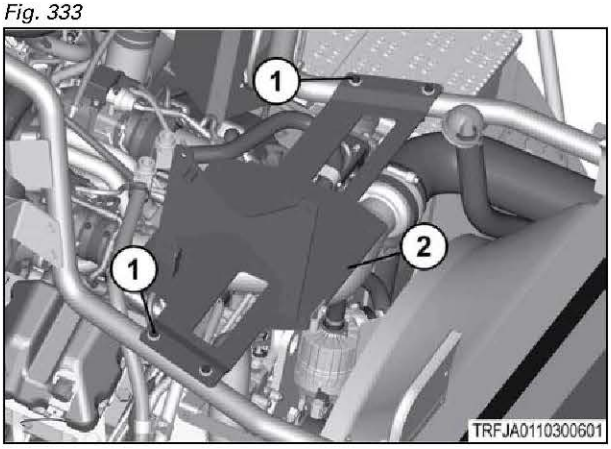


Fig. 334

21. Use the hardware (1), to install the hose clips (2).

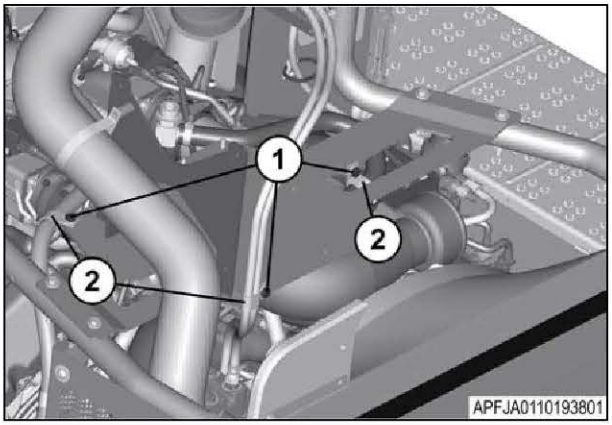


Fig. 335

22. Use the hardware (1) to install the air filter assembly (2).

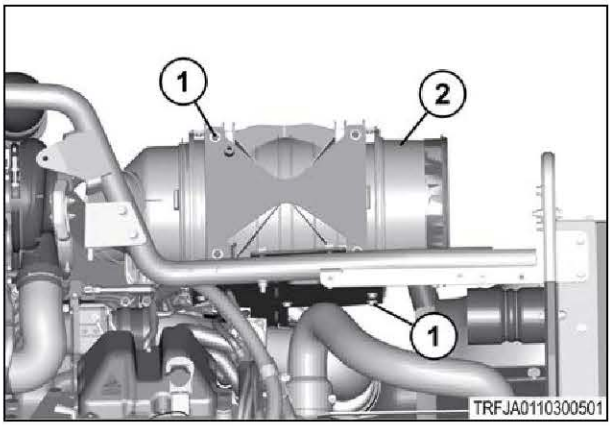


Fig. 336

23. Use the hose clamp (1) to connect the dust ejector tube (2).

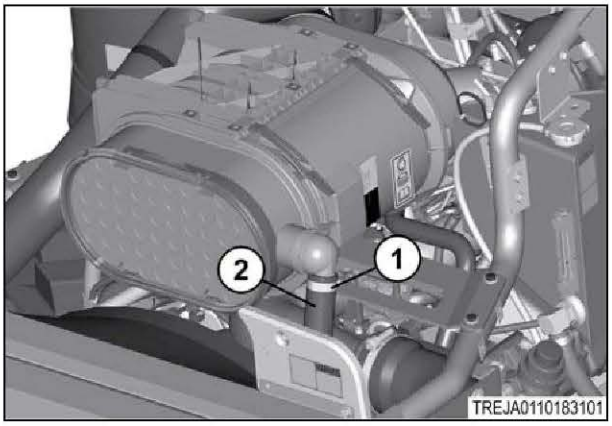


Fig. 337

24. Use the hose clamps (1) to connect the turbocharger inlet tubes (2).

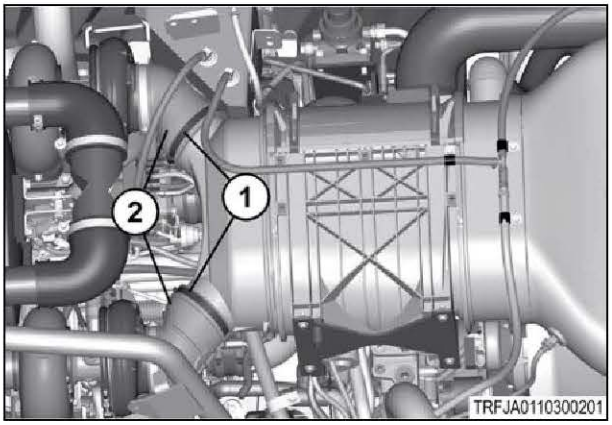


Fig. 338

25. Connect the two wire harnesses (1) to the air filter.

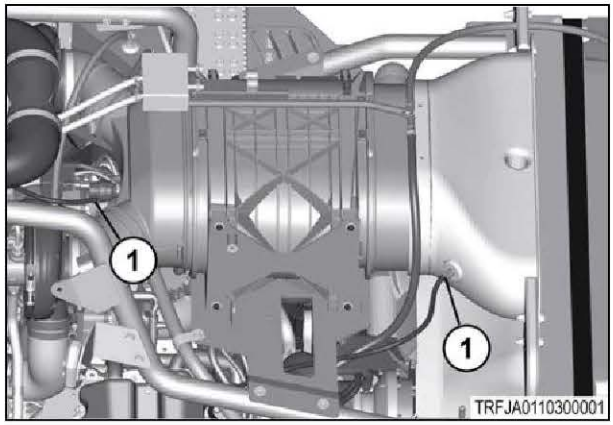


Fig. 339

26. Use the hardware (1), to install the hose clips (2), and the doser expansion tank bracket (3).

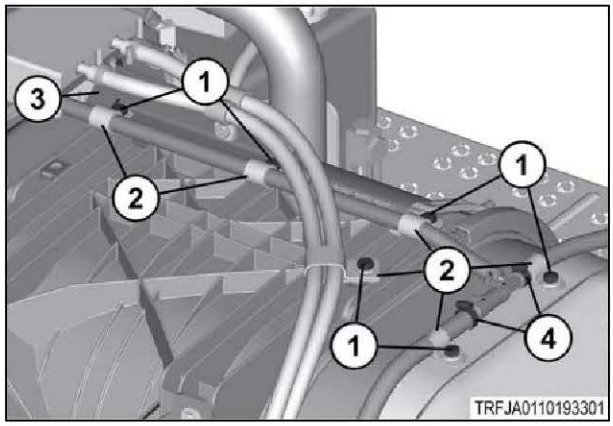


Fig. 340

27. Use the hardware (1) to install the air filter nozzle (2).

28. Use the hardware (3), to install the plastic seals (4).

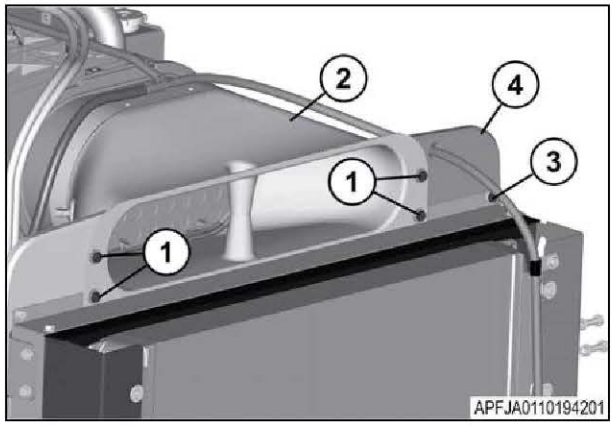


Fig. 341

29. Use the tube clamps (1) to install the right charge air cooler tube (2).

30. Use the hardware (3) to install the clamp (4).

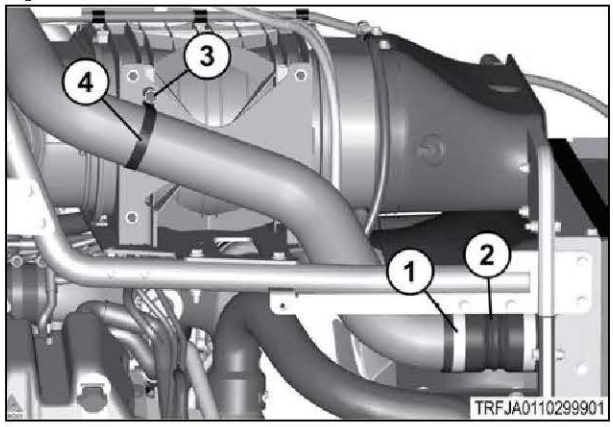


Fig. 342

31. Use the tube clamps (1) to install the left charge air cooler tube (2).

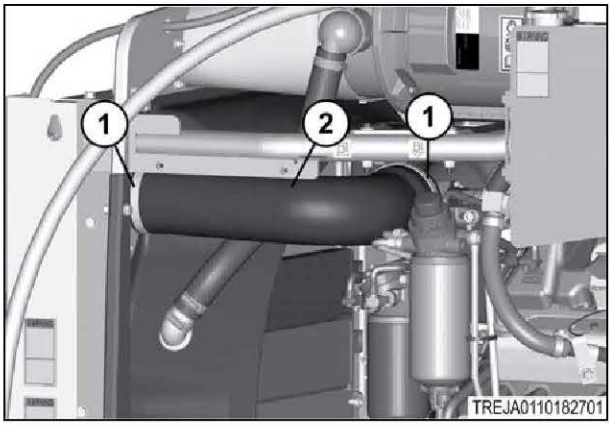


Fig. 343

32. Use the hardware (1) to install the left fan guard (2).

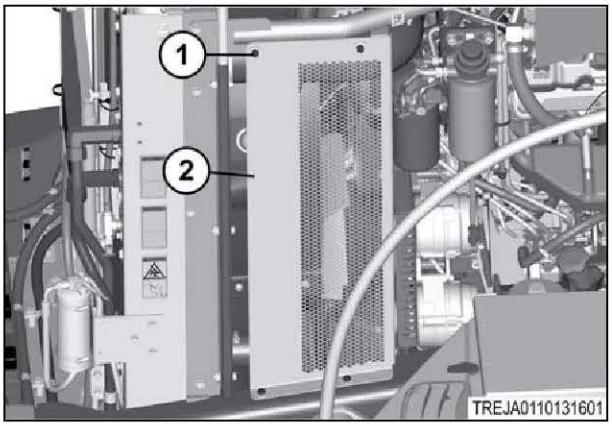


Fig. 344

33. Use the hardware (1, 3) to install the right fan guard (2).

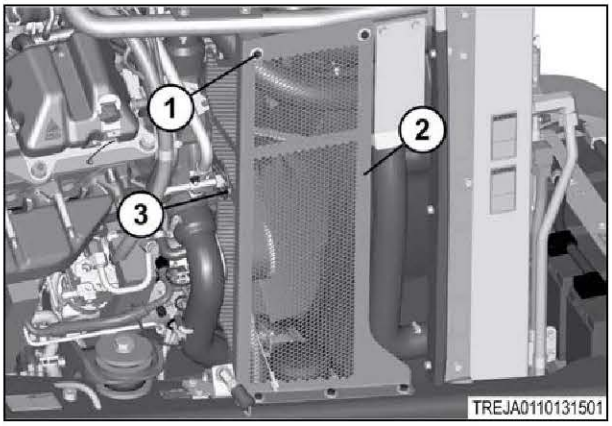


Fig. 345

34. Remove the temporary drain hose and tighten the drain valve (3).

35. Install the cover plate (2) with the hardware (1).

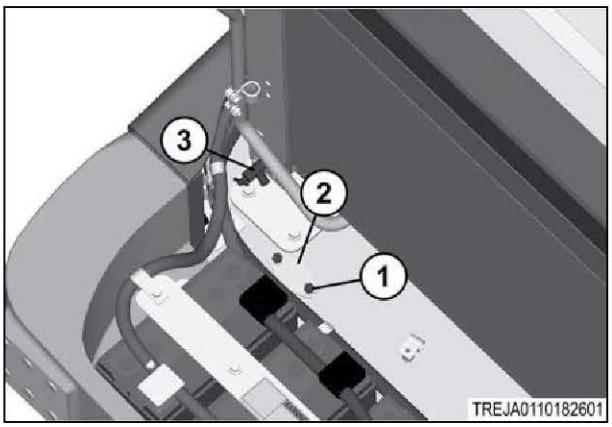


Fig. 346

36. Fill the radiator with the correct engine coolant.

37. Fill the hydraulic tank with the correct hydraulic fluid.

38. Install the engine cover.

39. Install the battery disconnect switch key.

40. Turn on the battery disconnect switch.

Related Links

Install the engine cover (MY2015 and earlier) page 13-16
Fill capacities page 1-18
Coolant quality requirements page 2-239
Install the batteries page 10-23
Refill the cooling system page 2-149

2.2.21 Remove the air conditioning receiver/dryer



WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.



WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.

NOTE: *Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.*

NOTE: *Use only certified technicians and equipment to service the air conditioning systems.*

NOTE: *When opening the air conditioning system, replace the air conditioning receiver-dryer. See the information for removing/installing the air conditioning receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.

2. Apply the parking brake, stop the engine, and take the key with you.

3. Turn the battery disconnect switch key (1) counterclockwise to disconnect the battery power.

   NOTE: *The battery disconnect switch is shown in the off position.*

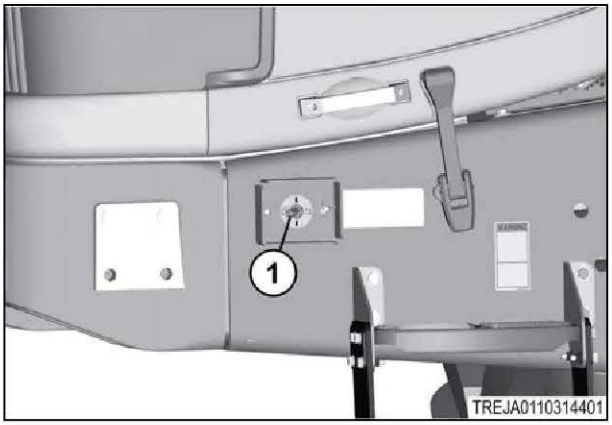


Fig. 347

4. Remove the battery disconnect switch key (1).

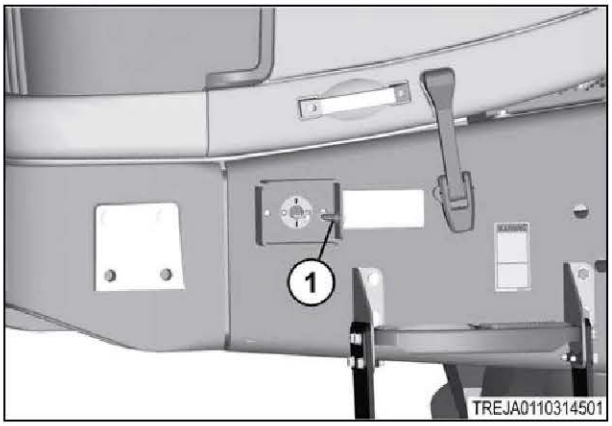


Fig. 348

5. **CAUTION:**
   Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

   Release both side latches (1) and open the engine cover (2) all the way.

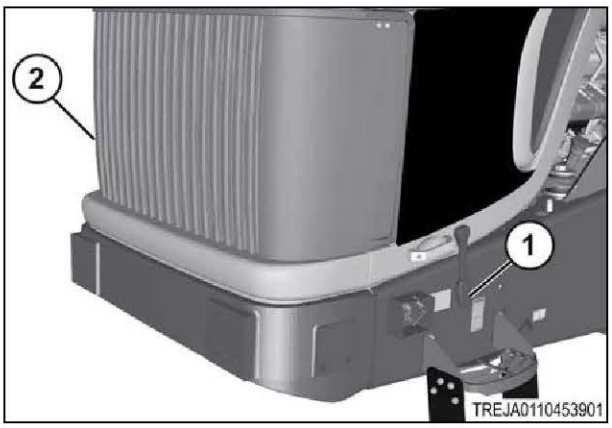


Fig. 349

6. Disconnect the air conditioning hoses (1) from the receiver/dryer (2).

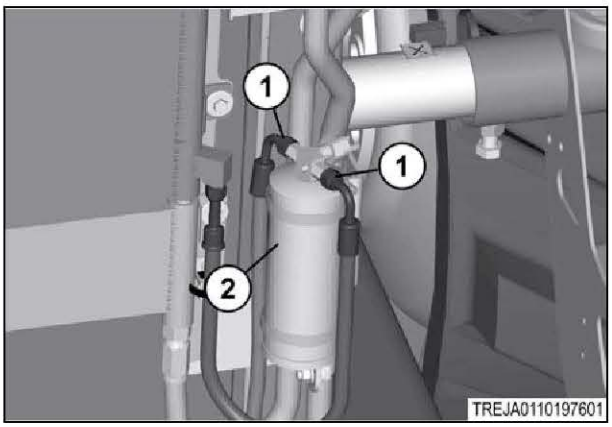


Fig. 350

7. Disconnect the wire harness (3).

8. Loosen the hose clamps (1) and remove the receiver/dryer (2).

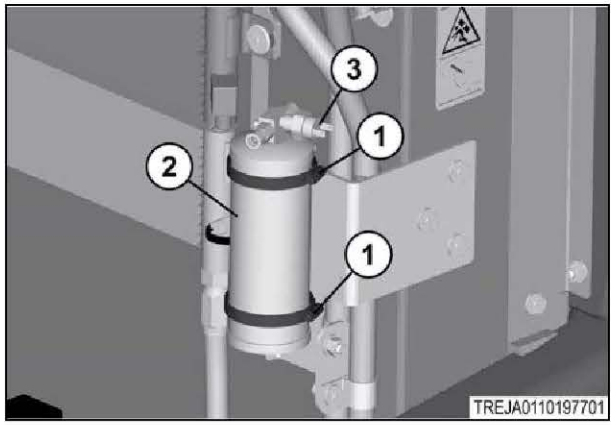


Fig. 351

9. Remove the hardware (1) and the receiver/dryer bracket (2).

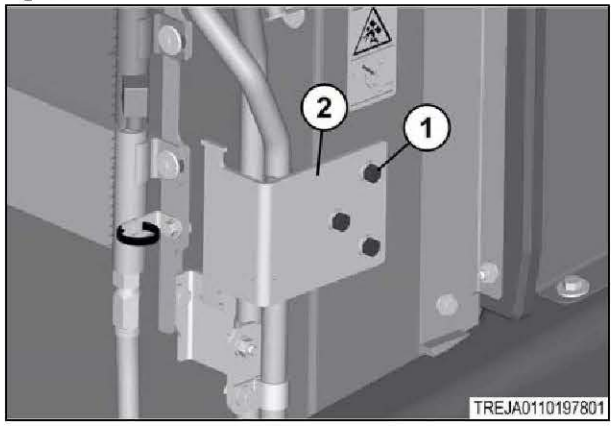


Fig. 352

2.2.22 Install the air conditioning receiver/dryer

Procedure

1. Use the hardware (1) to install the receiver/dryer bracket (2).

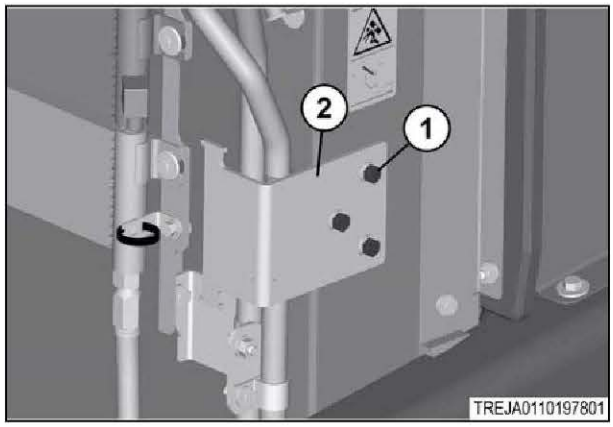


Fig. 353

2. Use the hose clamps (1) to install the receiver/dryer (2).

3. Connect the wire harness (3).

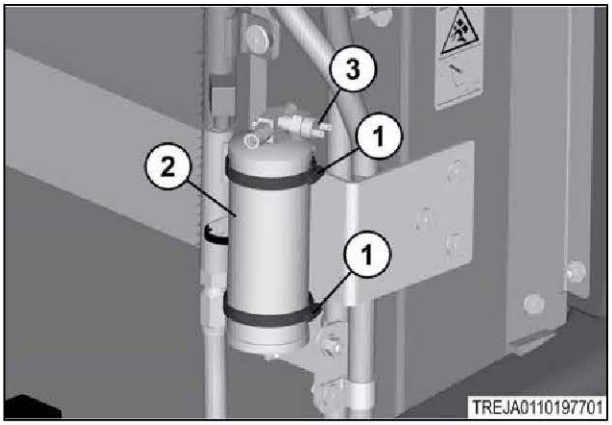


Fig. 354

4. Connect the air conditioning hoses (1) to the receiver/dryer (2).

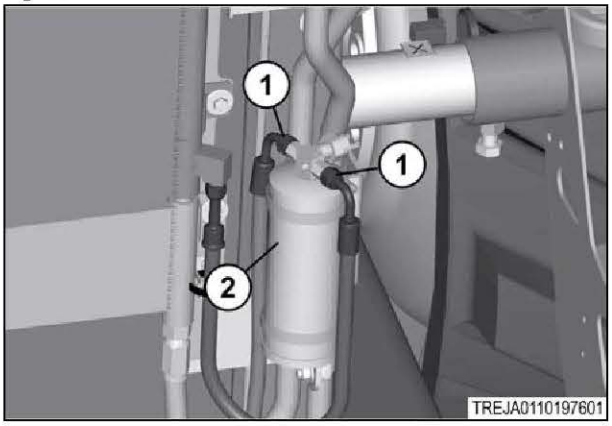


Fig. 355

5. Close the engine cover (2) all the way and connect both side latches (1).

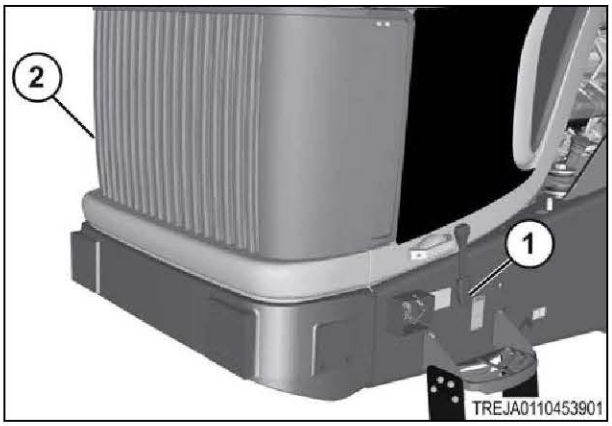


Fig. 356

6. Install the battery disconnect switch key (1).

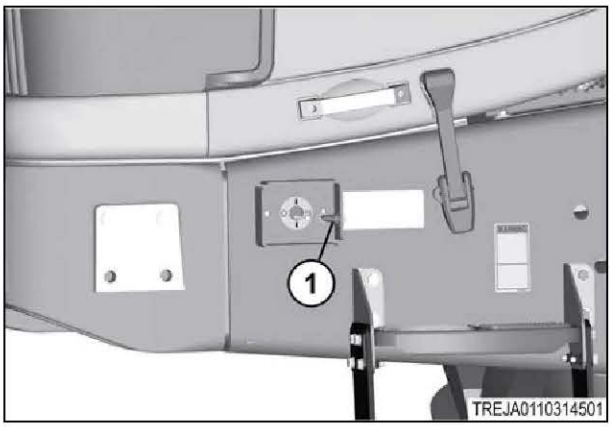


Fig. 357

7. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

   NOTE: *The battery disconnect switch is shown in the on position.*

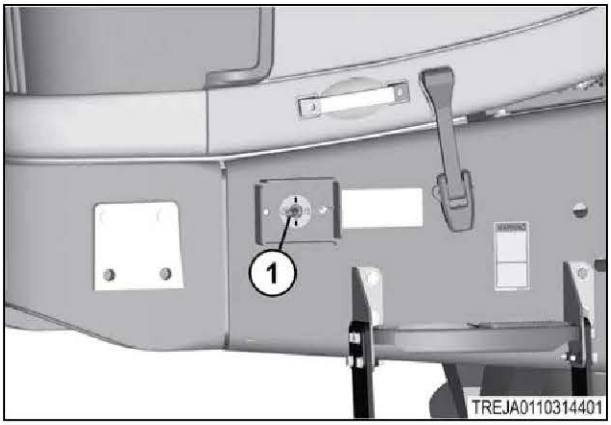


Fig. 358

2.2.23 Remove the engine mounts

Procedure

1. Remove the engine from the machine.

2. Remove the hardware (1), the front engine mount (3).

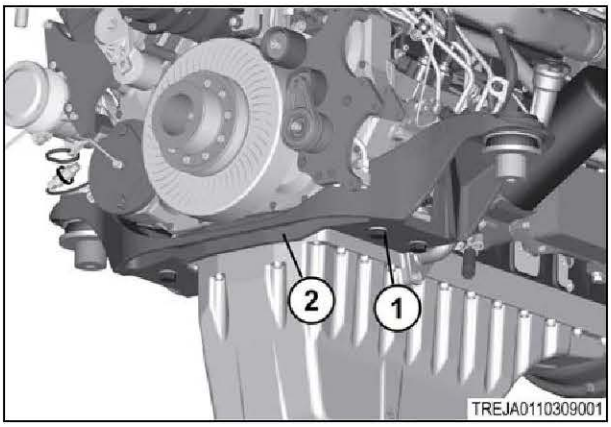


Fig. 359

3. Remove the rubber bushings (1) from the front engine mount (2).



Fig. 360

4. Remove the hardware (1), and the rear engine mount (2).

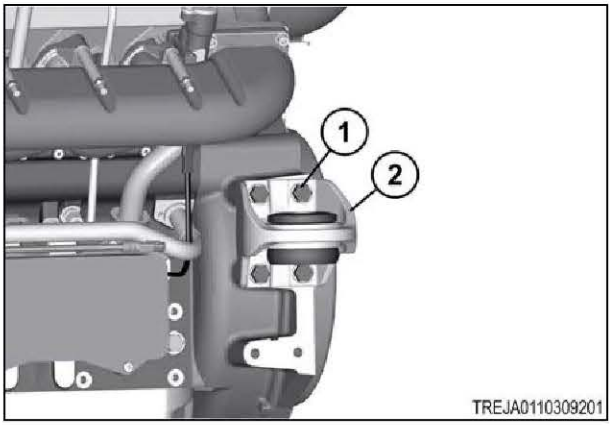


Fig. 361

5. Remove the rubber bushings (1) from the rear engine mount (2).

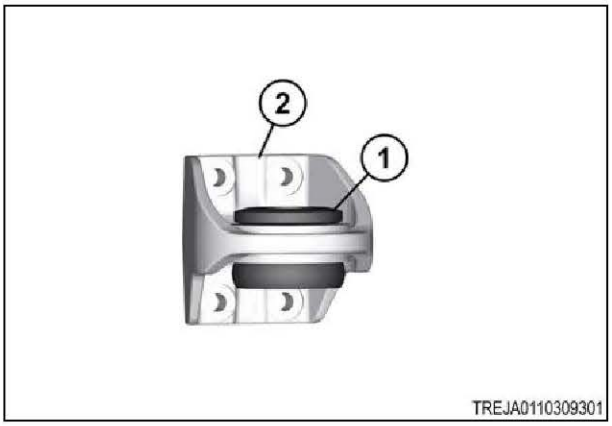


Fig. 362

Related Links

Remove the engine page 2-131

2.2.24 Install the engine mounts

Procedure

1. Install the rubber bushings (1) to the rear engine mount (2).

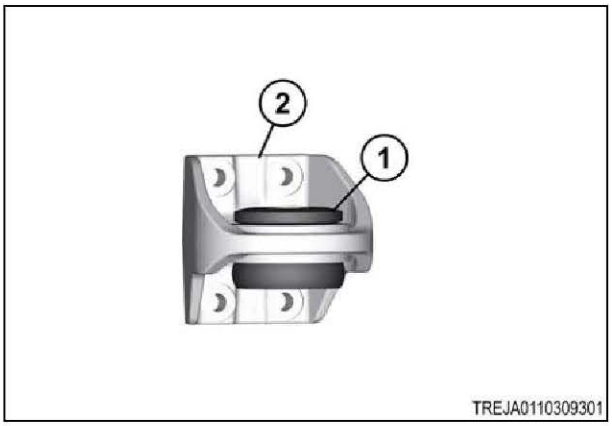


Fig. 363

2. Install the rear engine mount (2) with the hardware (1).

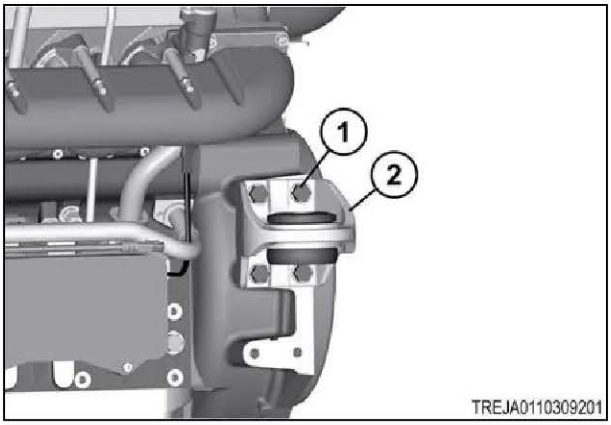


Fig. 364

3. Install the rubber bushings (1) to the front engine mount (2).



Fig. 365

4. Install the front engine mount (2) with the hardware (1).

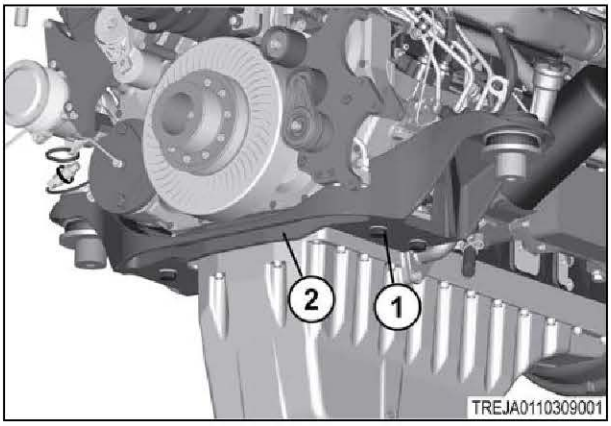


Fig. 366

2.2.25 Remove the air filter assembly

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.

Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.

Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.
4. Let the machine cool for 5 minutes.
5. Release the two latches (1) and open the engine cover.

CAUTION:
Safely prop open the engine cover. Closing the engine cover causes a pinch point that can cause serious bodily injury.

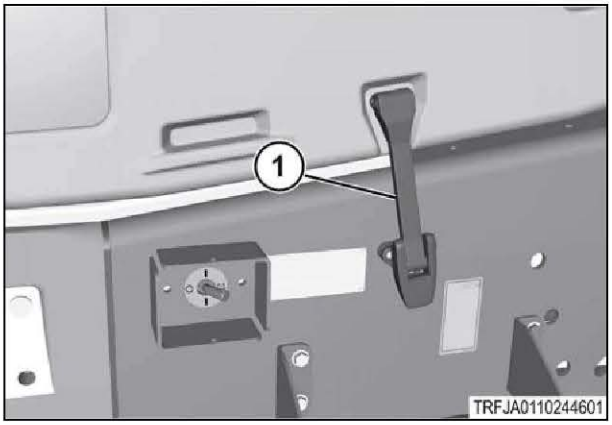


Fig. 367

6. Disconnect the two wire harnesses (1) from the air filter assembly.

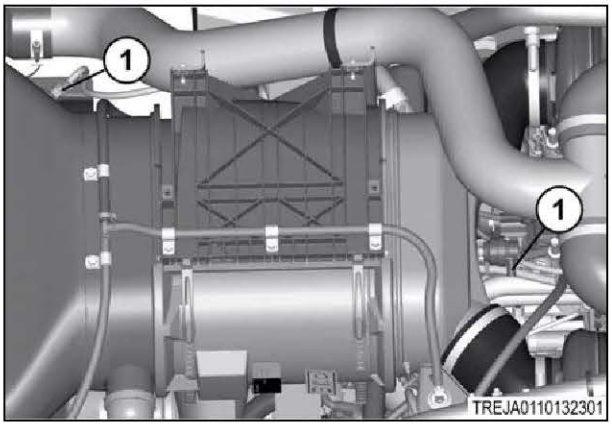


Fig. 368

7. If equipped with DEF, remove the hardware and clip (1).
8. Remove the hardware and clips (2) with the bracket (3).

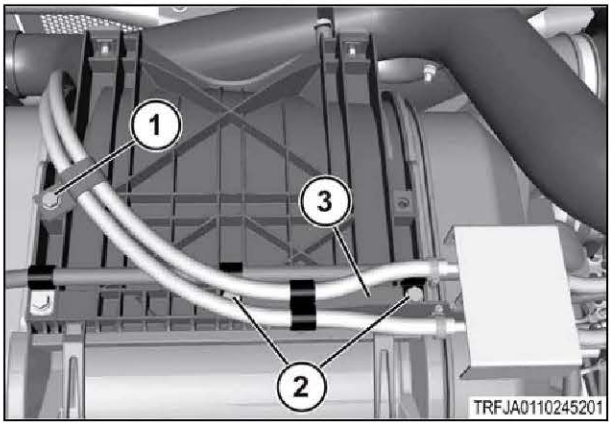


Fig. 369

9. Loosen the hose clamps (1) and disconnect the air filter intake tubes (2).

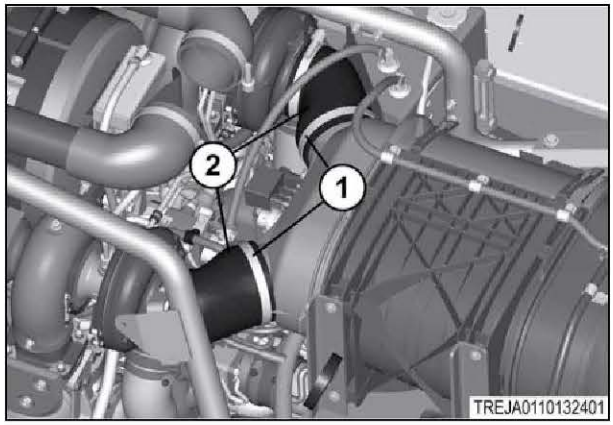


Fig. 370

10. Loosen the two hose clamps (1) and disconnect the two hoses (2).

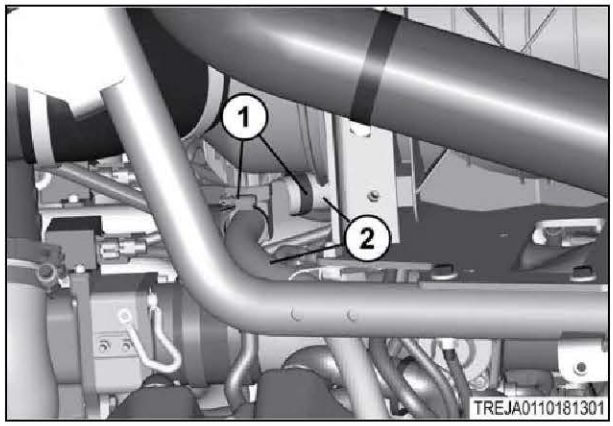


Fig. 371

11. Remove the hardware (1), loosen the hose clamps (2), and disconnect the hoses (3). Remove the air filter intake.

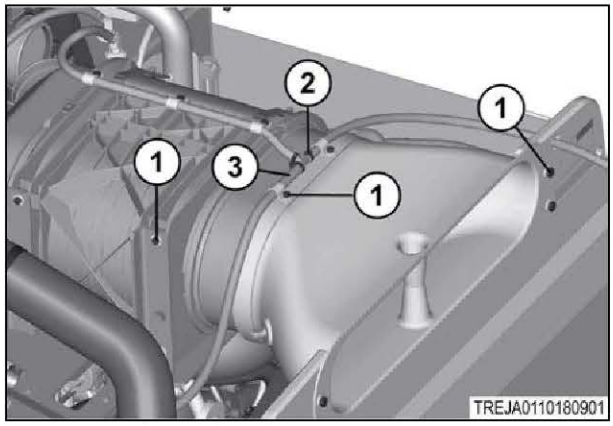


Fig. 372

12. Remove the hose clamp (1) and disconnect the dust ejector tube (2).

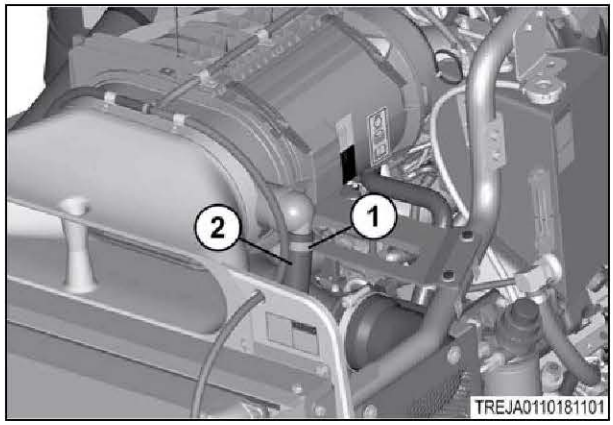


Fig. 373

13. Remove the hardware (1) and the air filter assembly (2).

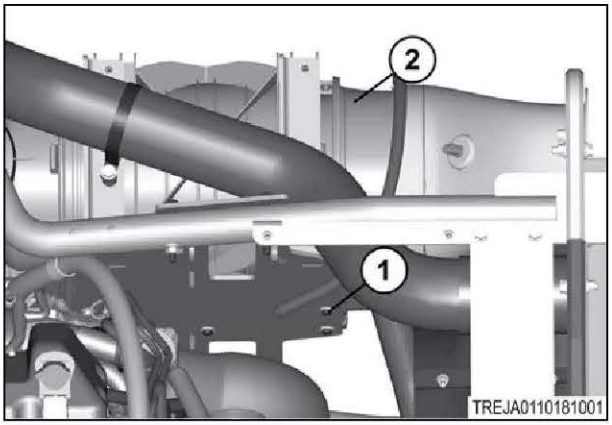


Fig. 374

14. Remove the hardware (1) and the mounting bracket.

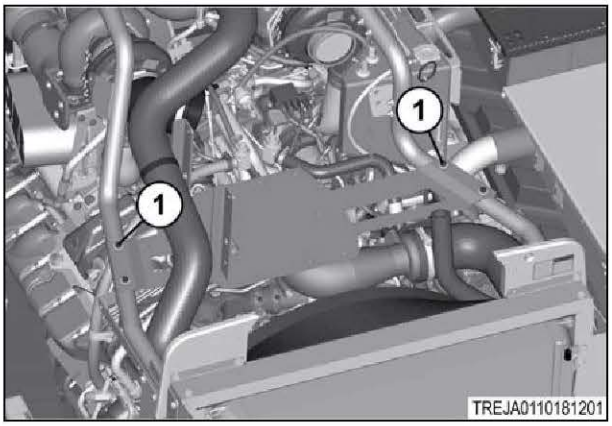


Fig. 375

2.2.26 Install the air filter assembly

Procedure

1. Install the mounting bracket with the hardware (1).

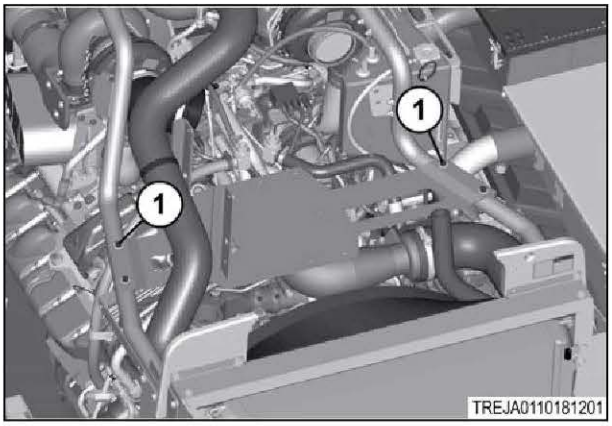


Fig. 376

2. Install the air filter assembly (2) with the hardware (1).

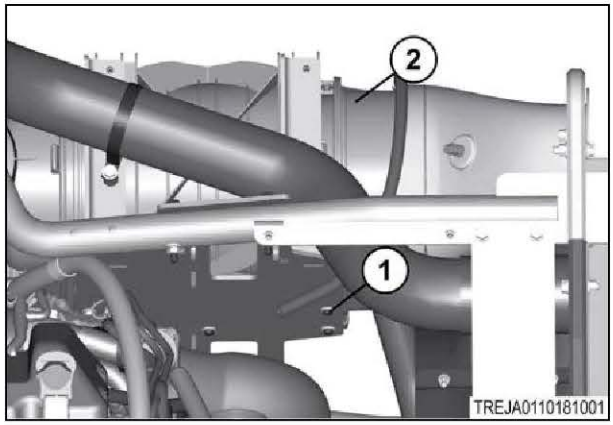


Fig. 377

3. Connect the dust ejector tube (2) with the hose clamp (1).

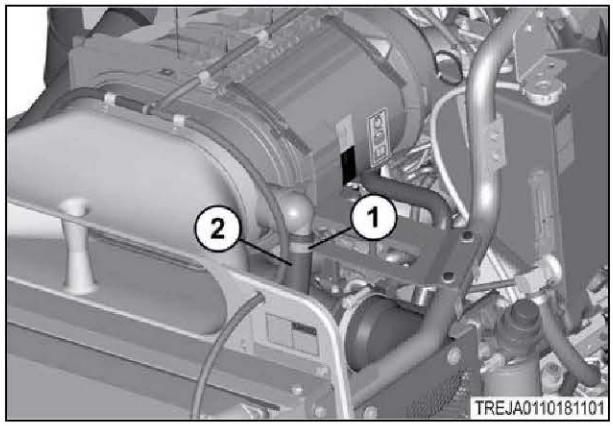


Fig. 378

4. Install the air filter intake. Connect the three hoses (3) to the tee with the hose clamps (2). Install the hardware (1).

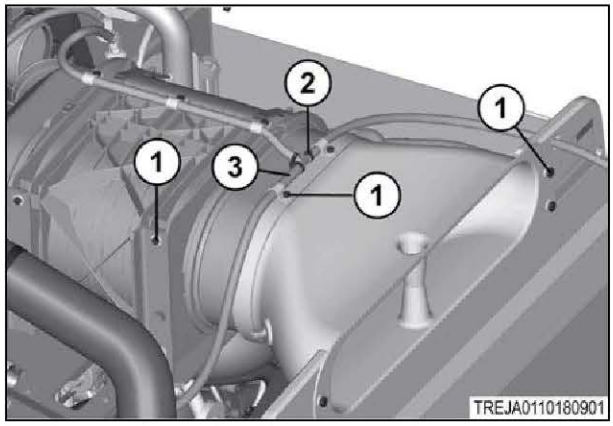


Fig. 379

5. Connect the two hoses (2) to the fittings with the two hose clamps (1).

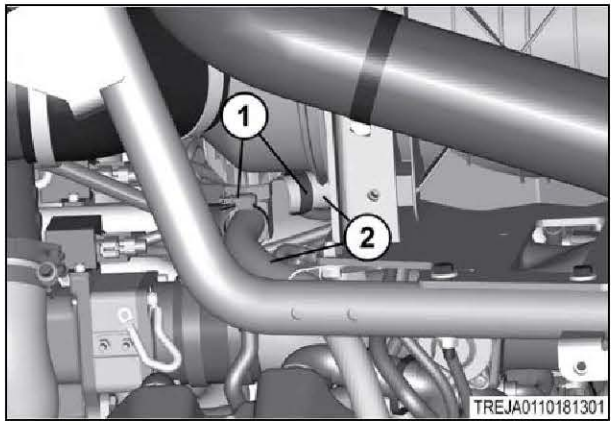


Fig. 380

6. Connect the two air filter intake tubes (2) with the hose clamps (1).

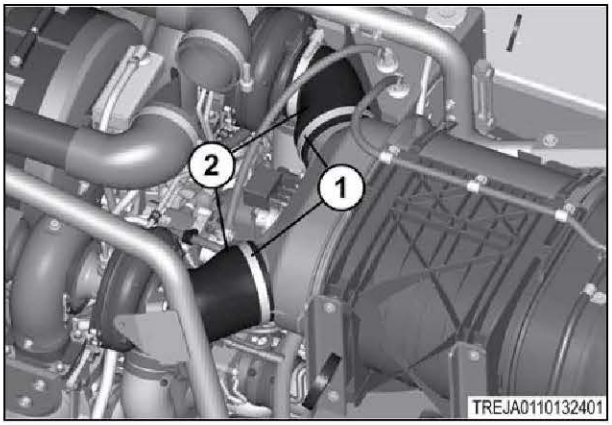


Fig. 381

7. If equipped with AdBlue®, install the bracket (3), clips and hardware (2, 1).

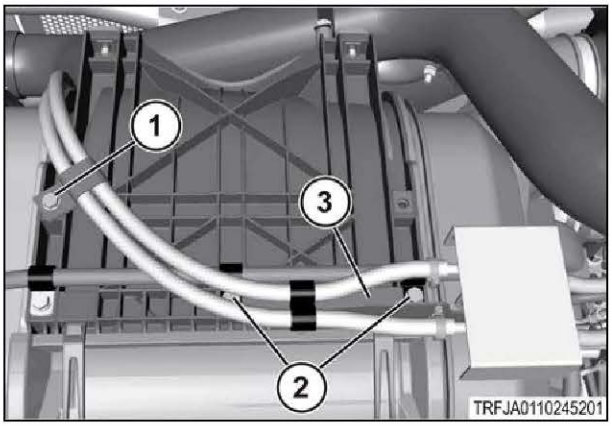


Fig. 382

8. Connect the two wiring harnesses (1) to the air filter.

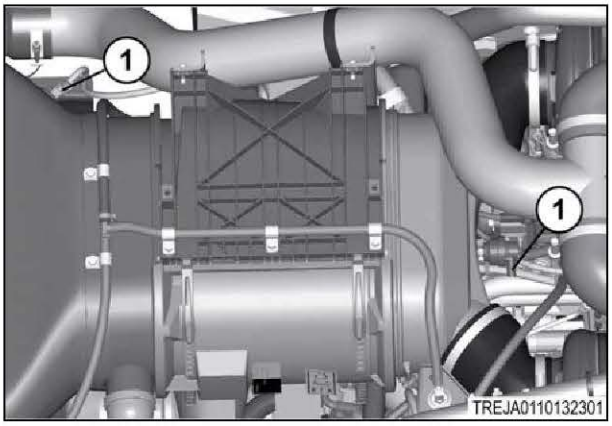


Fig. 383

9. Close the engine cover and connect the two latches (2).

10. Install the battery disconnect switch key (1).

11. Turn the battery disconnect switch key clockwise to connect the battery power.

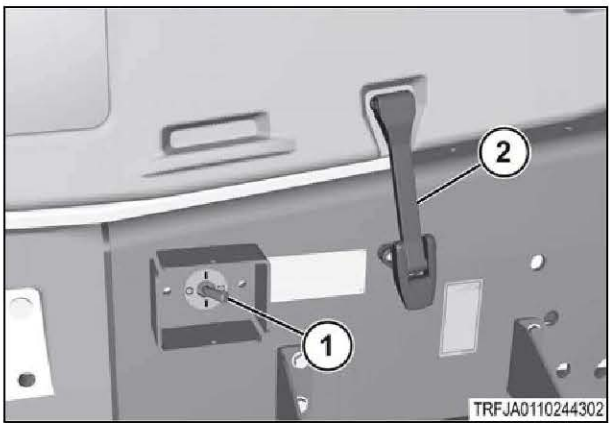


Fig. 384

2.2.27 Remove the fan

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Before removing the components, fasten identification tags on the components for correct assembly.

Completely clean all components to prevent contamination.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Block the wheels.
4. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.
5. Release the latches (1) and open the engine cover.

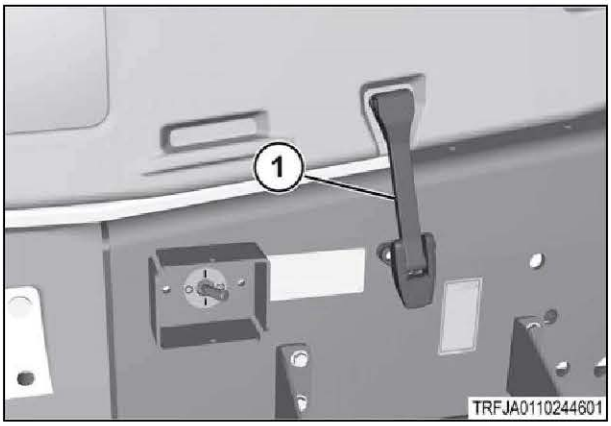


Fig. 385

6. Prop the engine cover (1).

CAUTION:
Engine cover can be a pinch point that can cause serious bodily injury.

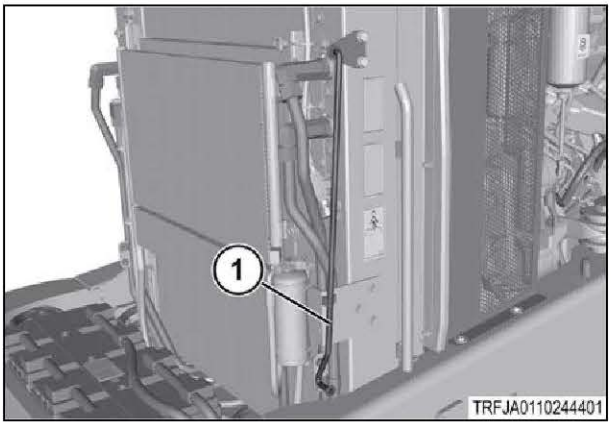


Fig. 386

7. Remove the hardware and the cover (1).

8. Install a drain hose to the drain valve (2).

9. Put a correct container below the drain valve and open the drain valve.

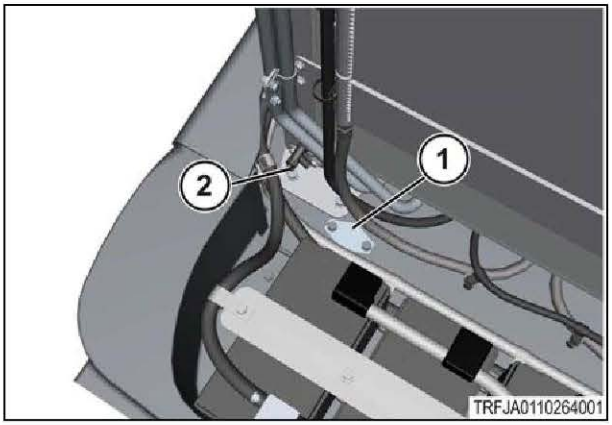


Fig. 387

10. Remove the hardware (1) and the fan guard (2).

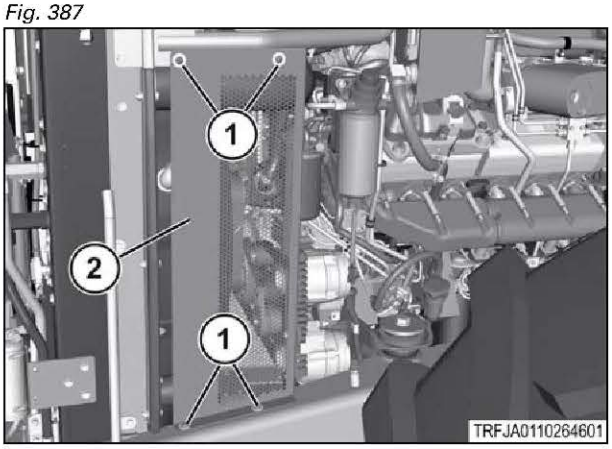


Fig. 388

11. Loosen the clamps (1) and remove the hose (2).

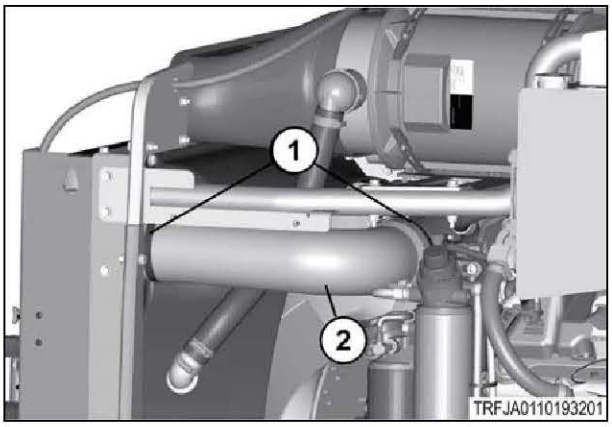


Fig. 389

12. Loosen the clamps (1) and remove the dust ejector hose (2).

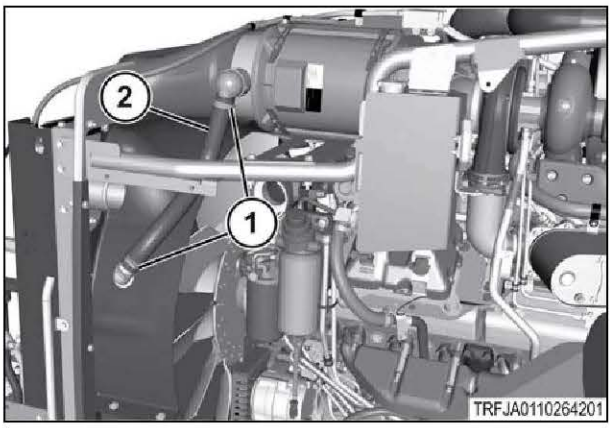


Fig. 390

13. Remove the hardware (1) on both sides of the shroud.

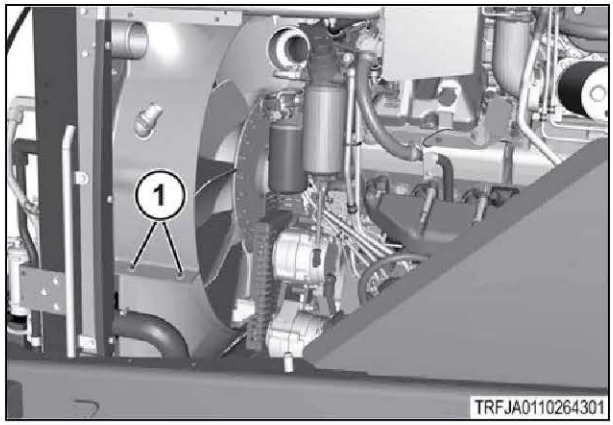


Fig. 391

14. Remove the hardware (1) on the top shroud and remove the shroud (2).

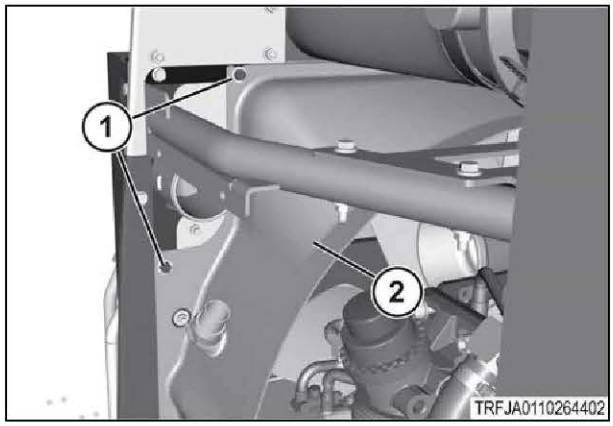


Fig. 392

15. Remove the hardware (1) on the fan.

16. Remove the fan (2).

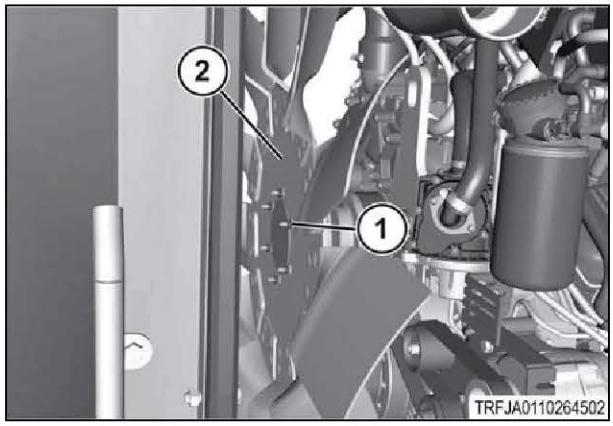


Fig. 393

2.2.28 Install the fan

Procedure

1. Install the fan.
2. Apply blue loctite sealant to the studs.
3. Torque the hardware to 26.5 Nm to 21.5 Nm (19.5 lbf-ft to 15.9 lbf-ft).

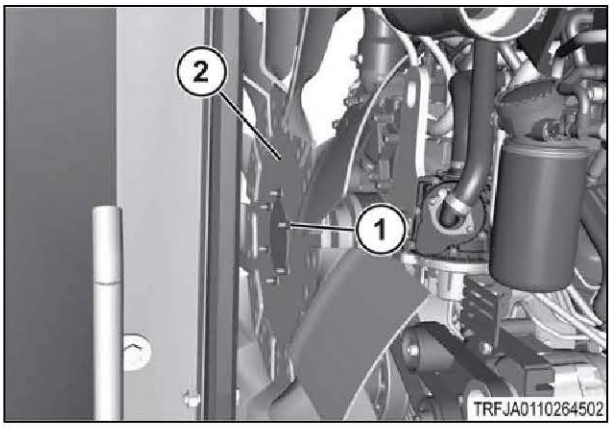


Fig. 394

4. Install the top shroud and the hardware (1).

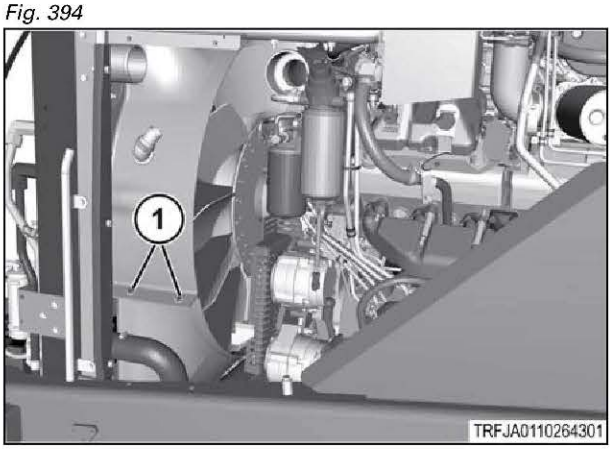


Fig. 395

5. Install the hardware (1).

   NOTE: *Make sure there is a clearance between the fan and the shroud* (2). *Damage can occur.*

6. Torque the hardware to no more than 45 Nm (33.2 lbf-ft).

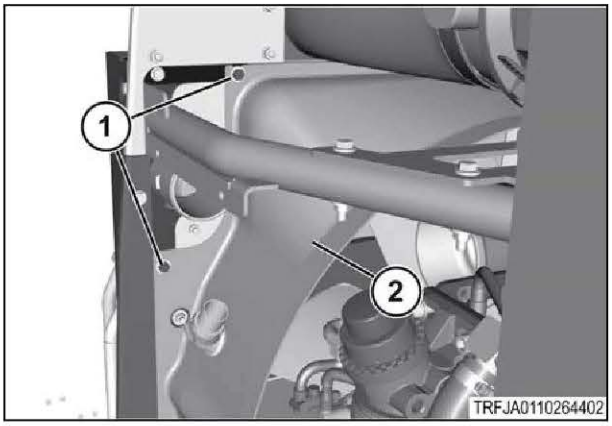


Fig. 396

7. Install the dust ejector hose (2) and the clamps (1).

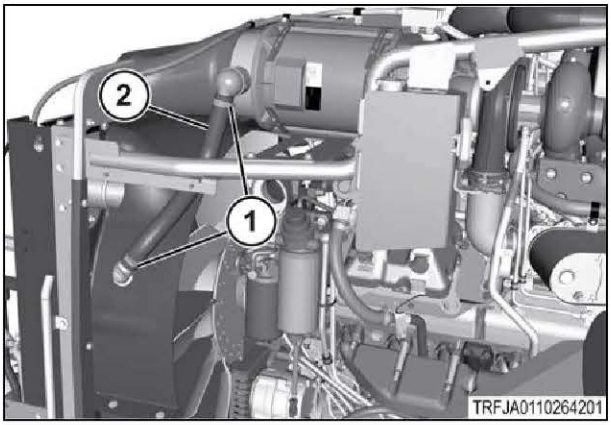


Fig. 397

8. Install the hose (2) and the clamps (2).

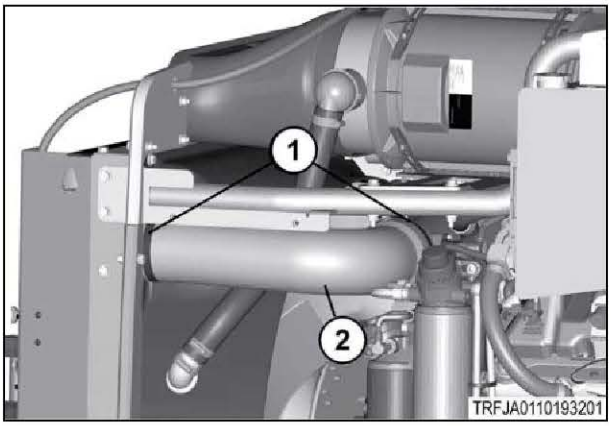


Fig. 398

9. Install the fan guard (2) with the hardware (1).

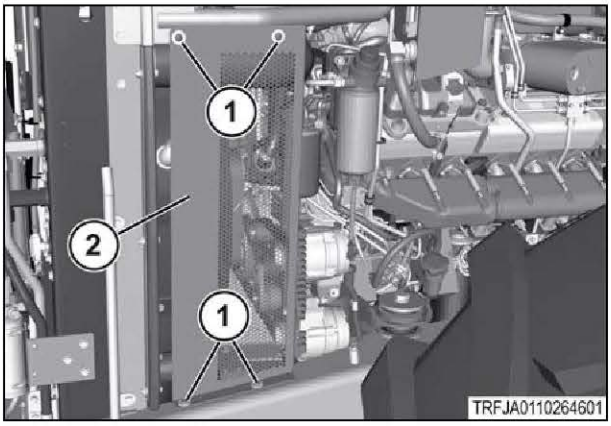


Fig. 399

10. Close the drain valve (2) and remove the drain hose.

11. Install the cover and hardware (1).

12. Refill the cooling system.

See the information on refilling the cooling system.

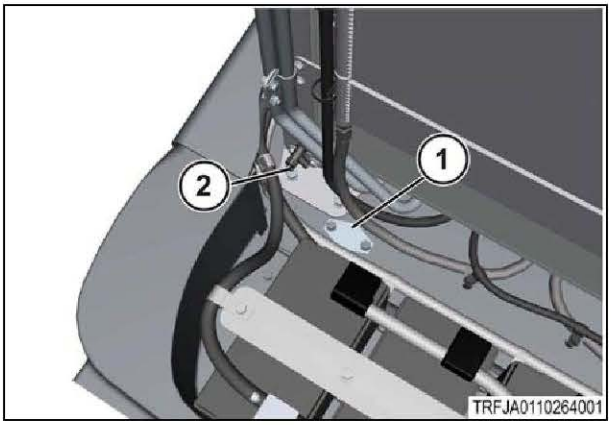


Fig. 400

13. Close the engine cover and secure the latches (1).

14. Install the key into the disconnect switch and turn to the on position.

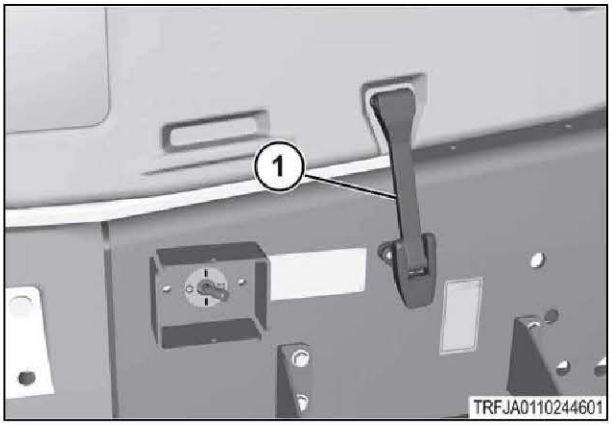


Fig. 401

2.2.29 Remove the air compressor

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Pressurized gases or fluids can be hazards.

Personal injury can result.

Relieve the pressure from the system or component before disconnecting components.

Before removing the components, fasten identification tags on the components for correct assembly.

Contain all fluids during inspection, maintenance, testing, adjustment, and repair of the machine. Before opening or disassembling any component containing fluids, prepare to contain fluids by having the correct containers available. Discard fluids according to local regulations and laws.

Complete all procedures on a clean work surface. Use a cover to keep the components clean. Protect the components from damage.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.

4. Release the latches (1) and open the engine cover.

CAUTION:
Safely prop open the engine cover (1). Closing the engine cover creates a pinch point that can cause serious bodily injury.

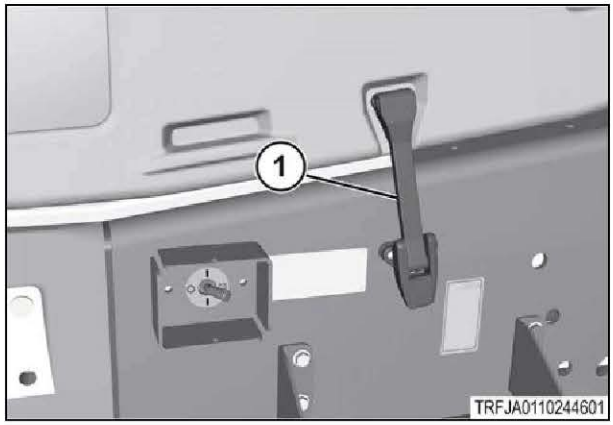


Fig. 402

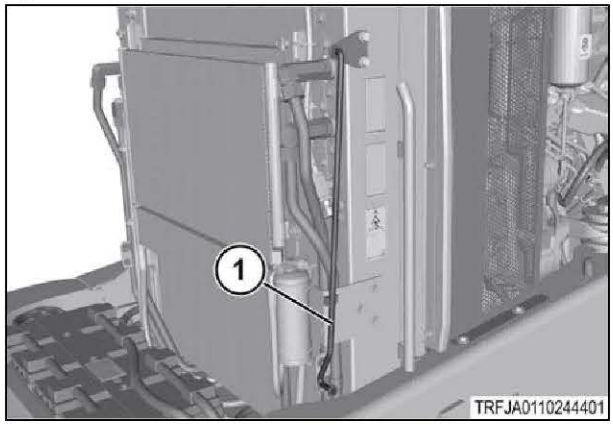


Fig. 403

5. Remove the hardware and the cover plate (1).

6. Install a hose to the radiator drain valve (2) and put through the access hole.

7. Set a correct container below the hose.

8. Loosen the radiator drain valve and drain the engine coolant.

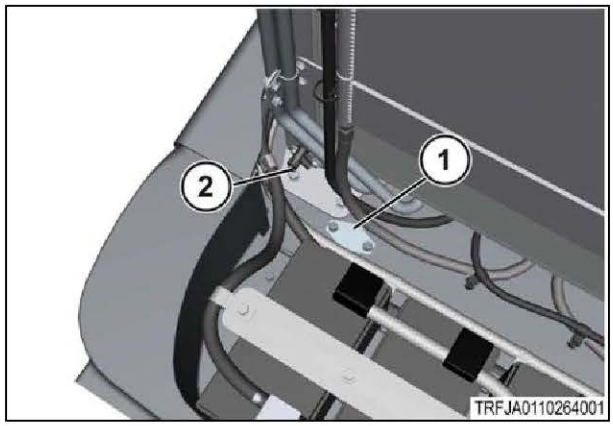


Fig. 404

9. Remove the hardware (1, 3) and the right-hand fan guard (2).

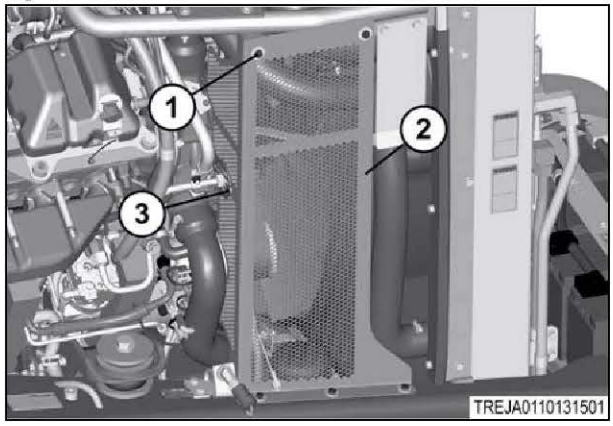


Fig. 405

10. Pull the drain valve ring (1) to release the air pressure.

IMPORTANT: *Do not disconnect the air lines until all compressed air is removed from the system.*

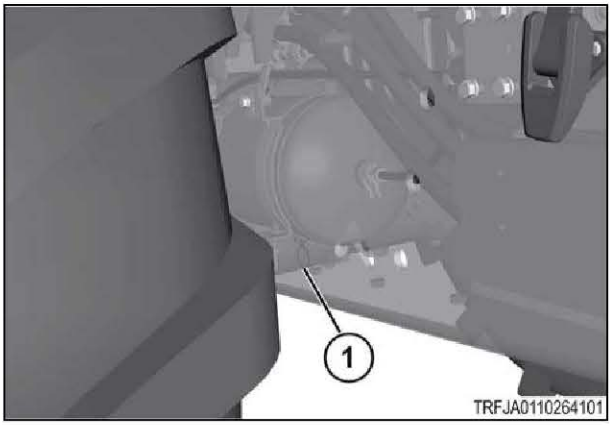


Fig. 406

11. Loosen the clamp (1) and disconnect the hose (2).

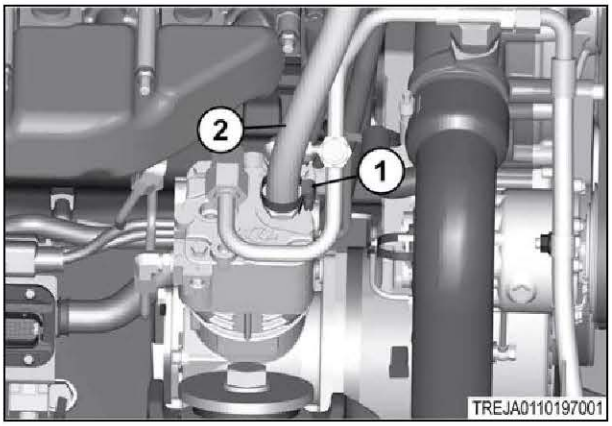


Fig. 407

12. Disconnect the discharge line (1).

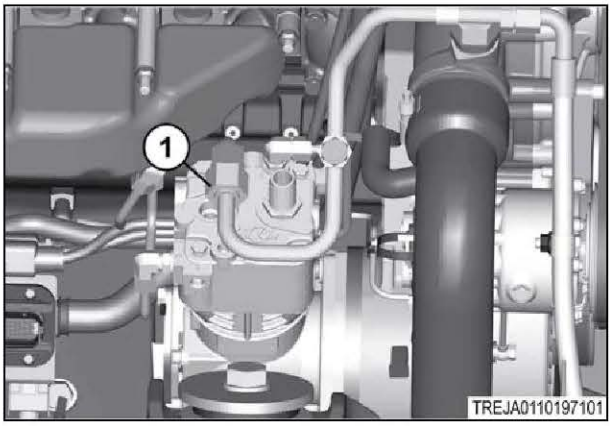


Fig. 408

13. Disconnect the coolant lines (1).

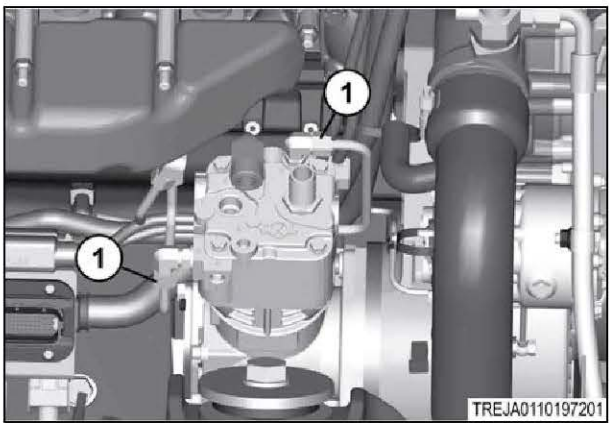


Fig. 409

14. Remove the bolt (3) from the tube (4).

15. Remove the hardware (1) and move the air compressor (2) to the rear and remove.

16. Remove the o-rings (5).

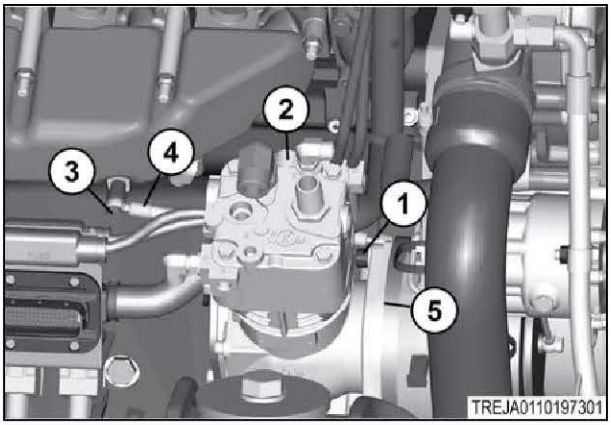


Fig. 410

17. Remove the tube (1), the coolant fittings (2), the discharge fitting (3), and the intake fitting (4).

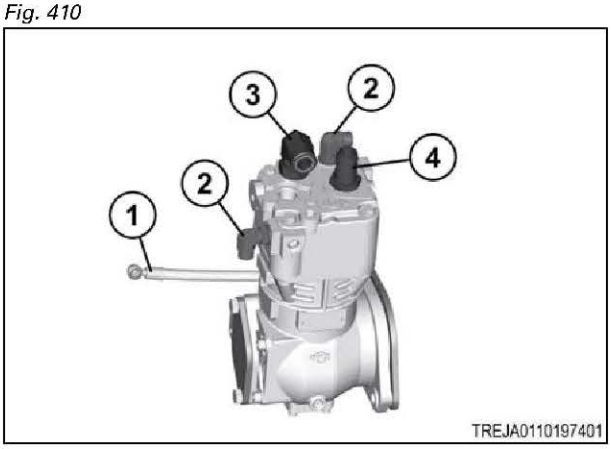


Fig. 411

2.2.30 Install the air compressor

Procedure

1. Install the tube (1), the coolant fittings (2), the discharge fitting (3), and the intake fitting (4).

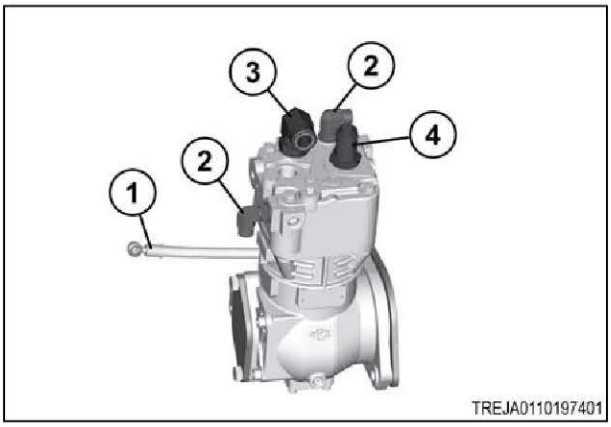


Fig. 412

2. Install the new o-rings (5) to both sides of the flange.

3. Install the air compressor (2) with the hardware (1).

4. Install the tube (4) with the bolt (3).

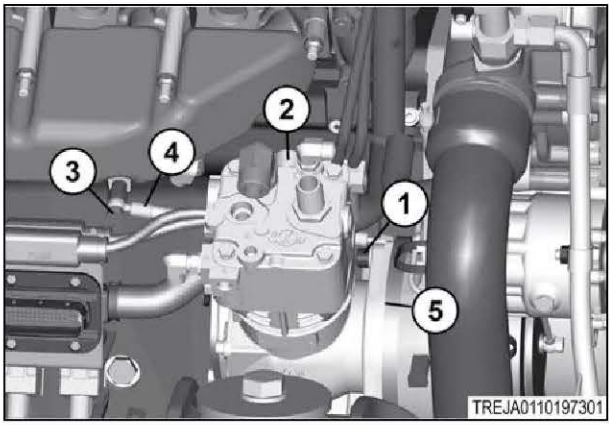


Fig. 413

5. Connect the coolant lines (1).

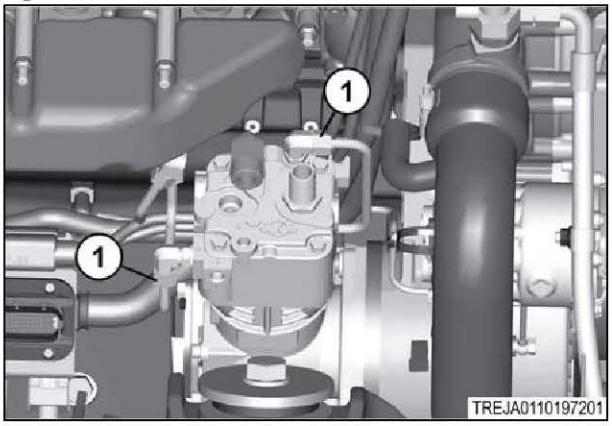


Fig. 414

6. Connect the discharge line (1).

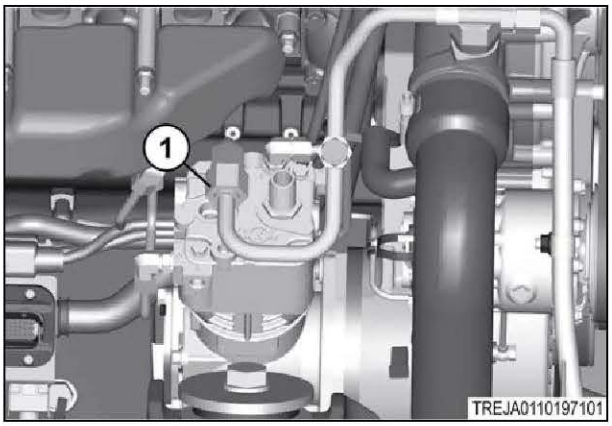


Fig. 415

7. Connect the hose (2) with the clamp (1).

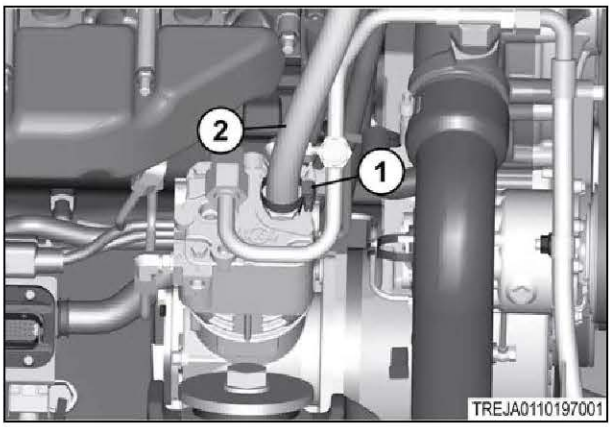


Fig. 416

8. Install the right-hand fan guard (2) with the hardware (1, 3).

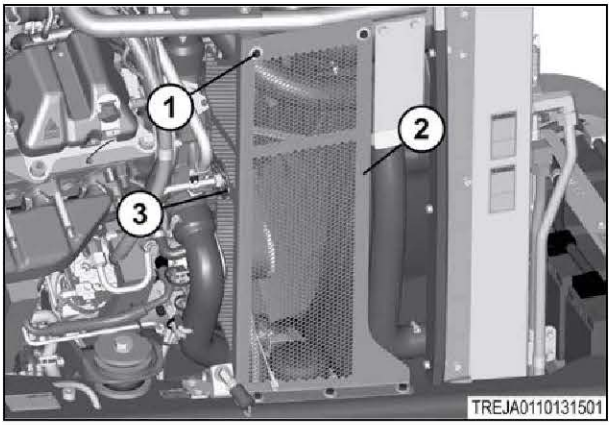


Fig. 417

9. Close the radiator drain valve (2) and remove the drain hose.
10. Install the cover plate with the hardware (1).
11. Fill the radiator with the correct engine coolant.

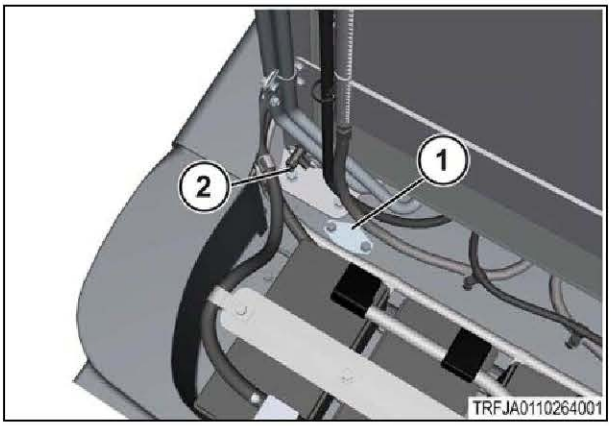


Fig. 418

12. Close the engine cover and attach the latches (1).
13. Insert the key into the disconnect switch and turn to the on position.

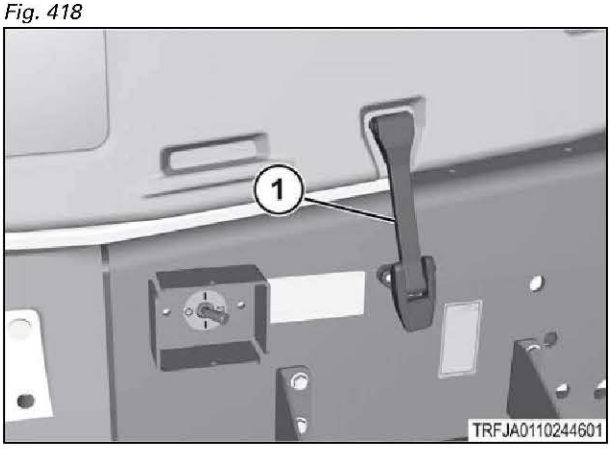


Fig. 419

Related Links

Coolant quality requirements page 2-239
Fill capacities page 1-18
Refill the cooling system page 2-149

2.2.31 Remove a starter

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.

3. Turn the battery disconnect switch (1) to the off position. Remove the key from the battery disconnect switch.

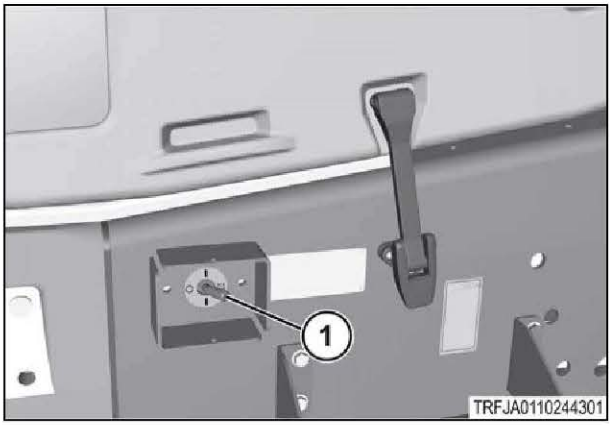


Fig. 420

4. Remove the hardware from the rear guard (1) and the frame (2).

5. Remove the engine guard (3).

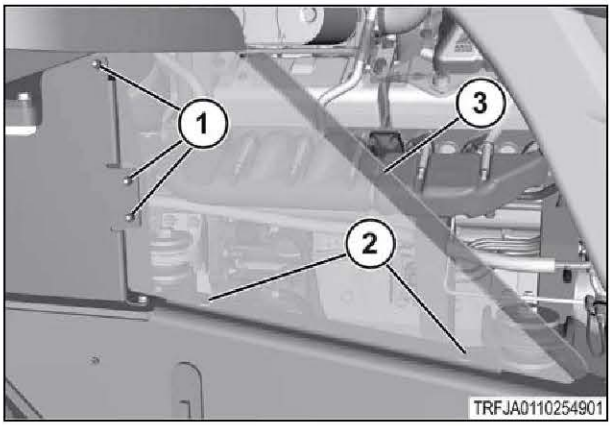


Fig. 421

6. Remove the battery cables (1) from the starter.

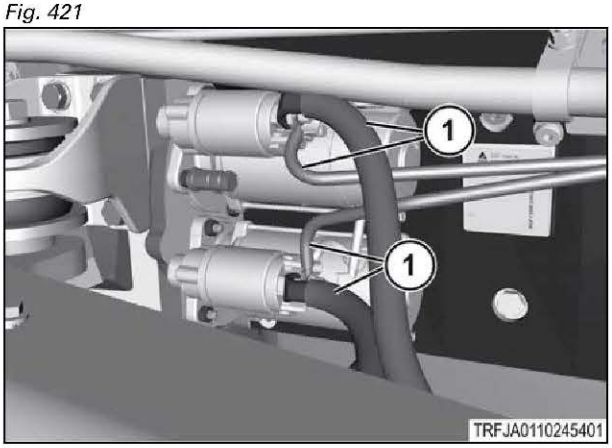


Fig. 422

7. Remove the terminal (1).

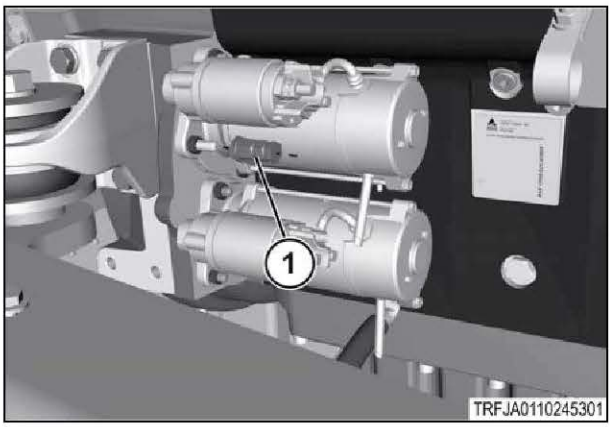


Fig. 423

8. Remove the hardware (1).

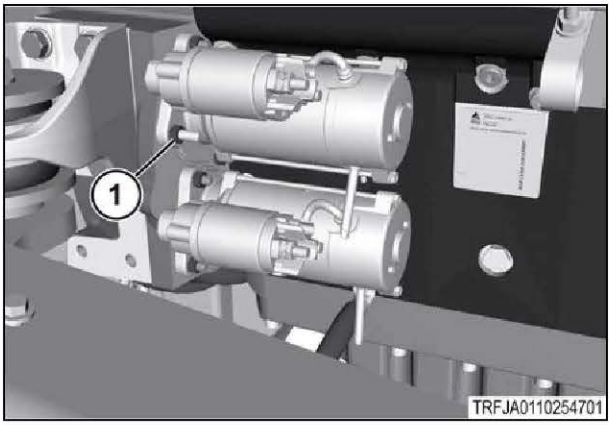


Fig. 424

9. Remove the starter (1).

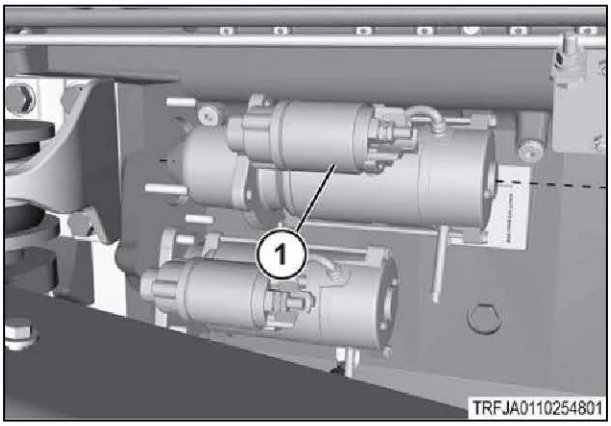


Fig. 425

2.2.32 Install a starter

Procedure

1. Install the starter (1).

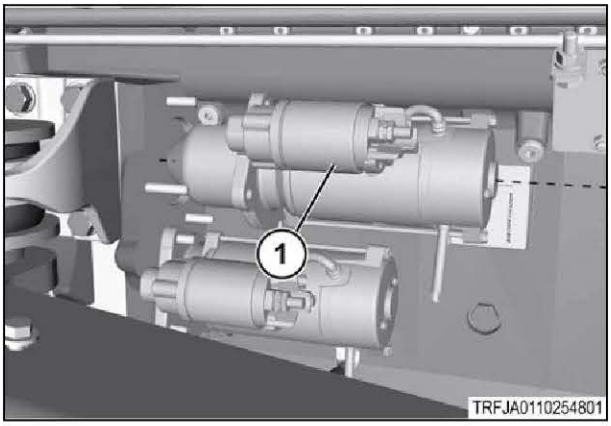


Fig. 426

2. Install the hardware (1).

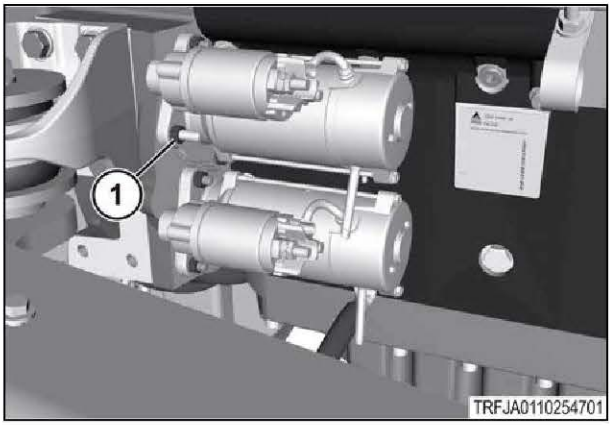


Fig. 427

3. Install the terminal (1).

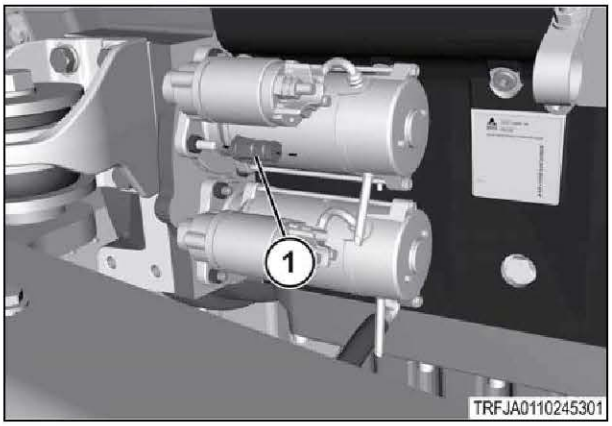


Fig. 428

4. Install the battery cables (1).

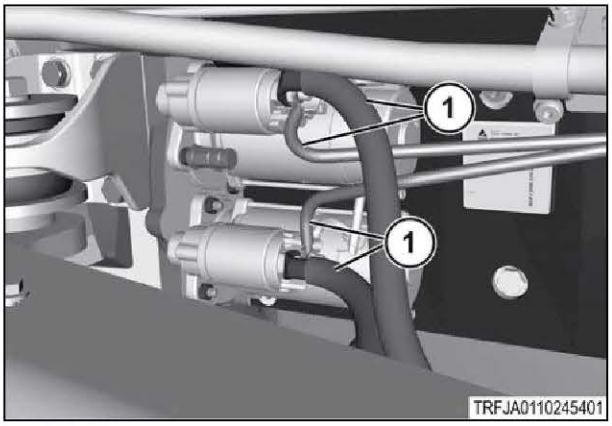


Fig. 429

5. Install the engine guard (3) and the hardware (1, 2).

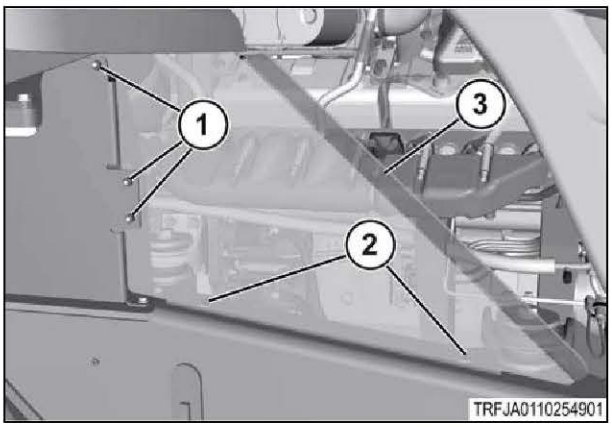


Fig. 430

2.2.33 Remove the engine



WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.



WARNING: Contact with refrigerant is a hazard. Refrigerant can cause frostbite and other serious injury.

Serious personal injury can occur.

Keep face and hands away to help prevent injury. Protective goggles must be worn when refrigerant lines are opened. Release fittings slowly in an well ventilated area. Do not inhale the refrigerant.



WARNING: Pressurized gases or fluids can be hazards.

Personal injury can result.

Relieve the pressure from the system or component before disconnecting components.



CAUTION:
Be careful when handling diesel exhaust fluid (DEF). DEF is aggressive to some materials and corrosive to some metals. In case of spillage rinse with plenty of water and dry with a clean cloth.



WARNING:
Be prepared to collect and contain fuel in a suitable container. Fuel can contaminate water supplies and cause personal injury if it comes in contact with skin and eyes. Fuel is highly flammable no smoking or open flames are allowed near fuel containers.

NOTE: *Before removal, put identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to contain fluids with the correct containers before opening any compartment or disassembling any component containing fluids. Discard fluids according to the local regulations and the laws.*

NOTE: *Fully clean all components to prevent contamination from entering the system. Contamination can damage the precision components. Complete the disassembly procedures on a clean work surface. Put a clean cloth on top of the components.*

NOTE: *Use only certified technicians and equipment to service the air conditioning systems.*

NOTE: *When opening the air conditioning system, replace the receiver-dryer. See the information for removing/installing the receiver-dryer.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Disconnect the battery with the battery disconnect switch.
4. Remove the engine cover.

5. Remove the hardware (1) and the cover plate (2).

6. Install a temporary hose to the radiator drain valve (3) and put through the access hole.

7. Set a correct container under the hose.

8. Loosen the radiator drain valve (3) and drain the engine coolant.

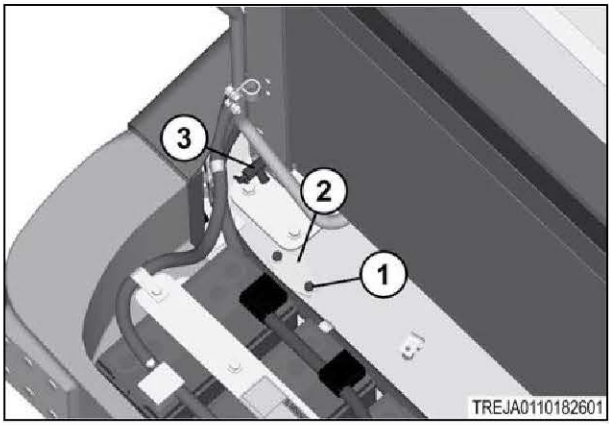


Fig. 431

9. Close the fuel shut off valve (1).

   NOTE: *The valve is shown in the open position.*

10. Remove the diesel exhaust fluid (DEF) system.

11. Remove the air filter assembly.

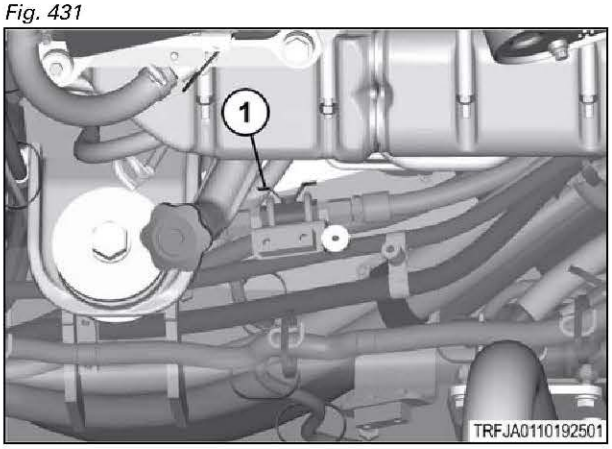


Fig. 432

12. Remove the hardware and the left fan guard (1).

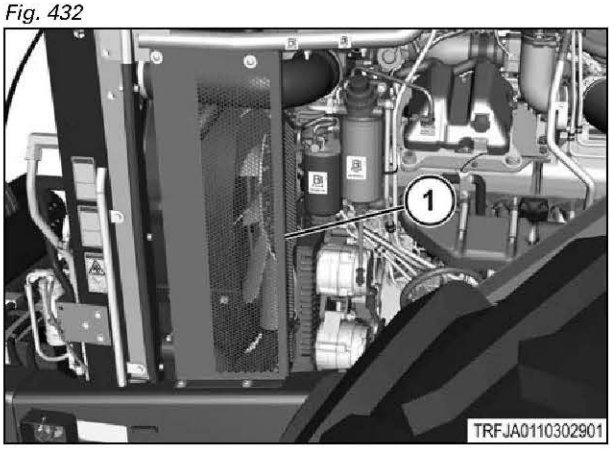


Fig. 433

13. Disconnect the electrical connections (1) on the left-hand side of the engine.

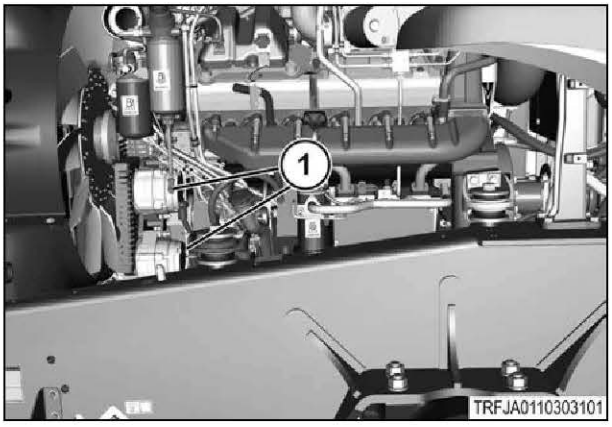


Fig. 434

14. Remove the hardware (1, 3) and the right fan guard (2).

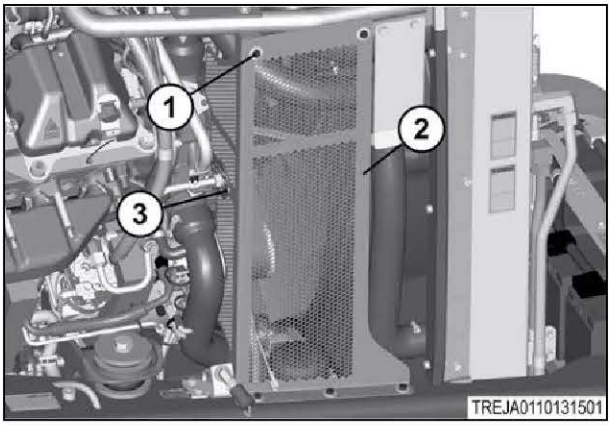


Fig. 435

15. Disconnect the electrical connections (1) on the right-hand side of the engine.

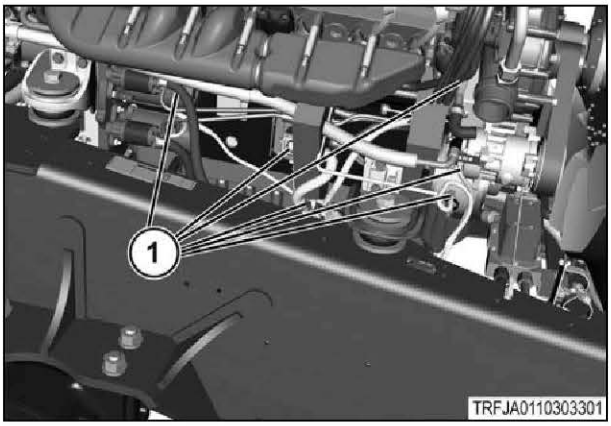


Fig. 436

16. Remove the hardware (1) and the air filter mounting bracket (2).

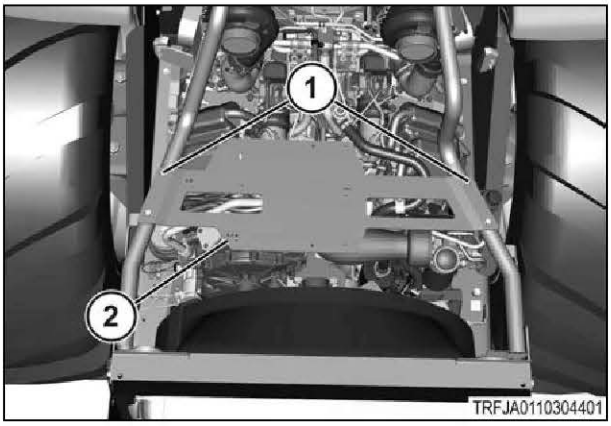


Fig. 437

17. Remove the hardware (1) and the right support bracket (2).

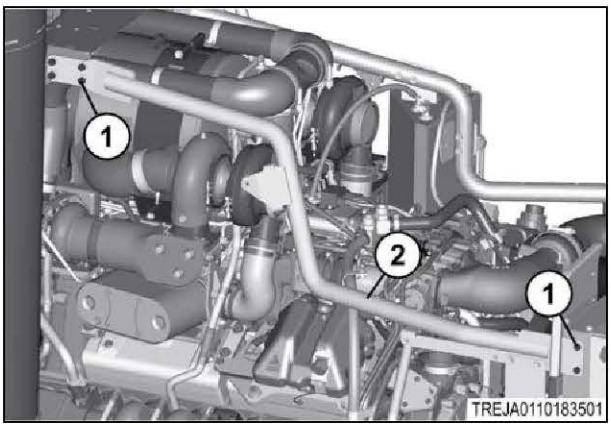


Fig. 438

18. Loosen the hose clamps (1) and disconnect the hoses (2) from the expansion tank.

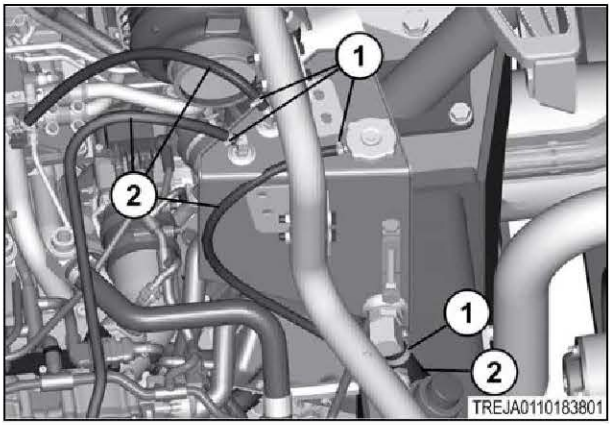


Fig. 439

19. Remove the hardware (1) and the expansion tank (2).

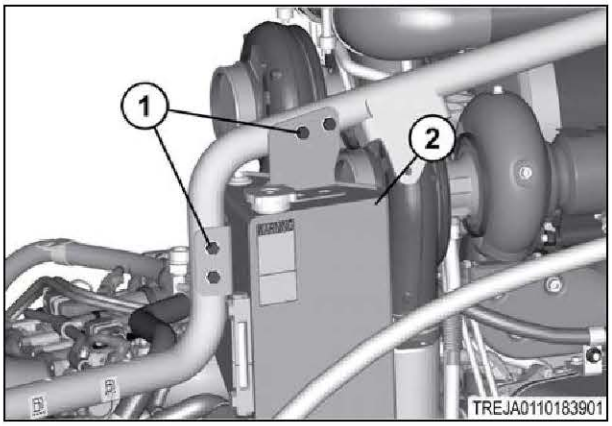


Fig. 440

20. Remove the hardware (1) and the left support bracket (2).

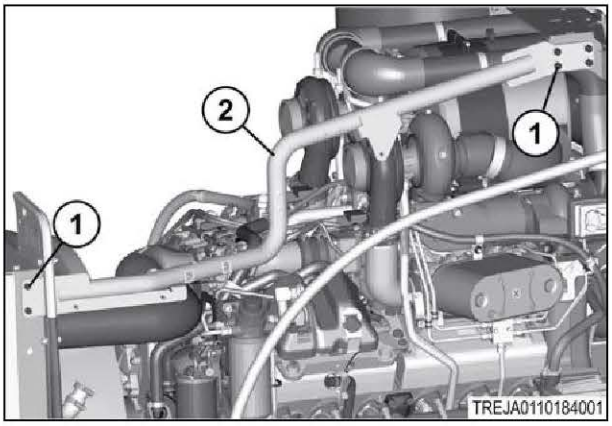


Fig. 441

21. Remove the hardware (1), the hose clamp (2), and the bracket (3).

22. Loosen the hose clamps (4) and disconnect the inlet radiator hose (5).

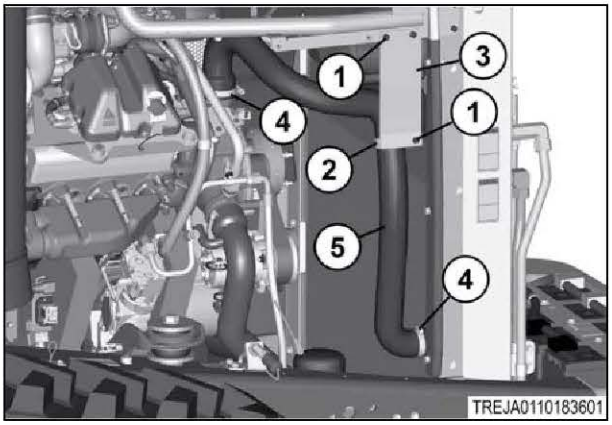


Fig. 442

23. Remove the hardware (1) and the hose clamp (2).

24. Loosen the hose clamps (3) and disconnect the outlet radiator hose (4).

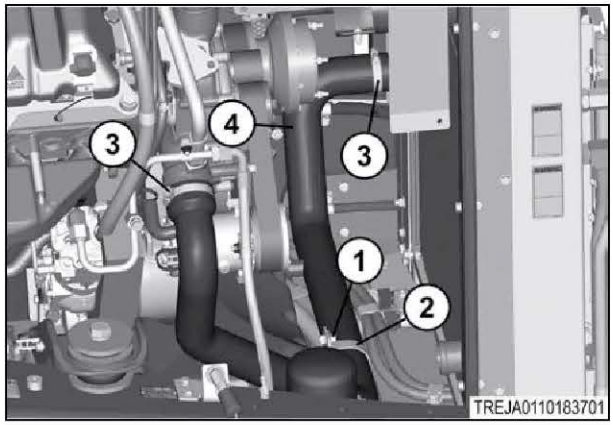


Fig. 443

25. Loosen the hose clamps (1) and disconnect the left charge air cooler hose (2).

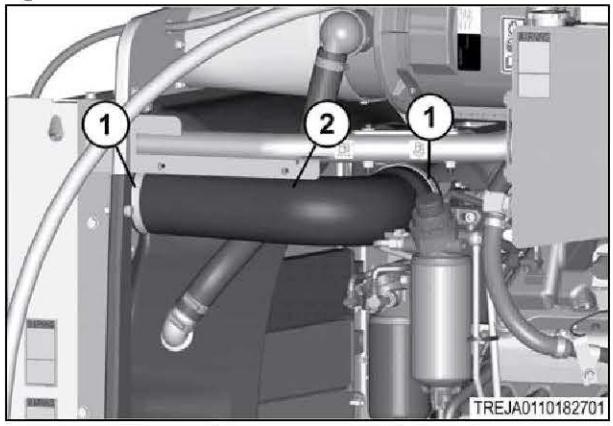


Fig. 444

26. Loosen the hose clamp (1) and disconnect the right charge air cooler hose (2).

27. Remove the hardware (3) and the hose clamp (4).

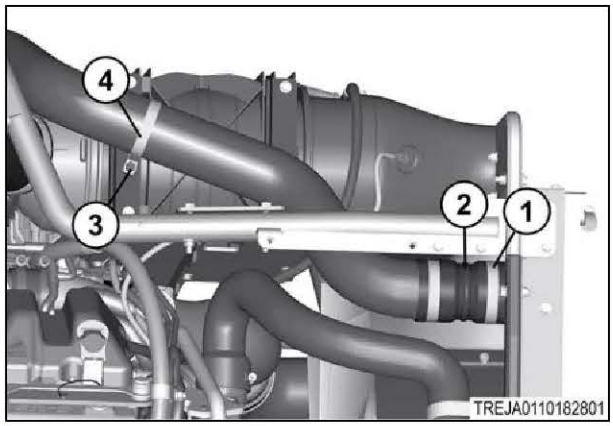


Fig. 445

28. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

NOTE: *The fan drive belt must first be removed to replace the accessories belt.*

Install the correct breaker bar into the square drive (1) of the accessories belt tensioner (2).

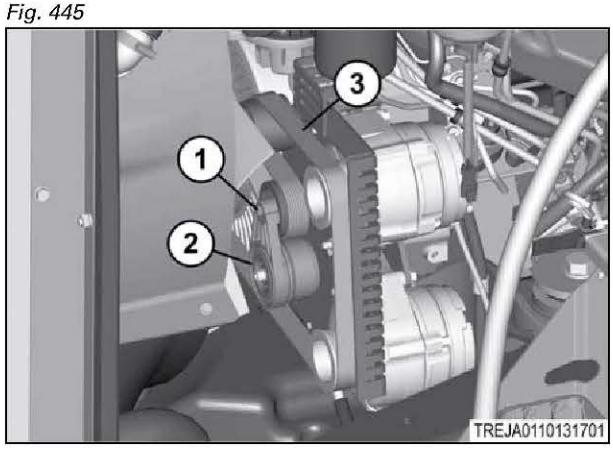


Fig. 446

29. Push counterclockwise and remove the accessories belt (3) from the pulleys.

30. Slowly release the accessories belt tensioner to the neutral position.

31. Remove the breaker bar.

32. Disconnect the fuel line (1) at the shut off. Disconnect the negative ground cable (2).

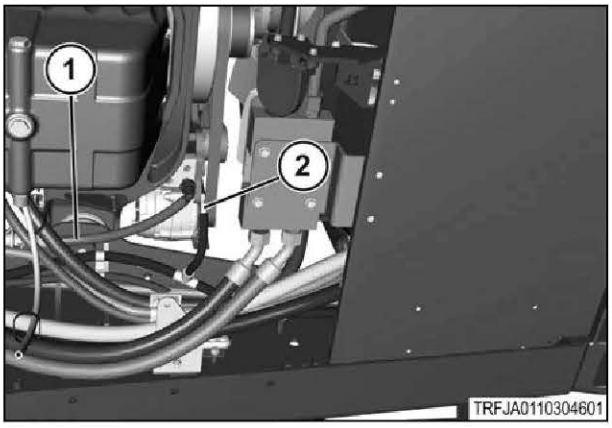


Fig. 447

33. Disconnect the wire harness (1) and the air conditioning lines (2).

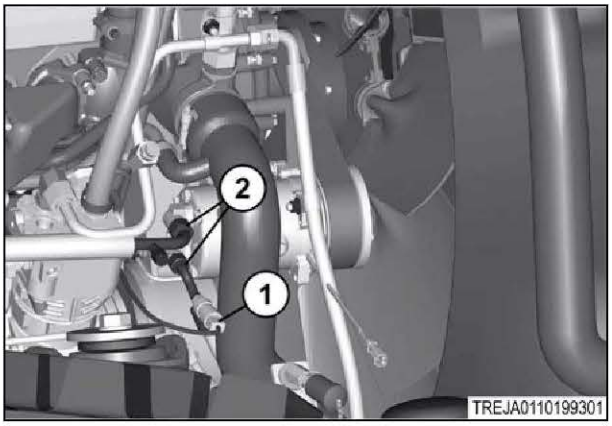


Fig. 448

34. Disconnect the hose (1) from the air compressor.

35. Remove the hardware (4) and the hose clip (5).

36. Remove the hardware (2) and the negative ground cable (3).

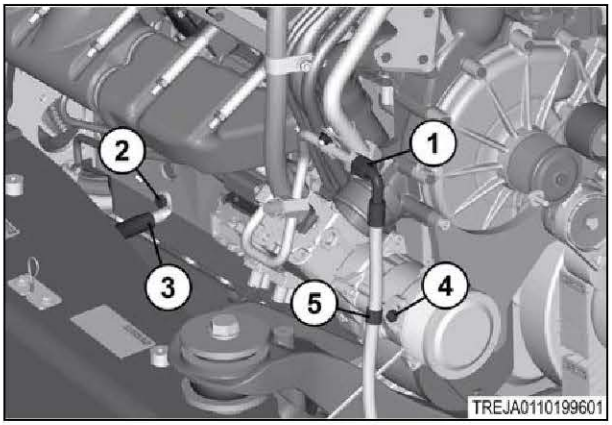


Fig. 449

37. Disconnect the positive power cables (1).

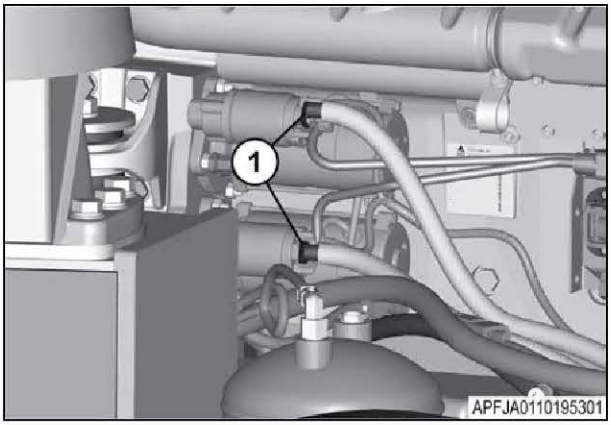


Fig. 450

38. Remove the hardware (1) and the bracket (2).

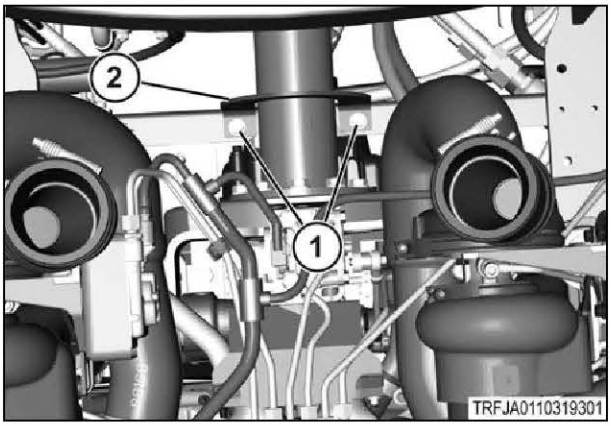


Fig. 451

39. Remove the hardware (1) from the yoke (2).

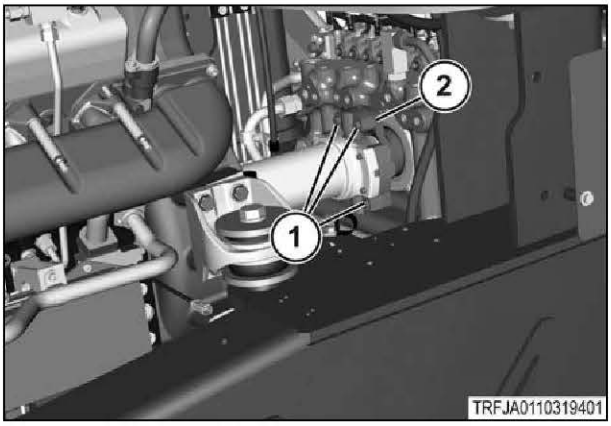


Fig. 452

40. Remove the hardware (1) and the transmission input shaft (2).

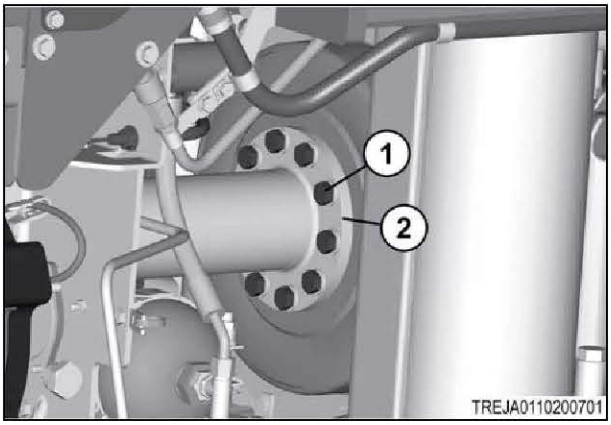


Fig. 453

41. Remove the hardware and the top fan shroud (1).

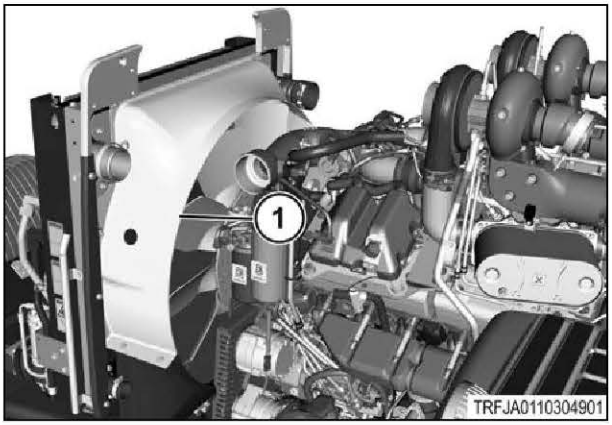


Fig. 454

42. Disconnect the wire harness (2).

43. Remove the hardware (1) and the boost pipe (3).

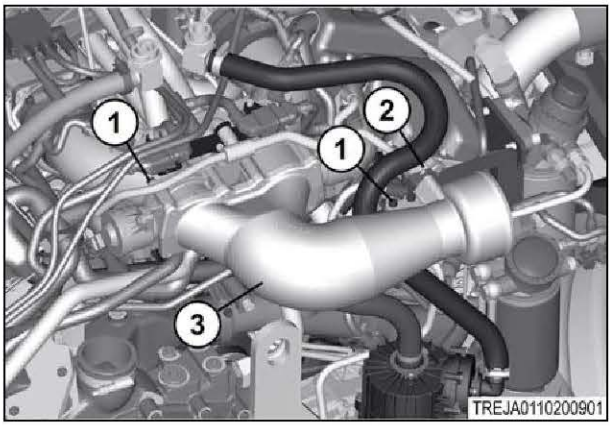


Fig. 455

44.

DANGER:
Do not fasten the lifting chains at an angle to the engine eye bolts. Install the lifting chains straight-above the engine eye bolts.

WARNING:
Always use extreme caution when lifting heavy objects overhead.

Fasten the lifting chains straight-up from the front engine lift bracket (1).

IMPORTANT: *The weight of the engine dry is approximately 1797 kg (3961 lb).*

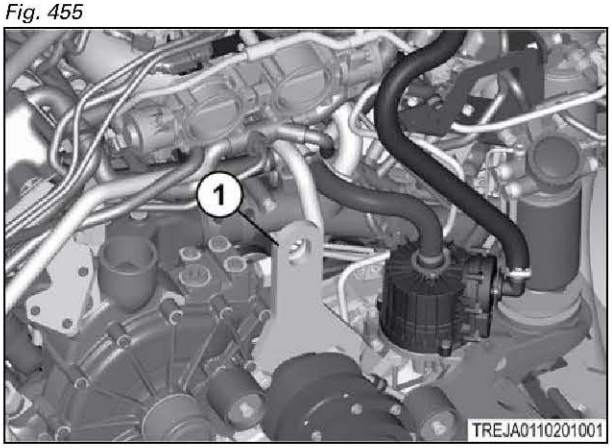


Fig. 456

45. Fasten the lifting chains straight-up from the rear engine lift bracket (1).

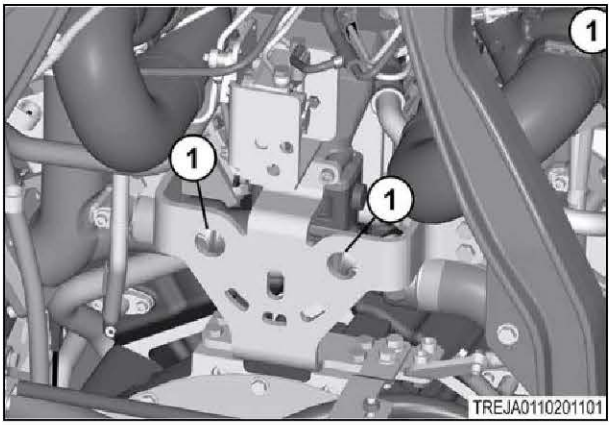


Fig. 457

46. Remove the right-hand side engine mounting bolts (1).

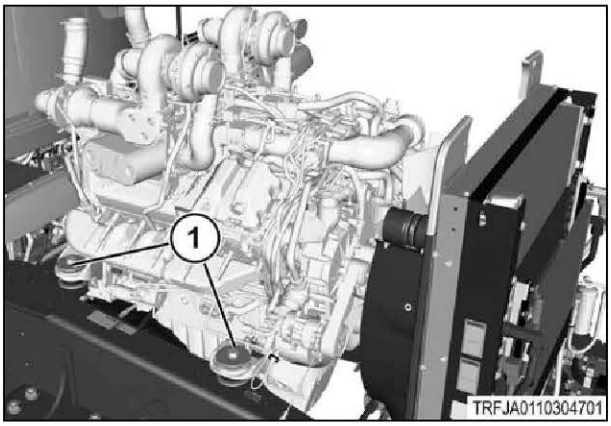


Fig. 458

47. Remove the left-hand side engine mounting bolts (1).

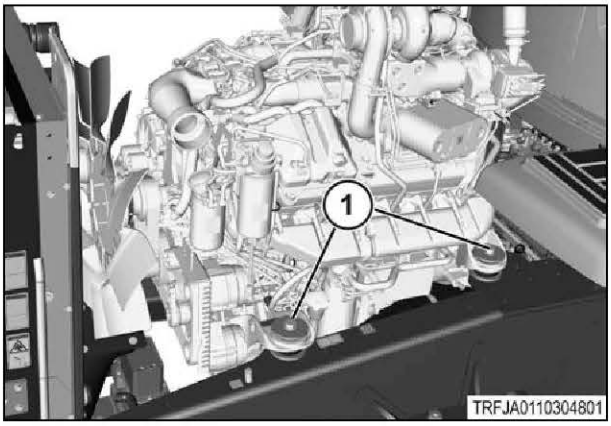


Fig. 459

48. **WARNING:**
Always use extreme caution when lifting heavy objects overhead.

Carefully lift the engine from the chassis.

IMPORTANT: *The weight of the engine dry is approximately 1797 kg (3961 lb).*

Related Links

Remove the engine cover page 13-3
Remove the exhaust system with the diesel exhaust fluid system page 2-178
Remove the air filter assembly page 2-111
Remove the batteries page 10-22

2.2.34 Installing the engine

Procedure

1. **DANGER:**
Do not fasten the lifting chains at an angle to the engine eye bolts. Install the lifting chains straight-above the engine eye bolts.

WARNING:
Always use extreme caution when lifting heavy objects overhead.

Fasten the lifting chains straight-up from the front engine lift bracket (1).

IMPORTANT: *The weight of the engine dry is approximately 1797 kg (3961 lb).*

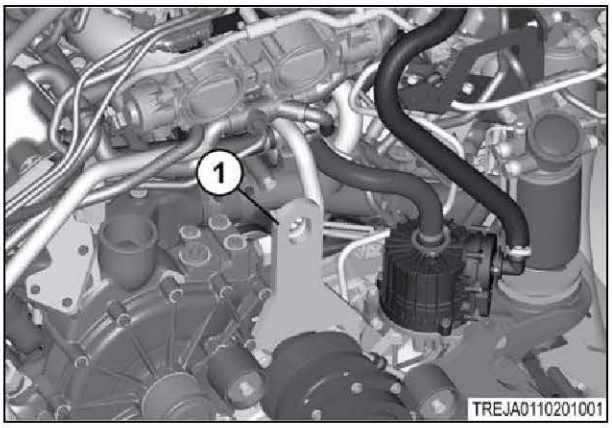


Fig. 460

2. Fasten the lifting chains straight-up from the rear engine lift bracket (1).

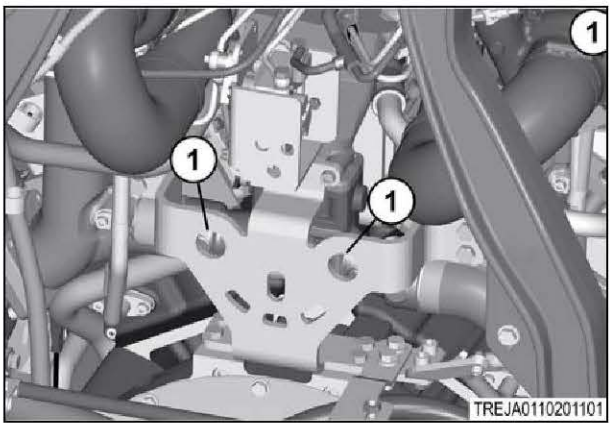


Fig. 461

3. **WARNING:**
Always use extreme caution when lifting heavy objects overhead.

Carefully lift the engine and set in the chassis.

IMPORTANT: *The weight of the engine dry is approximately 1797 kg (3961 lb).*

4. Install the right-hand side engine mounting bolts (1).

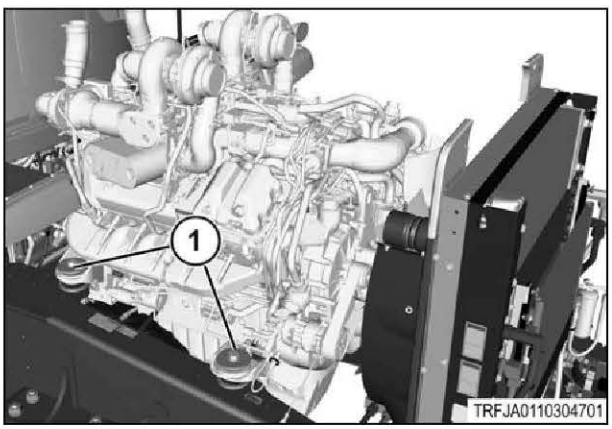


Fig. 462

5. Install the left-hand side engine mounting bolts (1).

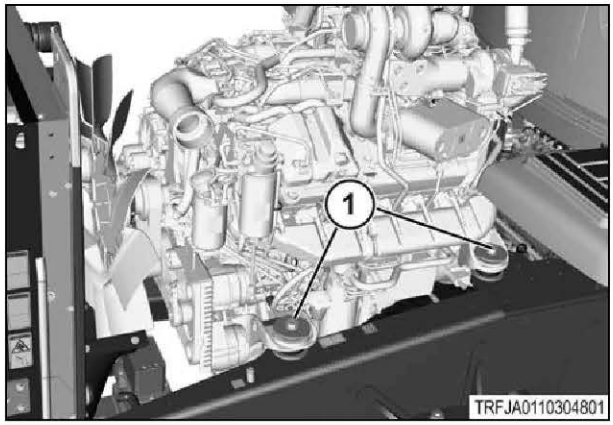


Fig. 463

6. Use the hardware (1) to install the boost pipe (3).

7. Connect the wire harness (2).

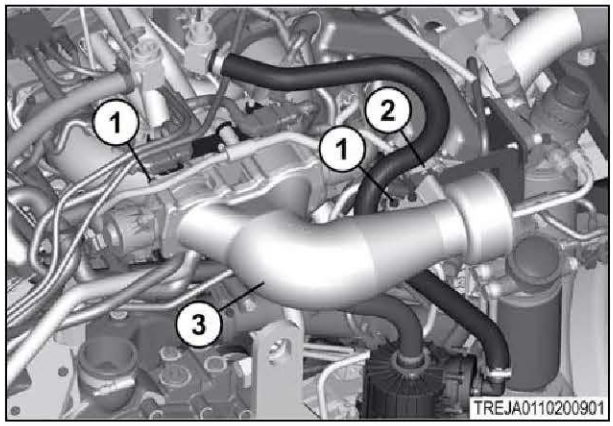


Fig. 464

8. Use the hardware to install the top fan shroud (1).

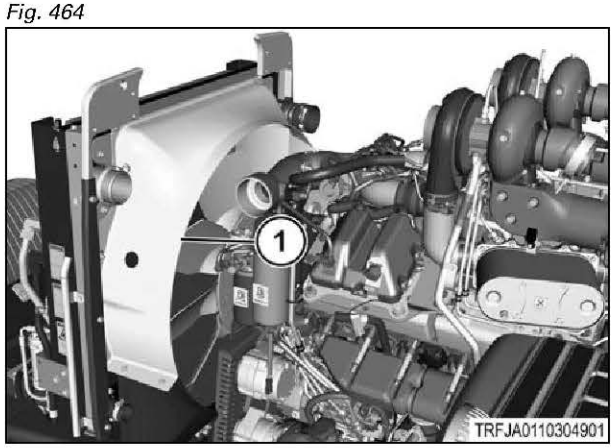


Fig. 465

9. Use the hardware (1) to install the input shaft (2).

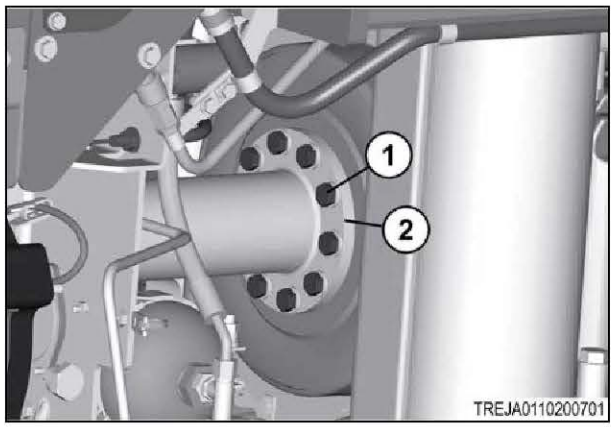


Fig. 466

10. Use the hardware (1) to install the yoke (2).

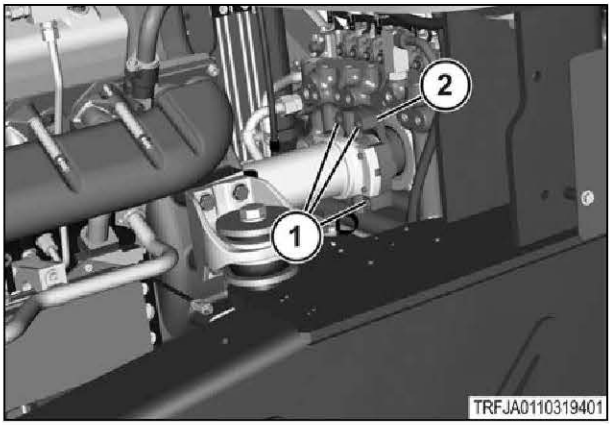


Fig. 467

11. Use the hardware (1) to install the bracket (2).

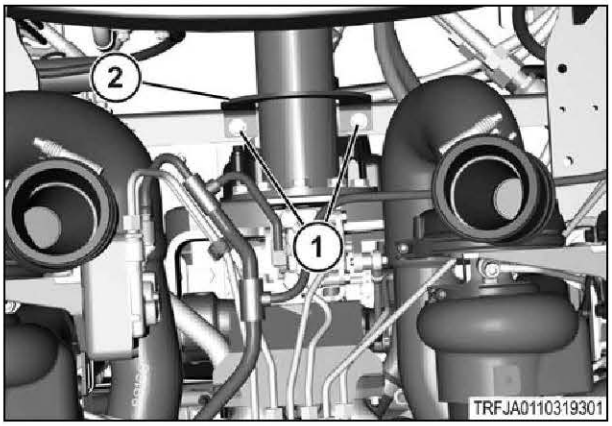


Fig. 468

12. Install the air conditioning compressor (1).

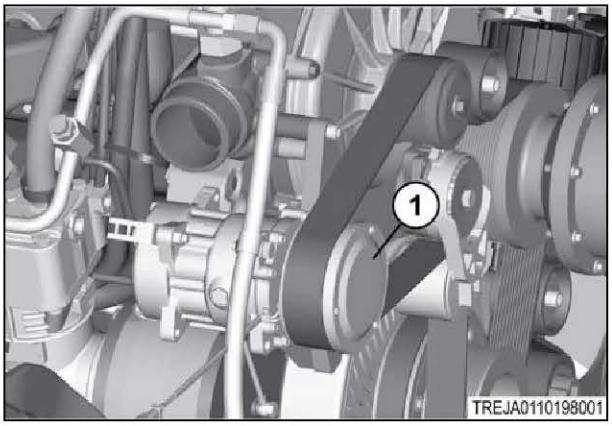


Fig. 469

13. Use the hardware (2) to install the ground cable (3).

14. Use the hardware (4) to install the hose clip (5).

15. Connect the hose (1) to the air compressor.

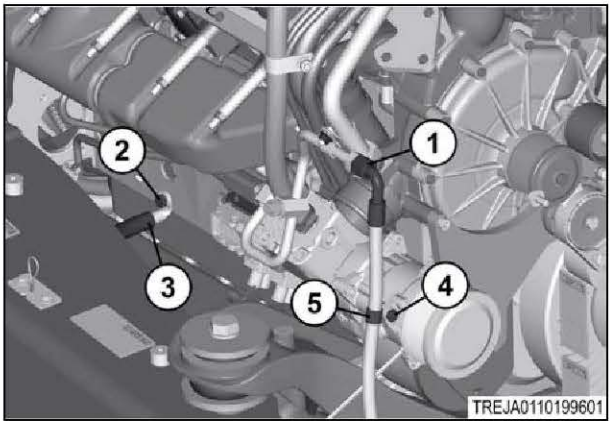


Fig. 470

16. Connect the wire harness (1) to the air conditioning compressor.

17. Connect the lines (2) to the compressor.

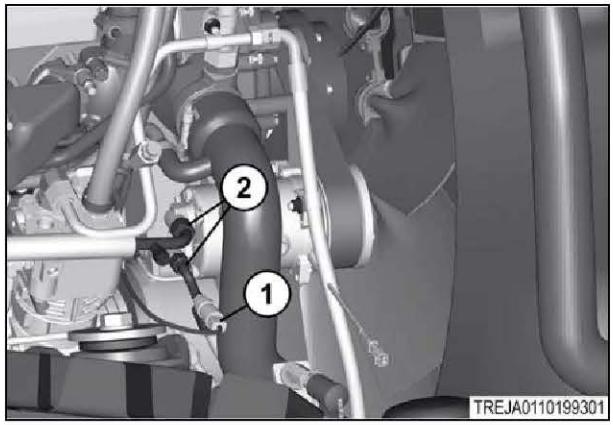


Fig. 471

18. Use the hardware to connect the fuel line (1) at the shut off. Connect the negative ground cable (2).

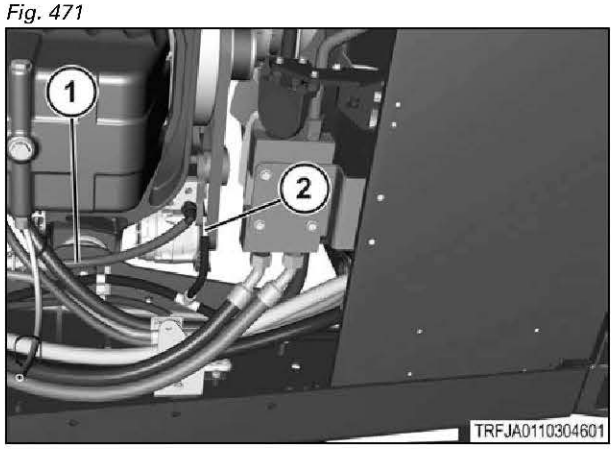


Fig. 472

19. **WARNING:**
Equipment or parts under spring tension can cause bodily injury. Use caution in releasing belt tension.

Install the correct breaker-bar into the square drive (1) of the accessories belt tensioner (2).

20. Push the breaker-bar counterclockwise and install the accessories belt (3) to the pulleys.

21. Slowly release the accessories belt tensioner to the neutral position, and remove the breaker bar.

22. Use the hose clamp (1) to connect the right side charge air cooler hose (2).

23. Use the hardware (3) to install the hose clamp (4).

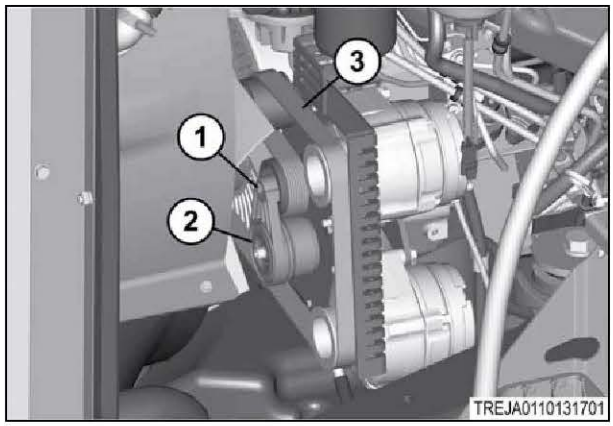


Fig. 473

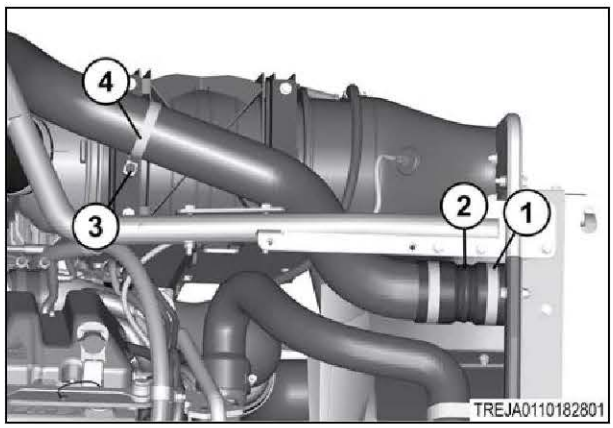


Fig. 474

24. Use the hose clamps (1) to connect the left side charge air cooler hose (2).

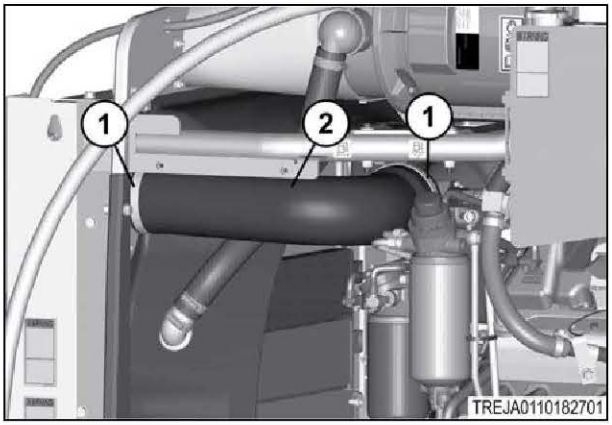


Fig. 475

25. Use the hose clamps (3) to connect the outlet radiator hose (4).

26. Use the hardware (1) to install the hose clamp (2).

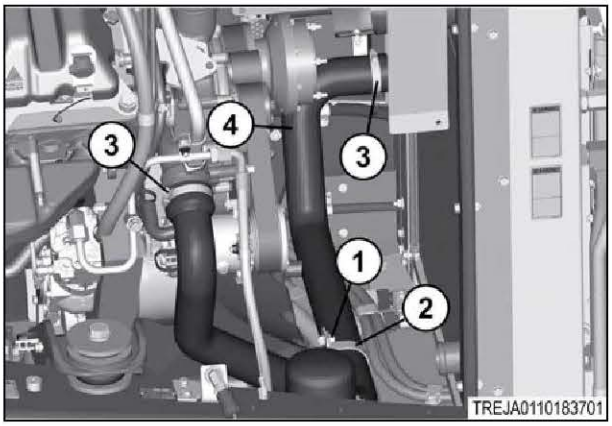


Fig. 476

27. Use the hose clamps (4) to connect the inlet radiator hose (5).

28. Use the hardware (1) to install the bracket (3) and the hose clip (2).

29. Install the diesel exhaust fluid (DEF) system.

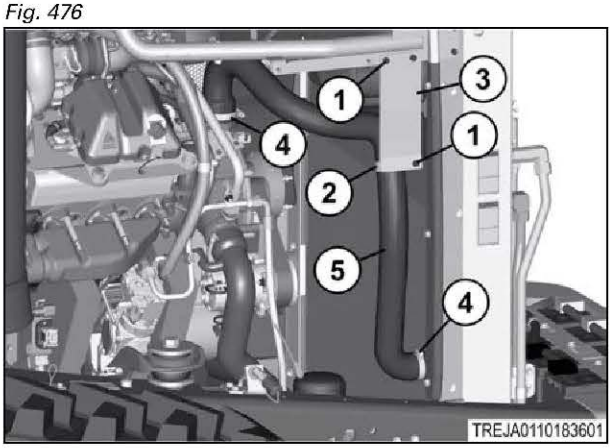


Fig. 477

30. Use the hardware (1) to install the left side support bracket (2).

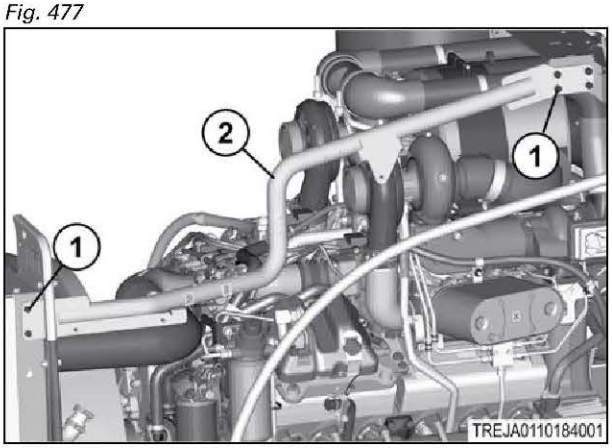


Fig. 478

31. Use the hardware (1) to install the expansion tank (2).

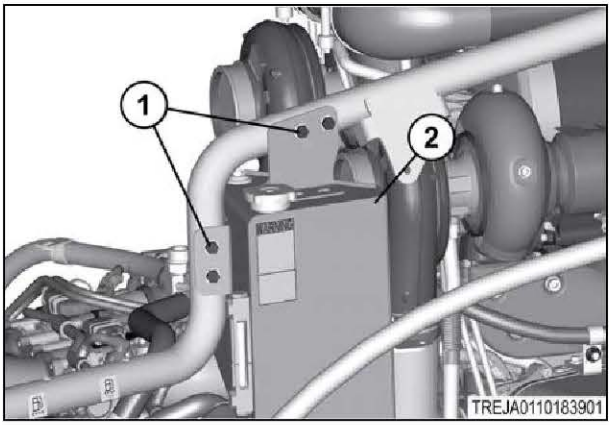


Fig. 479

32. Use the hose clamps (1) to connect the hoses (2) to the expansion tank.

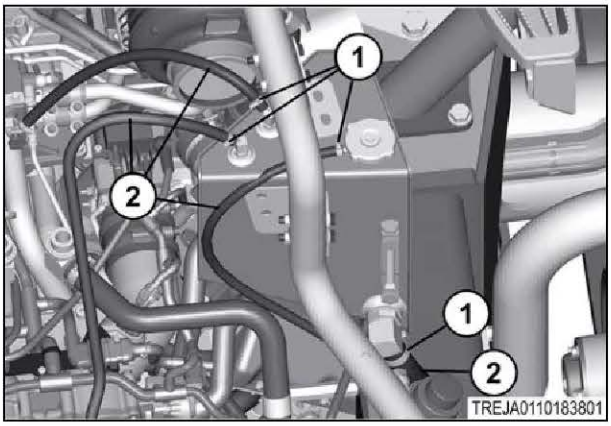


Fig. 480

33. Use the hardware (1) to install the right side support bracket (2).

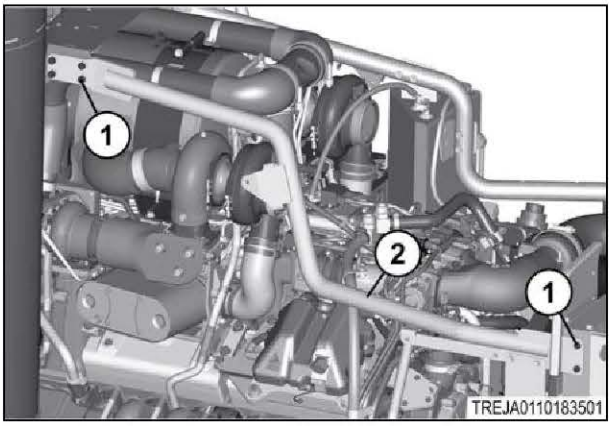


Fig. 481

34. Use the hardware (1) to install the air filter mounting bracket (2).

35. Install the air filter assembly.

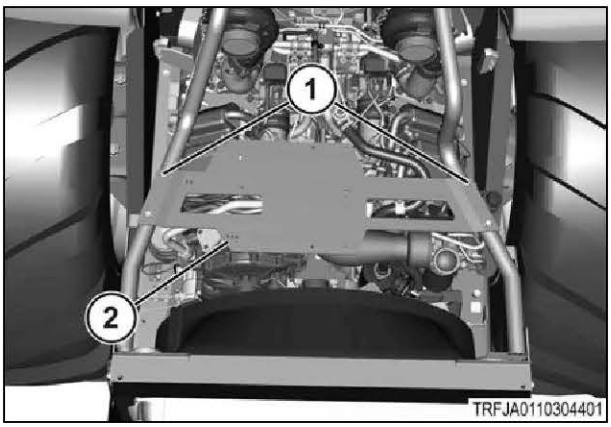


Fig. 482

36. Open the fuel shut off valve (1).

NOTE: *The valve is shown in the open position.*

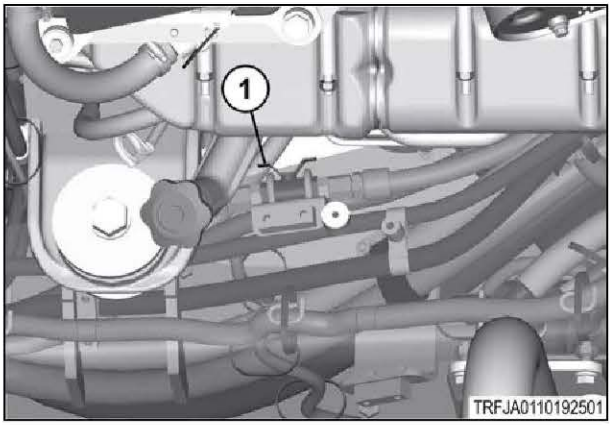


Fig. 483

37. Use the hardware to install the left fan guard (1).

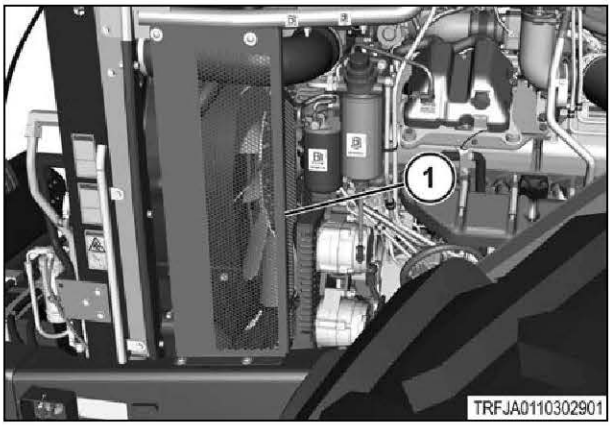


Fig. 484

38. Connect the electrical connections (1) on the left-hand side of the engine.

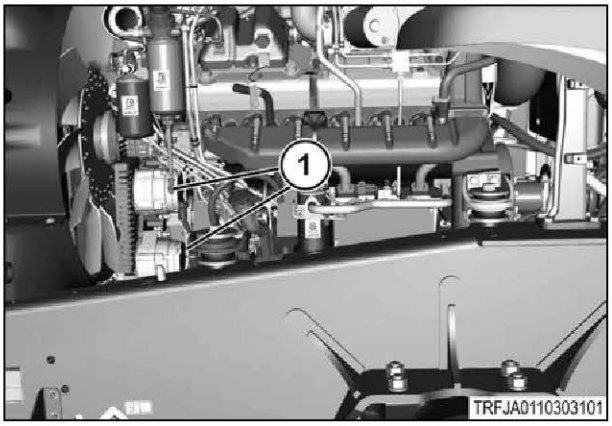


Fig. 485

39. Use the hardware (1, 3) to install the right fan guard (2).

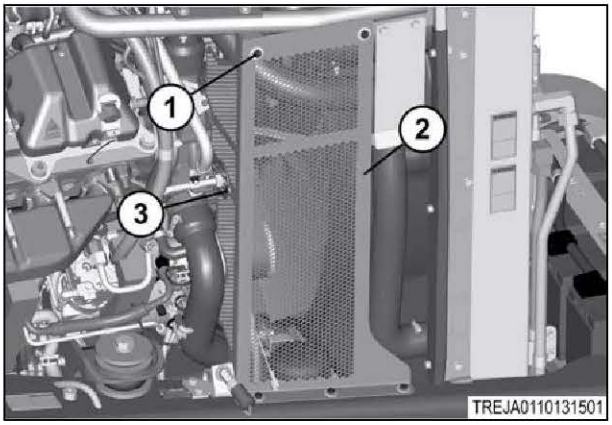


Fig. 486

40. Install the engine cover.

41. Fill the radiator with the correct type and the correct amount of engine coolant.

42. Fill the hydraulic tank with the correct type and the correct amount of hydraulic fluid.

43. Fill the fuel tank with the correct type and amount of diesel fuel.

44. Fill the air conditioning system with freon.

45. Fill the DEF tank with the correct type and the correct amount of diesel exhaust fluid.

Related Links

Install the air compressor page 2-125
Install the exhaust system with the diesel exhaust fluid system page 2-184
Install the air filter assembly page 2-114
Install the engine cover (MY2015 and earlier) page 13-16
Coolant quality requirements page 2-239
Fill capacities page 1-18
Lubricant viscosities page 1-18
Refill the cooling system page 2-149

2.3 Flush and refill the cooling system

2.3.1 Coolant system fluid

NOTE: *If these conditions occur, clean and flush the coolant system.*

Change the engine coolant more frequently if finding any of the following conditions:

- The cooling system is heavily contaminated.
- The engine overheats.
- Observe foaming in the expansion tank.
- The engine oil cooler has failed and the oil is in the coolant.
- The fuel has contaminated the cooling system.

IMPORTANT: *It is important to replace the water temperature thermostat to prevent unexpected failure. This is a good preventive maintenance practice that reduces chances of unscheduled downtime.*

2.3.2 Flush the cooling system

Procedure

1. Fill the cooling system with clean water and a five to ten percent concentration of cooling system cleaner.
2. Install the filler cap (1).
3. Start and run the engine for 90 minutes.
4. Stop the engine and let the engine cool. Loosen the filler cap to release the pressure.
5. Drain the water and flush the cooling system with water until draining the water is transparent.
6. Fully drain the cooling system and close the drain valve.

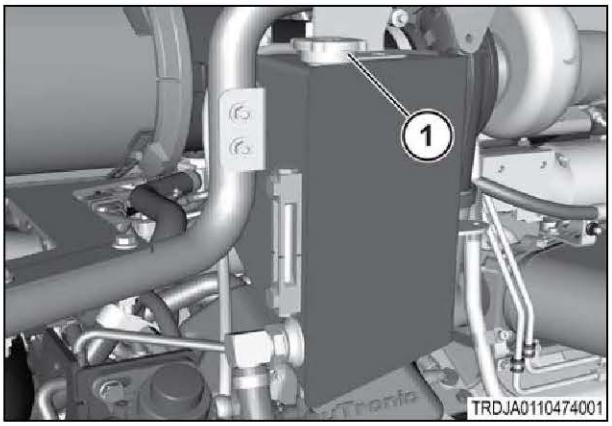


Fig. 487

2.3.3 Refill the cooling system

Procedure

1. Add the coolant solution by removing the filler cap (1).

Consult the dealer for information about diesel engine antifreeze/coolant.

2. Check the coolant level on the sight gauge (2). Keep the coolant level at or above the full cold mark.

3. Start the engine.

4. Operate the engine until the coolant reaches normal operating temperature, and until the coolant level stabilizes.

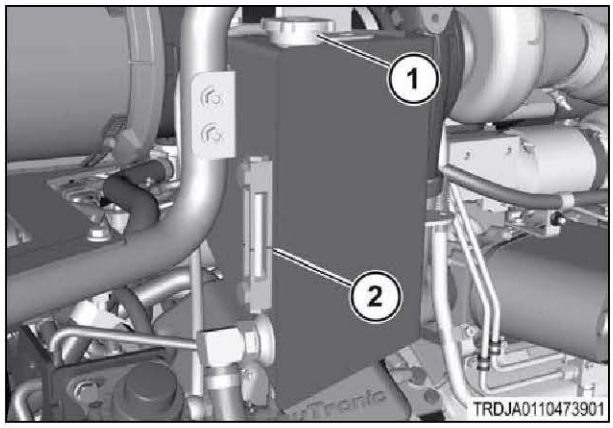


Fig. 488

5. After the engine has cooled, check the coolant level sight gauge. Keep the coolant lever at or above the full cold mark.

2.4 Engine troubleshooting

Engine starts hard or does not start	
Cause(s)	**Solution(s)**
Fuel level is low or fuel tank is empty. The shutoff valve is in closed position	Check fuel level, fuel lines, and fuel filters. Make sure the fuel shutoff valve is open
Fuel system has a loss of prime	There is air in fuel system. Prime fuel system
Fuel temperature is below cold filter plug point (CFPP)	Use the correct type of fuel
Incorrect viscosity oil in the engine	Check the engine for correct oil viscosity for ambient temperature
Fuel system is dirty	Clean fuel system

Fuel system is dirty	
Cause(s)	**Solution(s)**
Fuel pressure is low.	Check fuel pressure. If low fuel pressure, replace the fuel filters. Make sure fuel does not contain water, air, or dust. If fuel pressure is still low, replace the fuel transfer pump. Clean fuel system - check screen at tank outlet
Clogged fuel filter.	Replace fuel filter elements.
Fuel injectors are malfunctioning.	See your dealer
Engine tuned incorrectly.	See your dealer

Engine misfires or runs rough	
Cause(s)	**Solution(s)**
Fuel pressure is low.	Replace the fuel filters. Check the fuel pressure. Check for leaks in the low pressure fuel system. Check for air in the fuel system. Check for wear or for damage in the fuel transfer pump. Check the fuel system for too much fuel return caused by a malfunctioning return fuel pressure regulating valve. Replace the fuel filters.
Air in fuel system.	Find air leak. Correct problem. Purge air from fuel system.
Clogged fuel filter.	Replace fuel filter element.
Damaged fuel injectors.	See your dealer
The timing for the fuel injection is not correct.	See your dealer

Engine has low power	
Cause(s)	**Solution(s)**
There is a restriction in air cleaner.	Check air cleaner for a restriction.
Diesel engine operating temperature is too low.	Check the thermostats.
Fuel Filter (s) dirty	Replace the filter(s)
Overload of the engine	Reduce load
Fuel pressure is low.	Replace the fuel filters. Check fuel pressure. Check for leaks in low pressure fuel system. Check for air in fuel system. Check for wear or for damage in fuel transfer pump. Check for too much fuel return to tank caused by a malfunctioning return fuel pressure regulating valve.
Quality of the fuel is unsatisfactory	Remove the bad fuel from the fuel tank. Fill the fuel tank with quality diesel fuel. Replace the fuel filters.
The timing is incorrect for the fuel injection	See your dealer

Engine stalls at low rpm	
Cause(s)	**Solution(s)**
Overload of the engine.	Reduce the load.
Fuel pressure is low.	Replace the fuel filters. Check the fuel pressure. Check for leaks in low pressure fuel system. Check for air in fuel system. Check for wear or for damage in fuel transfer pump. Check for too much fuel return to tank. The cause of a malfunctioning return fuel pressure regulating valve can be from too much fuel return.

Engine uses too much oil	
Cause(s)	**Solution(s)**
Oil is leaking from the engine.	Replace the gaskets or the seals. Tighten all the connections.
The engine oil level is too high.	Do not over fill the engine. Determine the cause. Drain the excess oil.
Oil operating temperature is too high.	Check the oil level and viscosity.
Over load of the engine.	Reduce load
Too much wear on the valve guides.	See your dealer.
Worn piston rings.	Replace the components, as required. See your dealer.
Too much idling.	Reduce idle time.

Engine oil pressure is too low	
Cause(s)	**Solution(s)**
The oil level is too low.	Check the oil level. Add the engine oil, as required.
Plugged oil filter.	Install a new oil filter.
Air in the oil.	Check for foaming.
Diesel fuel is mixed with the engine oil.	Check the lip type seals on drive shaft for fuel transfer pump. Drain the crankcase. Refill the crankcase with clean engine oil.
The pickup tube is damaged.	Replace the pickup tube.
Oil pressure gauge and/or oil pressure sender are malfunctioning.	Install a new oil pressure gauge and/or install a new oil pressure sender.
The oil pump relief valve is stuck.	Clean the oil pump relief valve and clean housing. Replace the components, if necessary.
Crankshaft bearings have excessive clearance.	Replace the crankshaft bearings and/or replace the crankshaft. Check operation of the oil filter.
Bearings for timing gear have too much clearance.	Inspect bearings. If necessary, replace the components.
Bore of the rocker arm is too large or the rocker arm has too much wear.	Check lubrication. Replace the components if necessary.
A damaged oil pump.	Repair the oil pump or replace the oil pump. See your dealer. Dealer has the tools and the trained personnel for this service.

Engine uses too much fuel	
Cause(s)	**Solution(s)**
Internal Fuel Leakage	Internal leaks can cause large changes in fuel consumption. Low oil pressure and high oil level in engine oil sump can follow with internal leaks. Replace the components that leak.
Operating engine at higher speed than required for load.	Reduce engine speed
Engine knock results from unsatisfactory combustion.	Small increases in fuel consumption can be from a damaged fuel injection nozzle, or misfiring, or low engine power.
Fuel injection timing is not correct.	See your dealer.

Coolant in engine oil	
Cause(s)	**Solution(s)**
Oil cooler is leaking.	Install a new core for oil cooler. Drain the crankcase. Fill the crankcase with clean engine oil. Install a new oil filter element.
The cylinder head gasket has failed.	See your dealer
A damaged cylinder head has cracks.	See your dealer
Cylinder block has cracks, or has a defect.	See your dealer.

Engine oil in the coolant	
Cause(s)	**Solution(s)**
The head gasket has failed.	See your dealer

Coolant is too hot	
Cause(s)	**Solution(s)**
Engine speed is too low.	Increase throttle.
Flow of air through the radiator screen is restricted.	Clean the radiator screen.
	Remove debris from the outer surface of the radiator.
Coolant level is too low.	Determine the cause of the low coolant level. Replace the gaskets and hoses that leak. Tighten all the connections. Add the coolant.
Damaged thermostat or temperature gauge.	Check the thermostat for correct opening temperature. Make sure that the thermostat is correctly installed. Check the temperature gauge for correct operation.
There is combustion gases in coolant.	Find combustion gas leakage. Repair the components or replace the components.
Coolant flow is too low	Check the water pump impeller. Repair the water pump as necessary. Check the water pump belt, replace the belt if worn. Check the belt tensioner.

Engine emits too much white smoke	
Cause(s)	**Solution(s)**
Cold engine	White smoke is normal when starting the engine in cold weather.
Air in the fuel system.	Purge air from the fuel system. Check for air leaks on the inlet side of the engine oil suction tube.

Engine emits too much blue smoke	
Cause(s)	**Solution(s)**
Excess oil	Do not overfill the engine. Determine the cause. Drain the excess oil.
There is too much wear on the valve guides.	Repair the cylinder head assembly.
Piston rings stuck, or broken, or worn.	See your dealer.

Engine emits too much gray smoke or black smoke	
Cause(s)	**Solution(s)**
There is not enough air for combustion.	See your dealer.
A plugged or leaking fuel injector.	Replace the fuel injector.
The fuel setting is not correct or injection timing is not correct.	See your dealer.
The turbocharger has failed.	See your dealer.

2.4.1 Engine derating

Emissions related malfunction 1, no active DEF dosing

- First level inducement: engine torque is limited to 75% of maximum torque.
- At final inducement engine is disabled to low idle and to 50% of idle torque.
- Example: electrical or hydraulic fault that does not require active DEF dosing for detection.

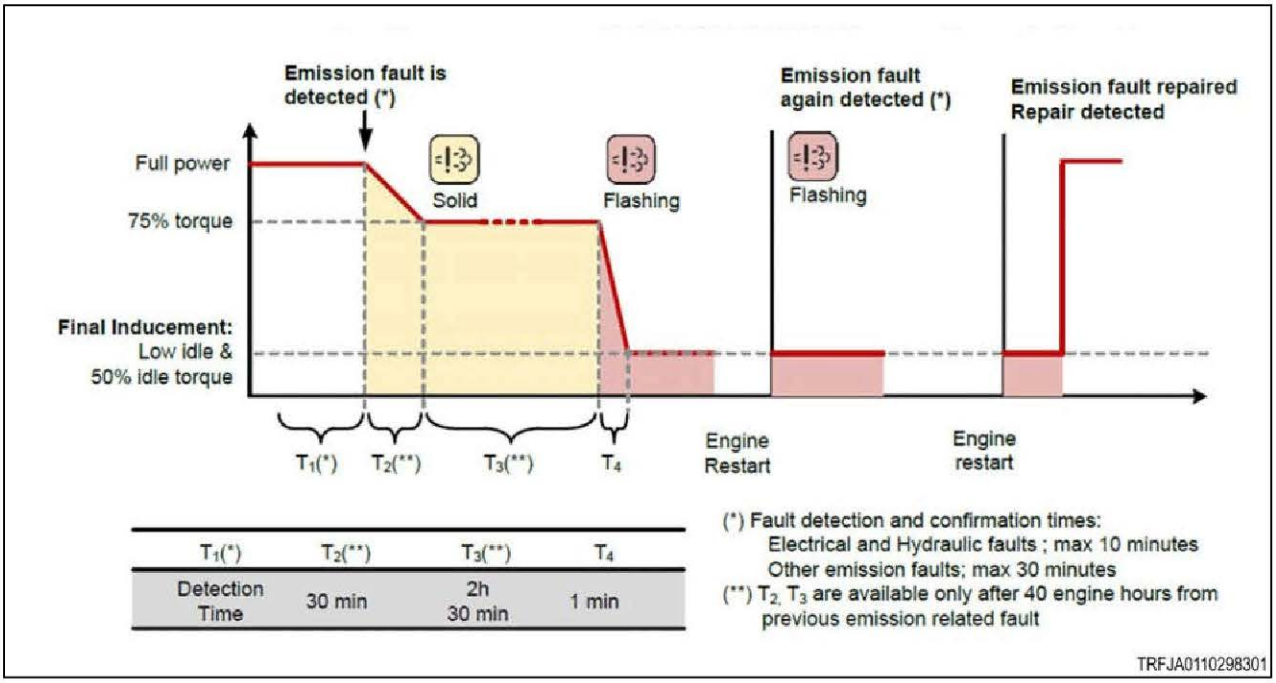


Fig. 489

Repeated emissions related malfunction 1 (T<40 hrs), no active DEF dosing

- Authorities require 40 hours of operation without any emission fault, before the full inducement time is allowed.
- If any emission related fault is detected within 40 hours after the previous fault was corrected, engine will derate to final inducement within 30 minutes.
- Example: T<40 hours repeated electrical or hydraulic fault that does not require active DEF dosing for detection.

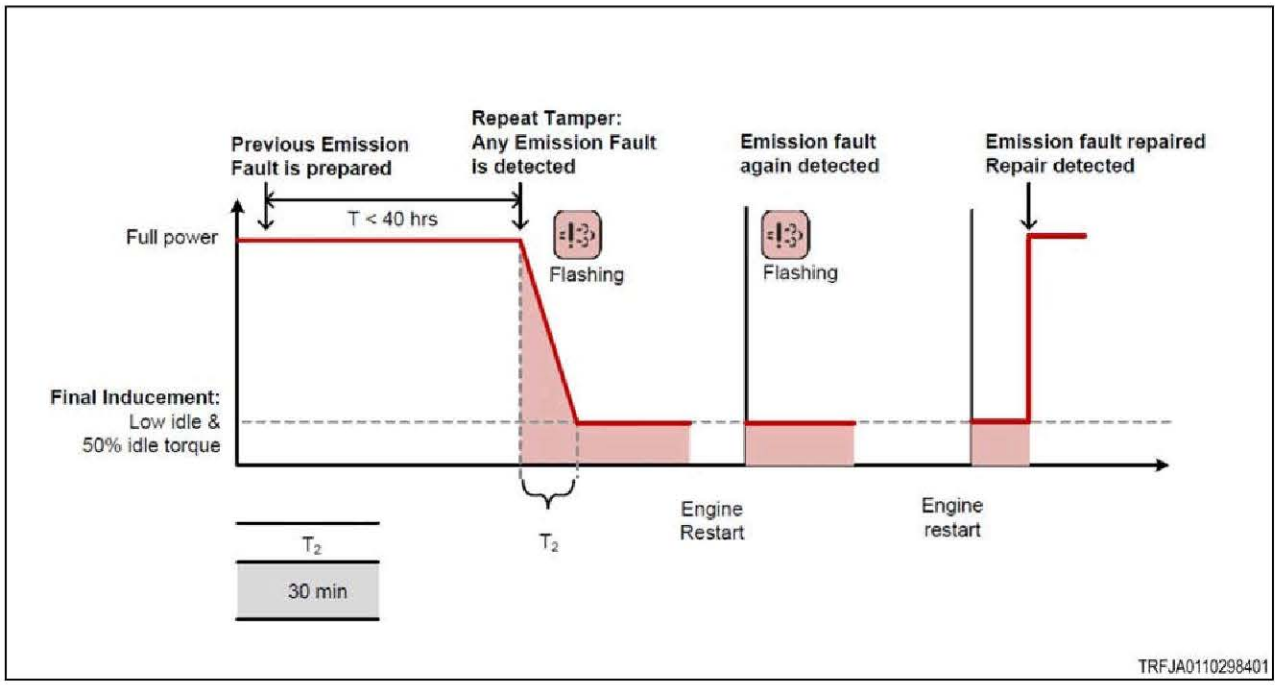


Fig. 490

Emissions related malfunction 2, active DEF dosing

- First level inducement: engine torque is limited to 75% of maximum torque.
- At final inducement engine is disabled to low idle and to 50% of idle torque.
- Fault detection possible with warm system and active dosing. Tx is detection time after restart when final inducement has been already active.
- Self healing is not possible after fault has been active 4 hours. To restore full power (after total time has been used), only service dealer with electronic diagnostic tool can clear emission faults and restore full power.

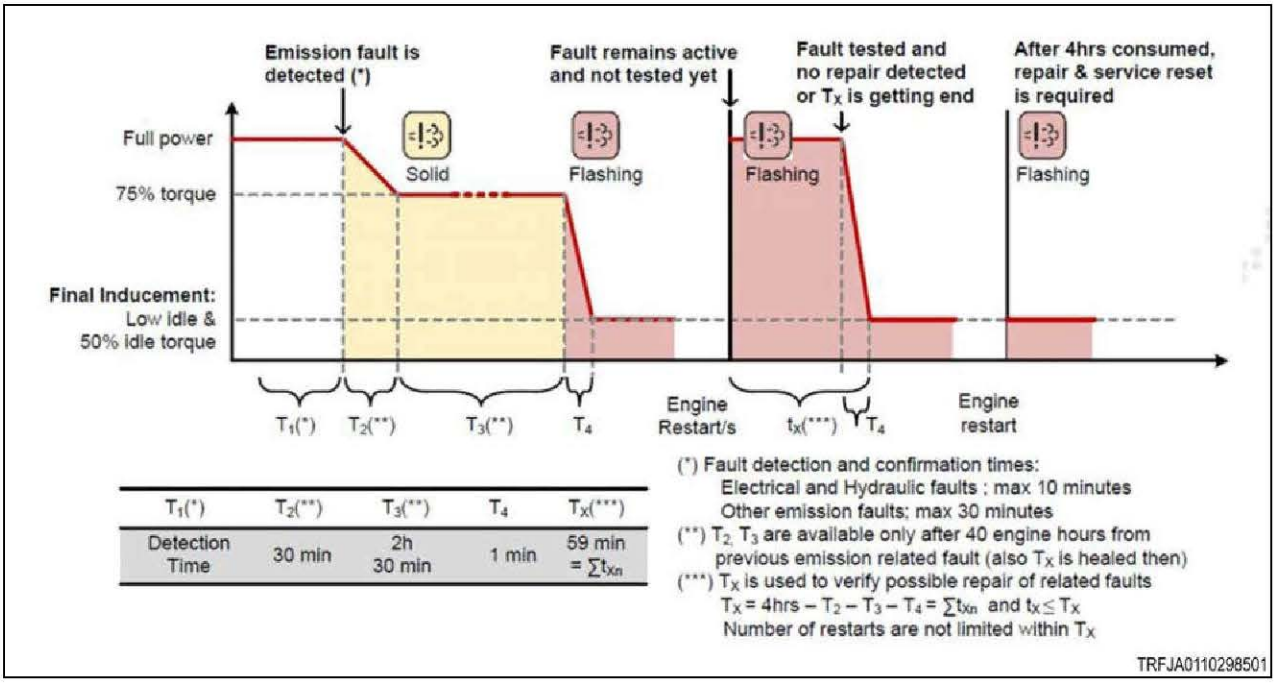


Fig. 491

Repeated emissions related malfunction 2 (T<40 hrs), active DEF dosing

- Authorities require 40 hours of operation without any emission fault, before the full inducement time is allowed.
- If any emission related fault is detected within 40 hours after the previous fault was corrected but Tx fault detection time hasn't elapsed, engine will have full power during Tx detection time until fault is tested again. Engine restarts are not limited.

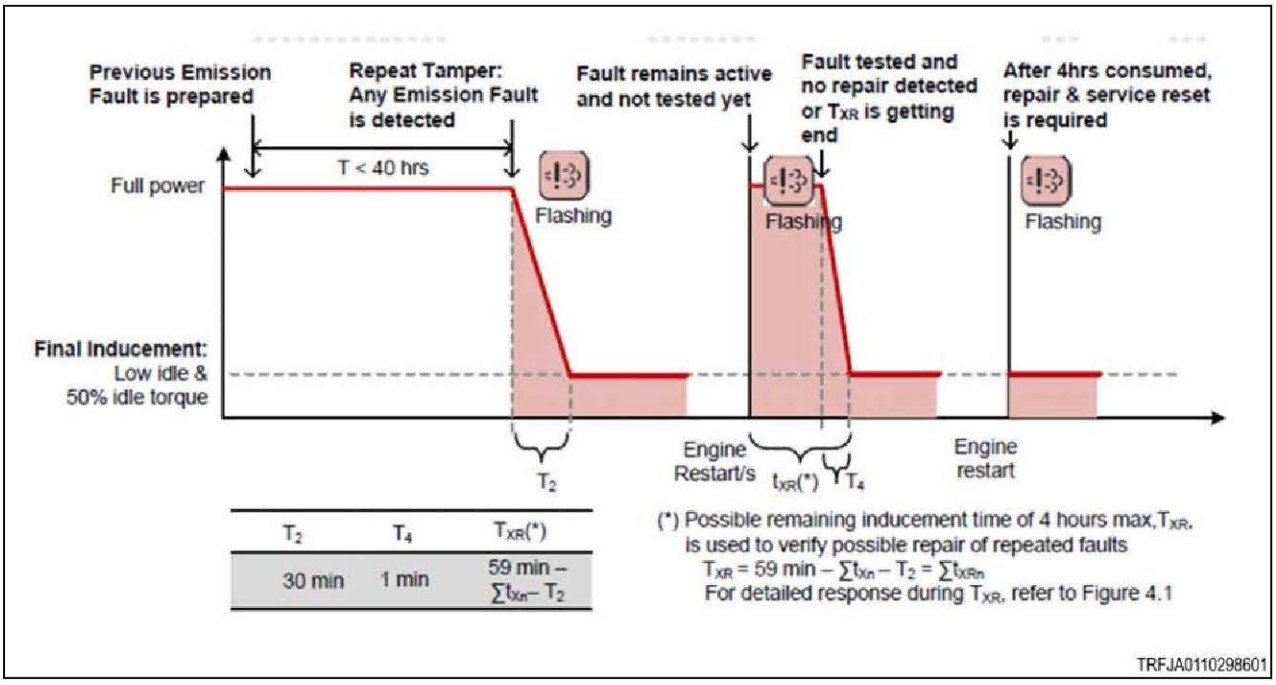


Fig. 492

- Authorities require 40 hours of operation without any emission fault, before the full inducement time is allowed.

- If any emission related fault is detected within 40 hours after the previous fault was corrected, and the 4 hour inducement time has been used, engine will ramp to final inducement within 30 minutes. To restore full power, only service dealer with electronic diagnostic tool can clear emission faults and restore full power.

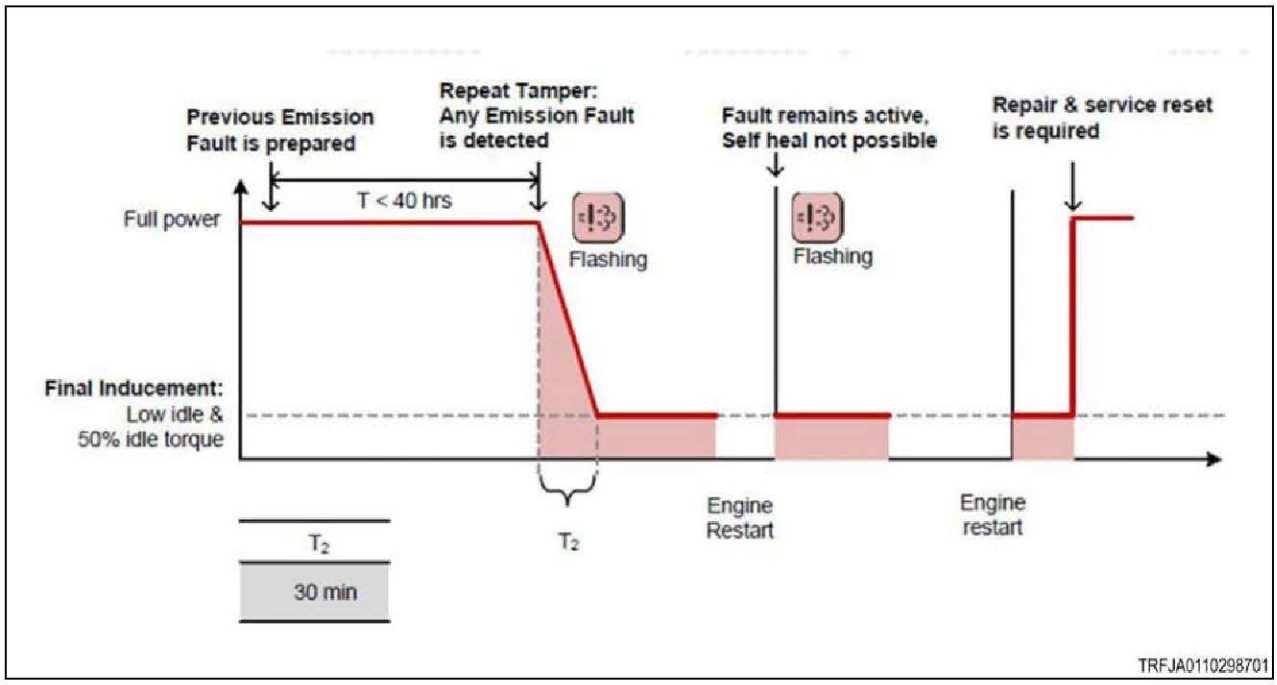


Fig. 493

2.5 Fuel system components

2.5.1 Remove the fuel lines

Before starting the procedure

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Fire hazard. Fuel safety.

Personal injury, death, or machine damage can occur.

Stop the engine and let the engine cool before fueling. Never smoke while fueling the machine.

Before removing the components, fasten identification tags on the components for correct assembly.

Contain all fluids during inspection, maintenance, testing, adjustment, and repair of the machine. Before opening or disassembling any component containing fluids, prepare to contain fluids by having the correct containers available. Discard fluids according to local regulations and laws.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.
4. Let the machine become cool.
5. Open the engine cover fully.
6. Drain the fuel.
7. Disconnect the fitting (1) from the high pressure pump.
8. Remove the hardware (2), the hose clamps (3), and the hose (4).

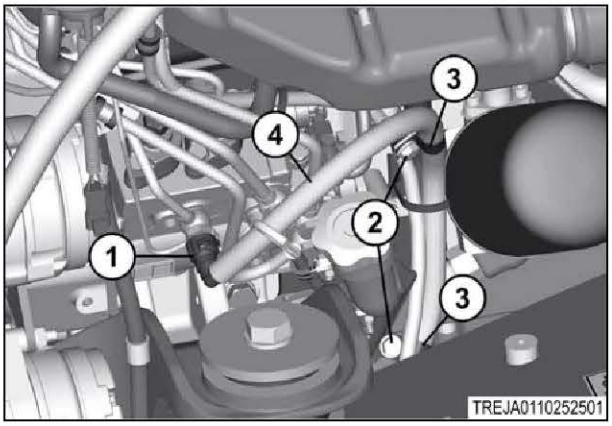


Fig. 494

9. Remove the fan blast deflector (1).

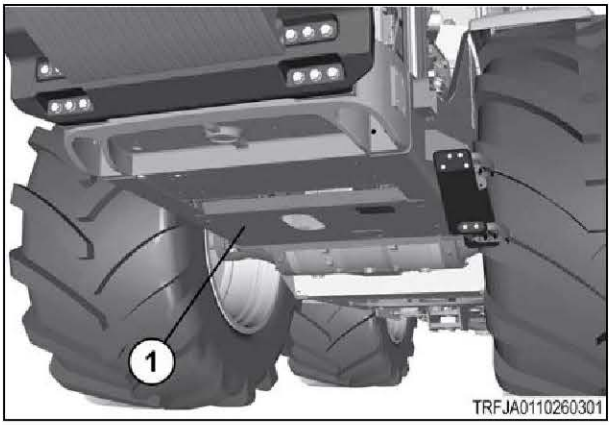


Fig. 495

10. Disconnect the hose (1).

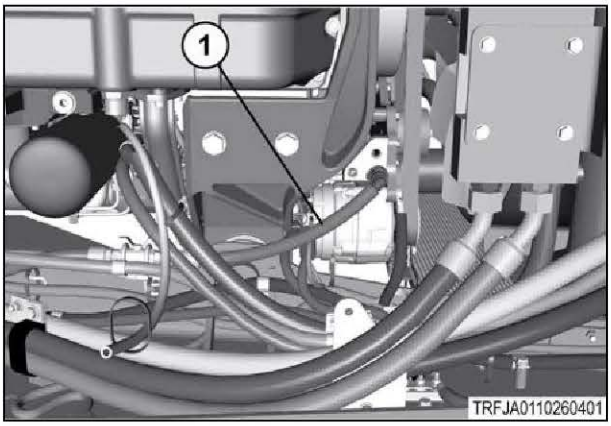


Fig. 496

11. Remove the loop clip (1) and the U-bolts (2).

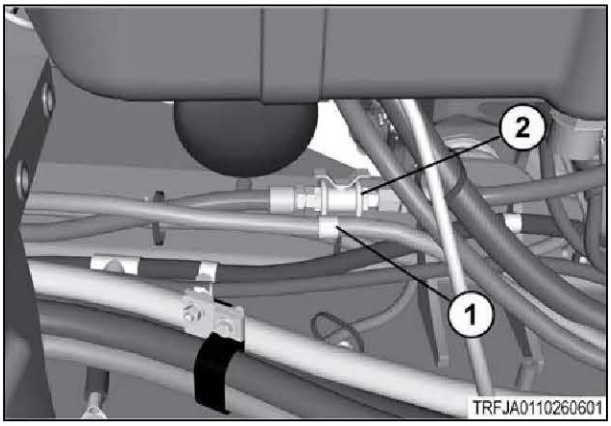


Fig. 497

12. Disconnect the hoses (1) from the fuel cooler (2).

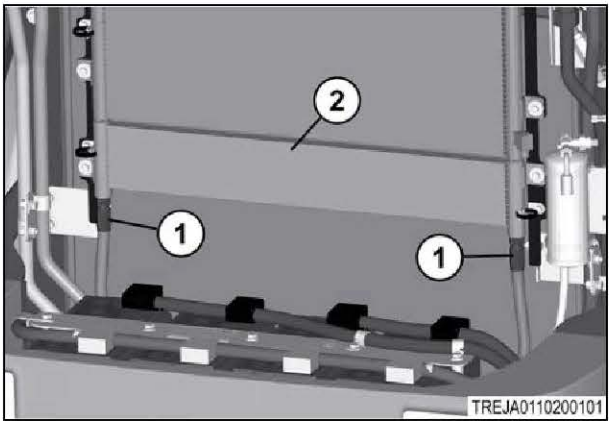


Fig. 498

13. Remove the hardware (1), the hose clamps (2), and the hoses (3).

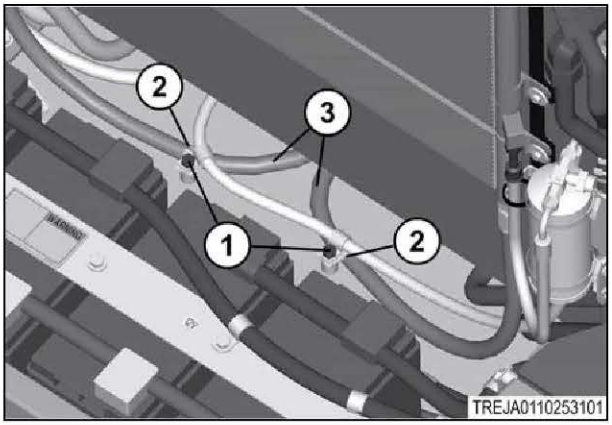


Fig. 499

14. Disconnect the hoses (1) from the fuel tank.

15. Disconnect the hoses from the loop clips.

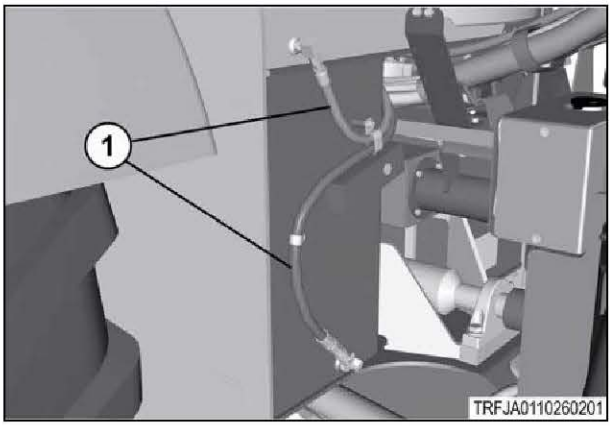


Fig. 500

16. Disconnect the hoses from the loop clips (1) on the chassis and the drive train.

17. Remove the fuel line hoses.

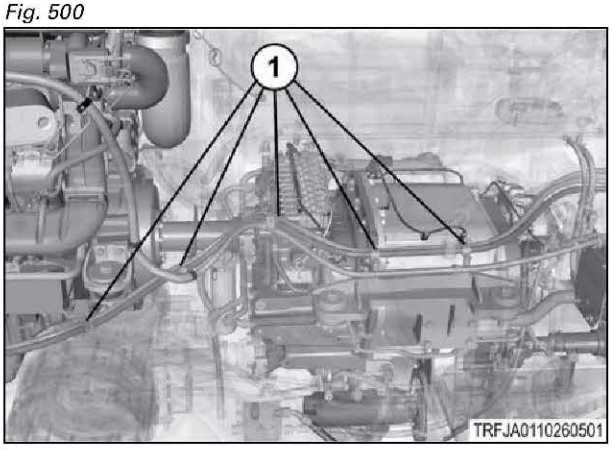


Fig. 501

2.5.2 Install the fuel lines

Before starting the procedure

Procedure

1. Install the fuel line hoses with the loop clips (1) on the chassis and the drive train.

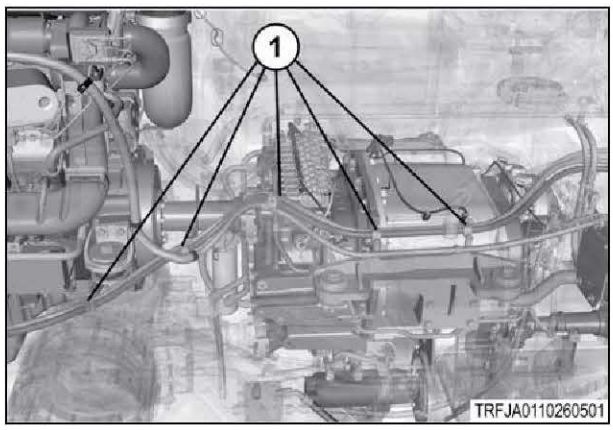


Fig. 502

2. Connect the hoses (1) to the fuel tank.
3. Install the loop clips.

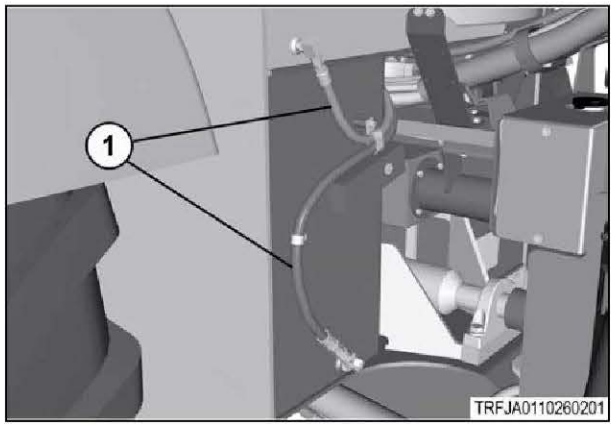


Fig. 503

4. Connect the hoses (1) to the fuel cooler (2).

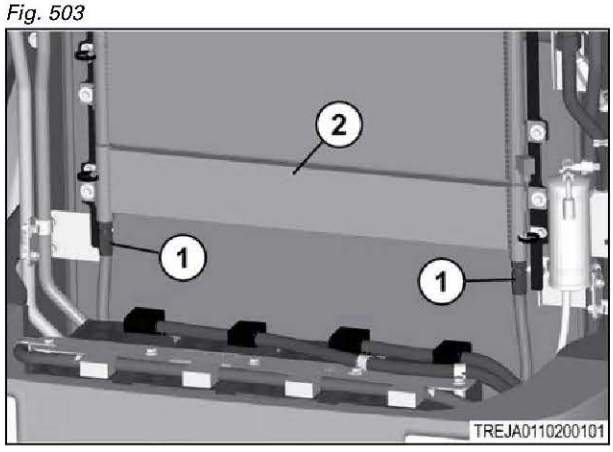


Fig. 504

5. Install the hoses (3) with the hose clamps (2), and the hardware (1).

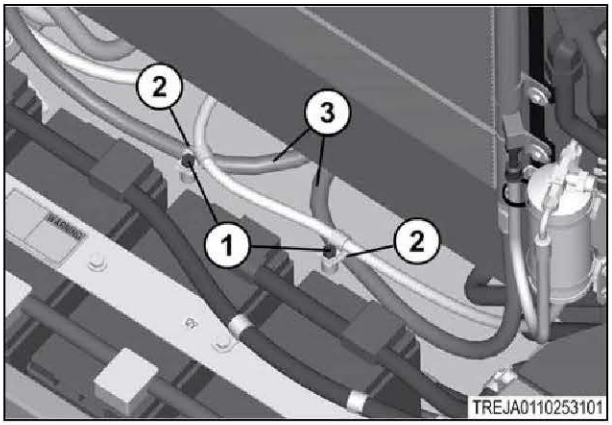


Fig. 505

6. Install the hoses with the loop clip (1) and the U-bolts (2).

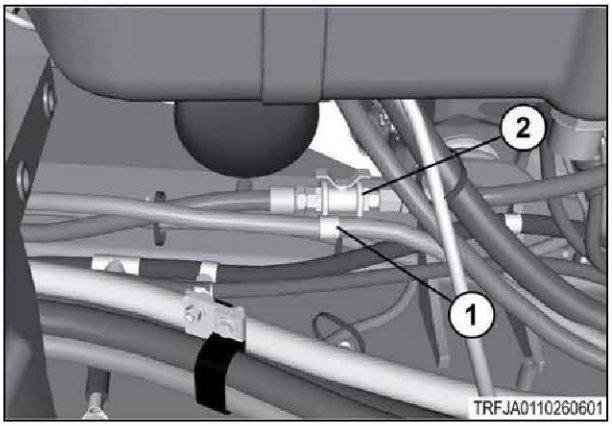


Fig. 506

7. Connect the hose (1).

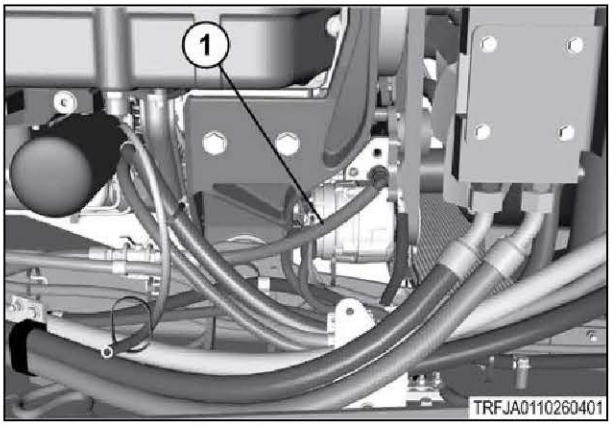


Fig. 507

8. Install the hose (4) to the high pressure pump with the fitting (1).

9. Install the hose clamps (3) with the hardware (2).

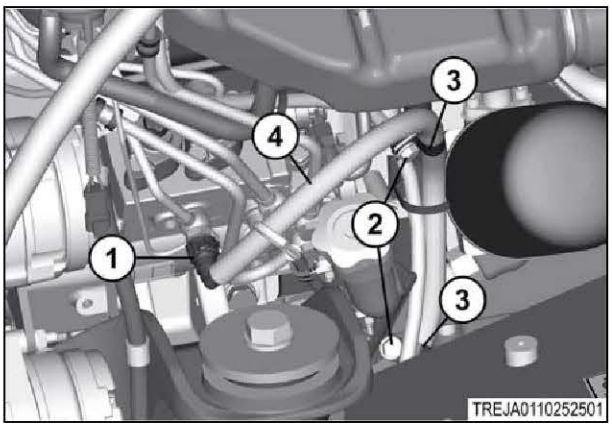


Fig. 508

10. Install the fan blast deflector (1).

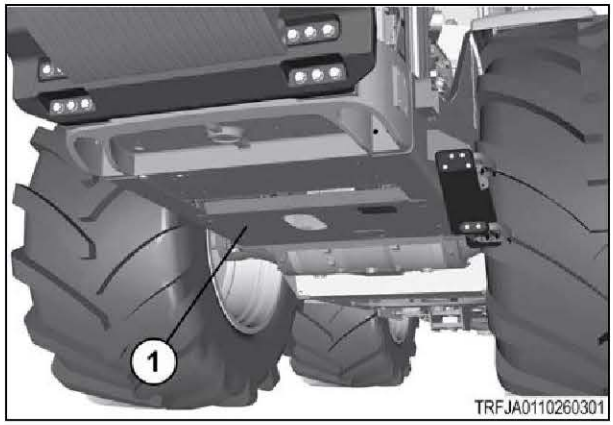


Fig. 509

2.5.3 Remove the primary fuel filter

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Fire hazard. Fuel safety.

Personal injury, death, or machine damage can occur.

Stop the engine and let the engine cool before fueling. Never smoke while fueling the machine.

WARNING:
Be prepared to collect and contain fuel in a suitable container. Fuel can contaminate water supplies and cause personal injury if it comes in contact with skin and eyes. Fuel is highly flammable no smoking or open flames are allowed near fuel containers.

NOTE: *Use precaution when removing a fitting. If system is under pressure, release fitting slowly in a well ventilated area.*

NOTE: *Before removal, fasten identification tags on the parts for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to collect fluids with the correct containers before opening any compartment or disassembling any component containing fluids. When discarding fluids, check the local regulations and the local laws.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Disconnect the battery with the battery disconnect switch.
4. Remove the key from the battery disconnect switch.

5. **CAUTION:**
Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

Release the two latches (1) and open the engine cover (2) all the way.

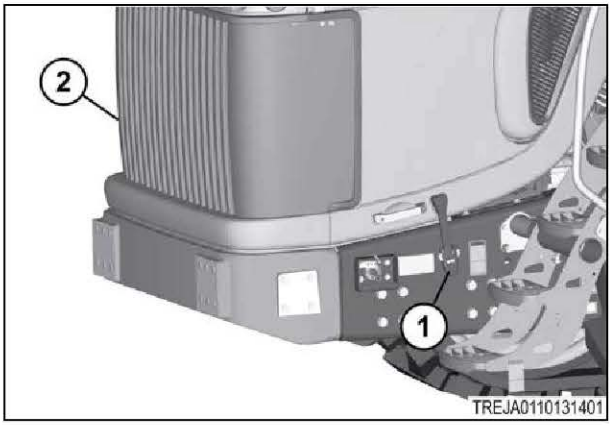


Fig. 510

6. Close the fuel shut off valve (1).

NOTE: *The valve is shown in the open position.*

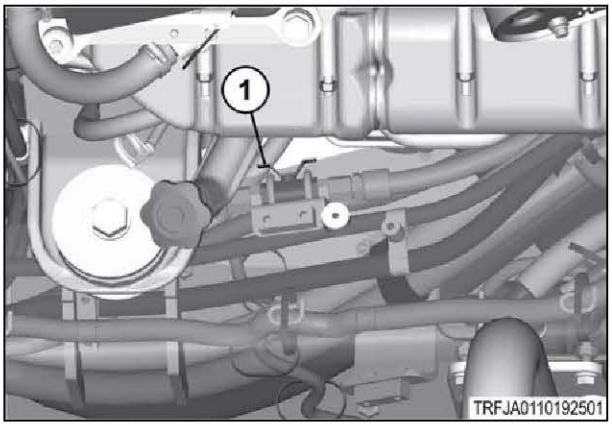


Fig. 511

7. Put a correct container under the primary fuel filter (2) to catch the fuel.
8. Open the fuel filter drain valve (1) to drain any fuel from the filter housing.
9. Close the drain valve (1) when empty.
10. Disconnect the water sensor from the bottom of the fuel filter.
11. Turn the housing counterclockwise, to remove the primary fuel filter element (2).
12. Clean the surface where the element touches the fuel filter housing. Remove the current gasket.

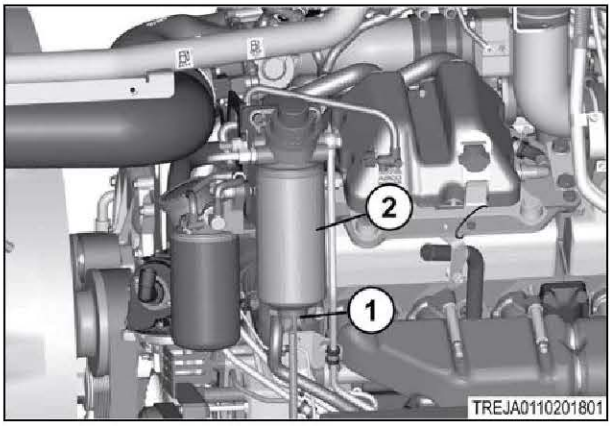


Fig. 512

2.5.4 Install the primary fuel filter

Procedure

1. Turn the fuel filter housing (2) clockwise to install the primary fuel filter element.
2. Close the drain valve (1).
3. Connect the water sensor to the bottom of the fuel filter.

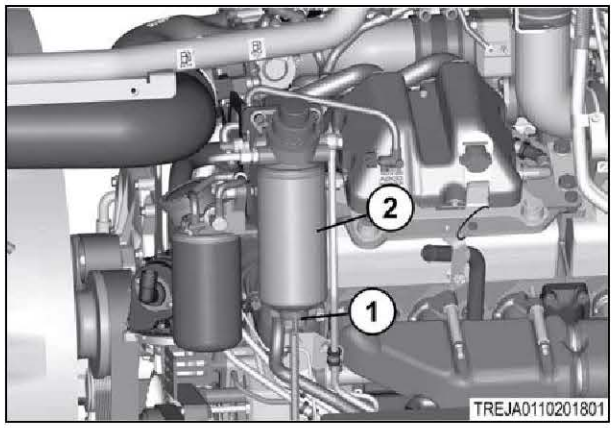


Fig. 513

4. Open the fuel shut off valve (1).

   NOTE: *The valve is shown in the open position.*

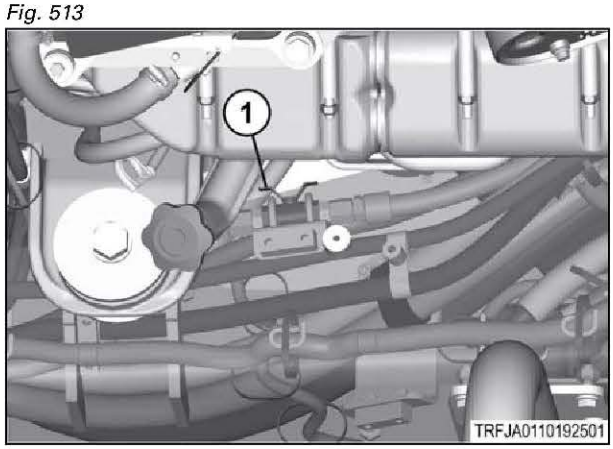


Fig. 514

5. Close the engine cover (2) and connect the two latches (1).

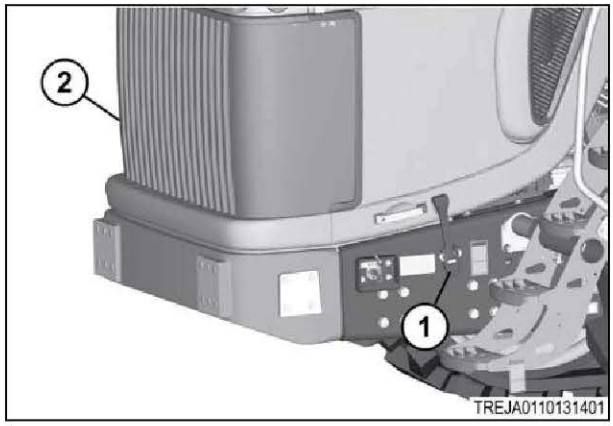


Fig. 515

6. Install the battery disconnect switch key (1).

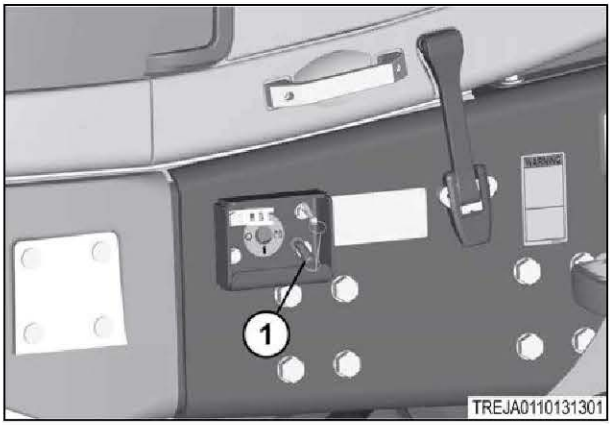


Fig. 516

7. Turn the battery disconnect switch key (1) clockwise to connect the battery power.

   NOTE: *The battery disconnect switch is shown in the on position.*

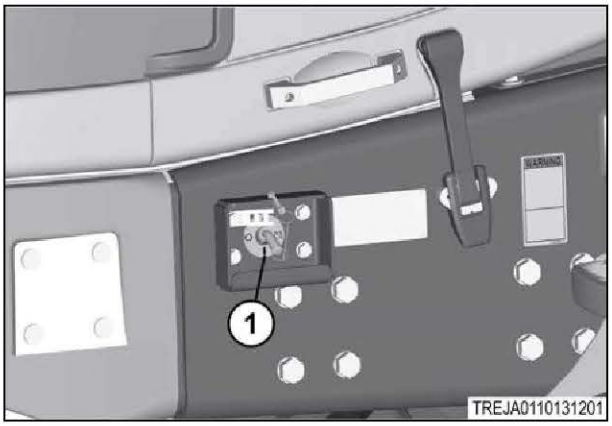


Fig. 517

2.5.5 Remove the secondary fuel filter

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Fire hazard. Fuel safety.

Personal injury, death, or machine damage can occur.

Stop the engine and let the engine cool before fueling. Never smoke while fueling the machine.

WARNING:
Be prepared to collect and contain fuel in a suitable container. Fuel can contaminate water supplies and cause personal injury if it comes in contact with skin and eyes. Fuel is highly flammable no smoking or open flames are allowed near fuel containers.

NOTE: *Use precaution when removing a fitting. If system is still under pressure, release fitting slowly in a well ventilated area.*

NOTE: *Before removal, fasten identification tags on the components for correct installation at assembly. Put caps and plugs on all hoses, fittings, and ports to prevent contamination from entering the system.*

NOTE: *Contain all fluids during the performance of inspection, maintenance, doing tests, adjusting, and repair of the machine. Prepare to collect fluids with the correct containers before opening any compartment or disassembling any component containing fluids. When discarding fluids, check the local regulations and the local laws.*

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Disconnect the battery with the battery disconnect switch.
4. Remove the key from the battery disconnect switch.
5. **CAUTION:**
   Safely prop open the engine cover. Closing engine cover creates a pinch point that can cause serious bodily injury.

   Release the two latches (1) and open the engine cover (2) all the way.

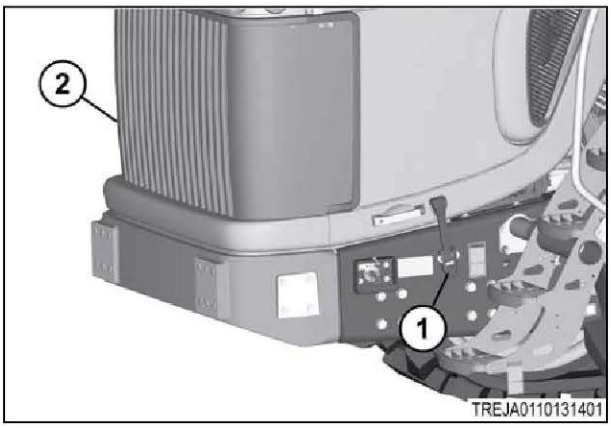


Fig. 518

6. Close the fuel shut off valve (1).

   NOTE: *The valve is shown in the open position.*

7. Put a correct container under the secondary fuel filter to catch the fuel.

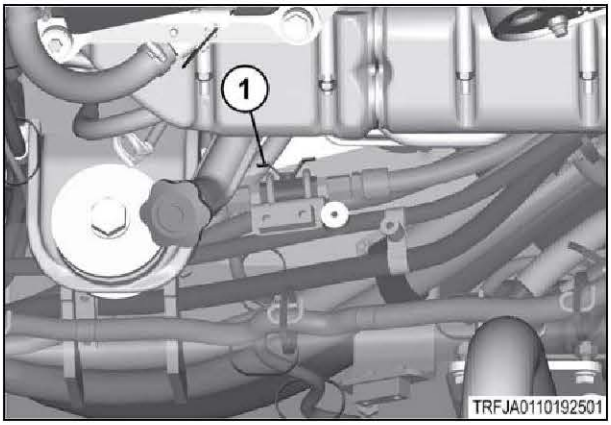


Fig. 519

8. Turn the filter counterclockwise to remove the secondary fuel filter (1).
9. Clean the surface of the secondary fuel filter head where the filter touches the head.
10. Remove the current gasket.

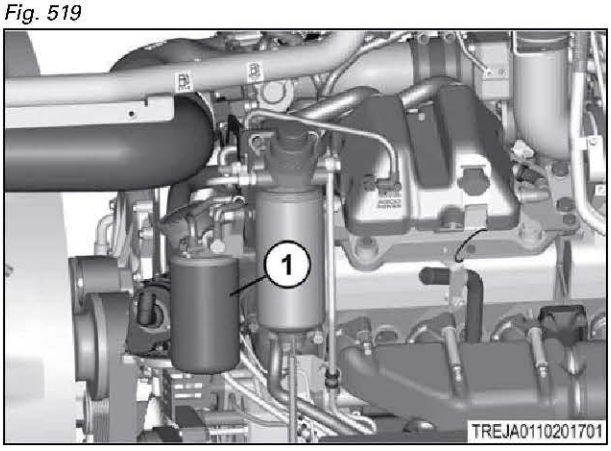


Fig. 520

2.5.6 Install the secondary fuel filter

Procedure

1. Turn the filter clockwise to install the secondary fuel filter (1).

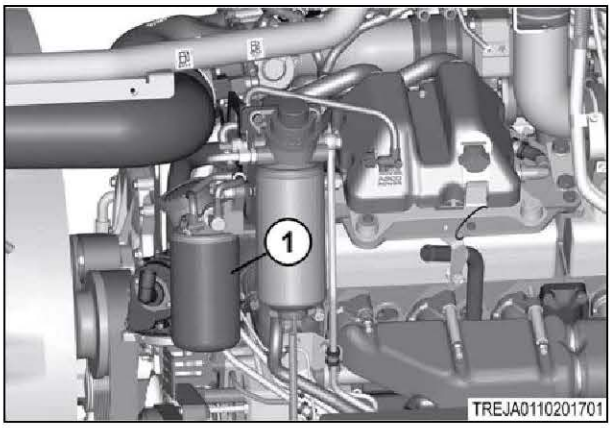


Fig. 521

2. Open the fuel valve (1).

   NOTE: *The valve is shown in the open position.*

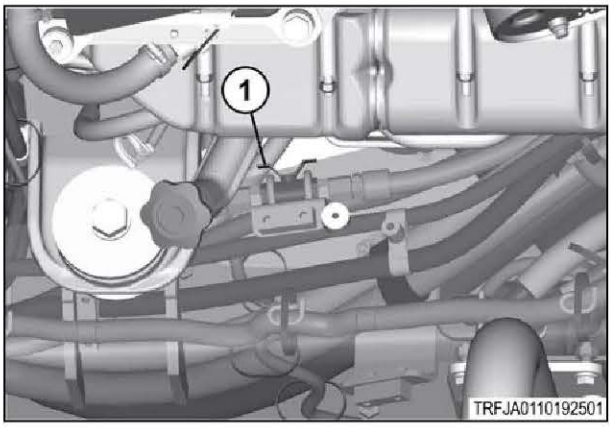


Fig. 522

3. Close the engine cover (2) and connect the two latches (1).

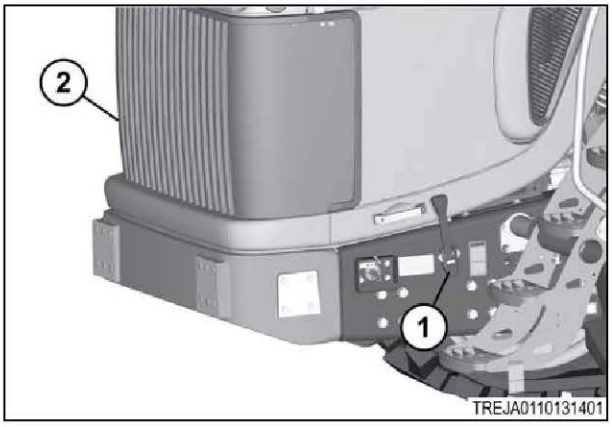


Fig. 523

4. Install the battery disconnect switch key.
5. Turn the battery disconnect switch key clockwise to connect the battery power.

2.5.7 Remove the fuel / water separator

Contain all fluids during inspection, maintenance, testing, adjustment, and repair of the machine. Before opening or disassembling any component containing fluids, prepare to contain fluids by having the correct containers available. Discard fluids according to local regulations and laws.

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Put caps and plugs on all hoses, fittings, ports, and openings to prevent contamination.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Let the engine cool for 5 minutes.
4. Release the latches (1) and open the engine cover.

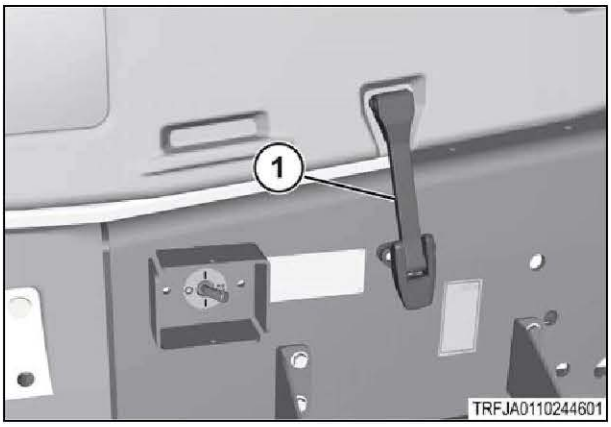


Fig. 524

5. Turn off the valve (1) located on the inner left frame.
6. Install a drain hose on the fuel water separator.
7. Open the fuel water separator and drain the separator into the correct container.
8. Close the fuel water separator.

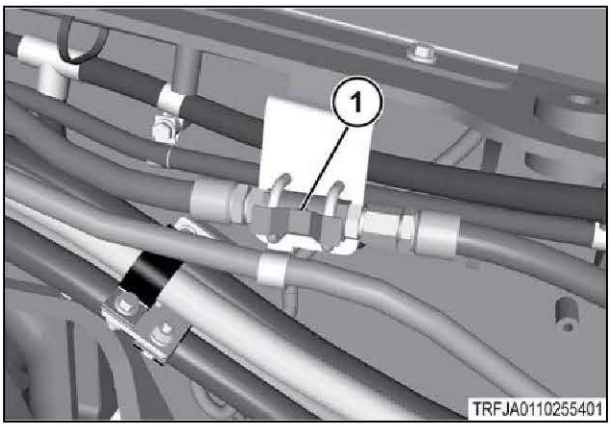


Fig. 525

9. Remove the hardware (1) and the tube (2) from the separator.

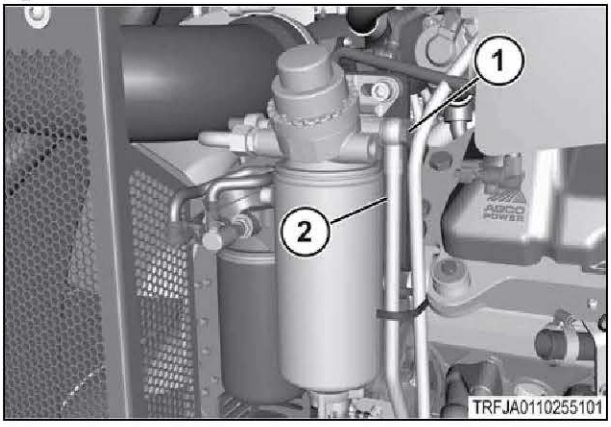


Fig. 526

10. Remove the tube (1) from the fuel water separator.

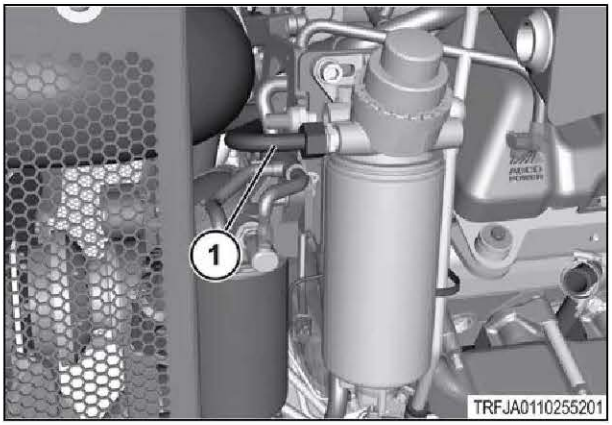


Fig. 527

11. Remove the hardware (1) and the fuel water separator (2).

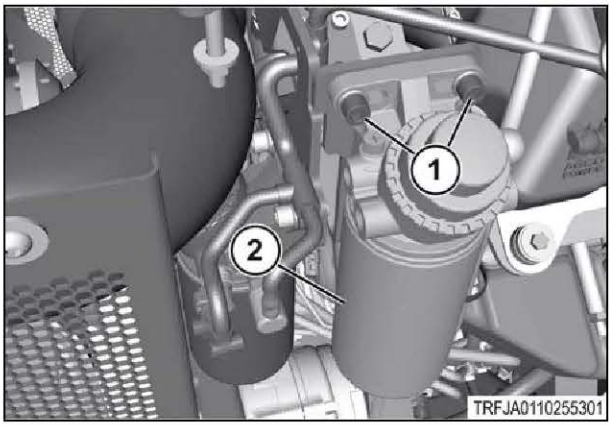


Fig. 528

2.5.8 Install the fuel / water separator

Procedure

1. Install the fuel water separator (2) to the engine with the hardware (1).

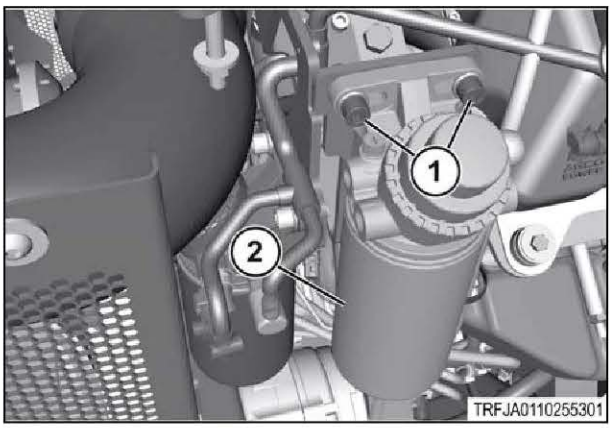


Fig. 529

2. Install the tube (1) to the fuel water separator.

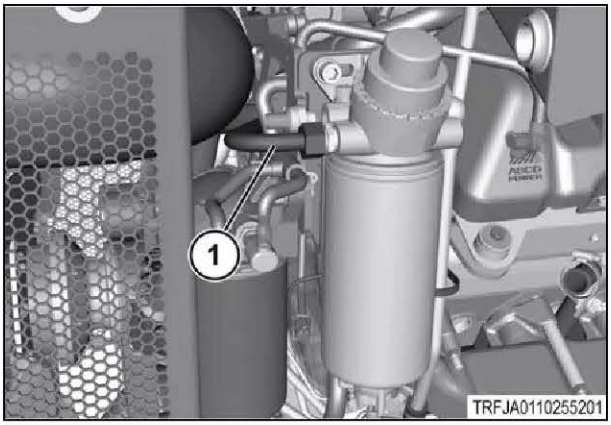


Fig. 530

3. Install the tube (2) and the hardware (1).

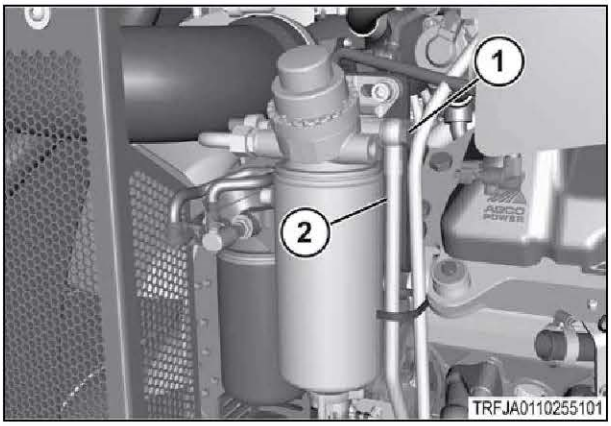


Fig. 531

4. Turn on the valve (1) on the inner left frame.

5. Prime the fuel water separator.

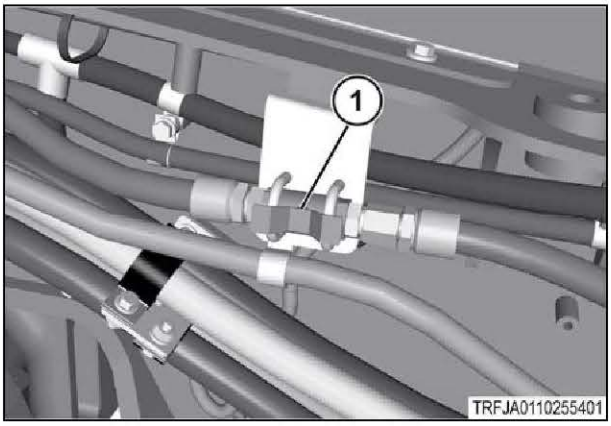


Fig. 532

6. Close the engine cover and secure the latches (1).

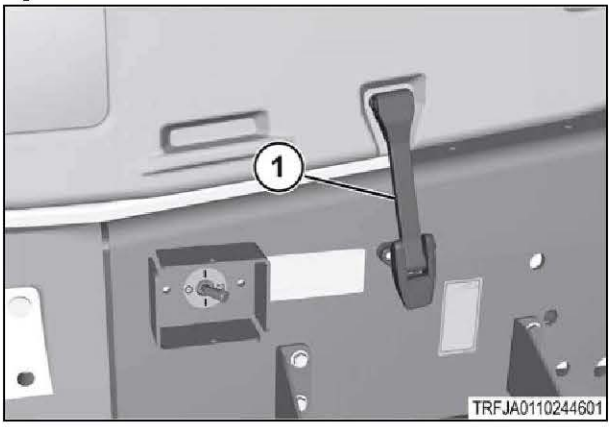


Fig. 533

Related Links

Prime the fuel system page 2-172

2.5.9 Prime the fuel system

IMPORTANT: *Do not turn the engine for more than 30 seconds. Let the starter motor cool for two minutes before starting again. Keep the engine rpm low until oil pressure is correct or damage to the turbocharger can result.*

IMPORTANT: *Do not loosen the fuel lines at the fuel manifold. The fittings can be damaged and/or a loss of priming pressure can occur when the fuel lines are loosened.*

Procedure

1. Make sure there is fuel in the tank. Make sure the fuel tank supply valve (1) is open.

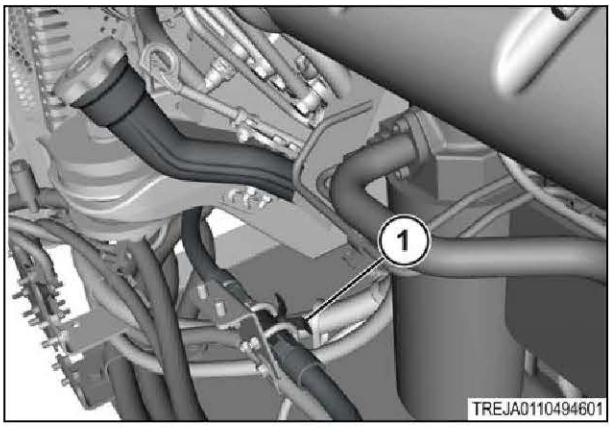


Fig. 534

2. Loosen the plug (2) to let air release from the fuel lines. Make sure the plug is open enough or priming the pump will not work.

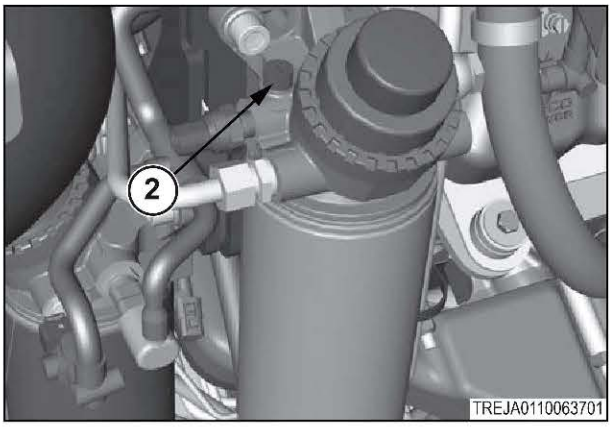


Fig. 535

3. Operate the plunger (1) until a strong pressure is felt, and the fuel is leaking out of the plug. This procedure requires many strokes.
4. Tighten the plug (2).
5. Press down the plunger six more times to build fuel pressure.
6. Start the engine. If the engine does not start, try procedure again. If the engine runs rough, run the engine at low idle speed until the engine runs smoothly.

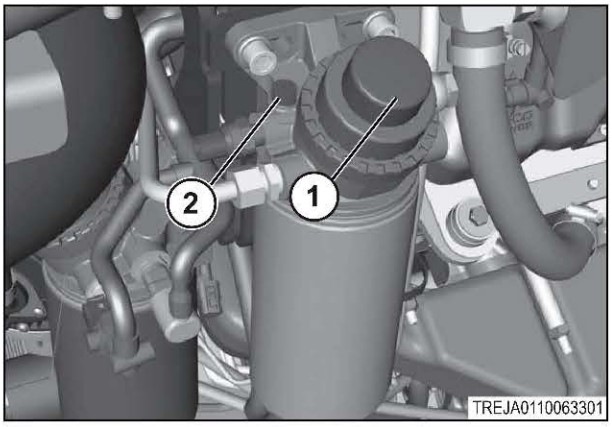


Fig. 536

2.5.10 Remove the diesel exhaust fluid system

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Completely clean all components to prevent contamination.

Before removing the components, fasten identification tags on the components for correct assembly.

Contain all fluids during inspection, maintenance, testing, adjustment, and repair of the machine. Before opening or disassembling any component containing fluids, prepare to contain fluids by having the correct containers available. Discard fluids according to local regulations and laws.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Block the wheels.
4. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.
5. Put a correct container below the diesel exhaust fluid (DEF) tank drain plug (1).
6. Remove the drain plug and drain the DEF tank.
7. Install the drain plug and torque to 8 Nm to 14 Nm (6 lbf-ft to 10 lbf-ft).

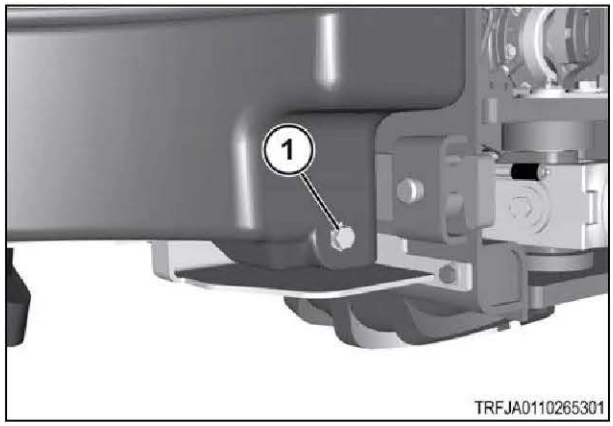


Fig. 537

8. Disconnect the harness (1) from the DEF tank sensor.
9. Loosen the hose clamps (2) and disconnect the hoses (3).

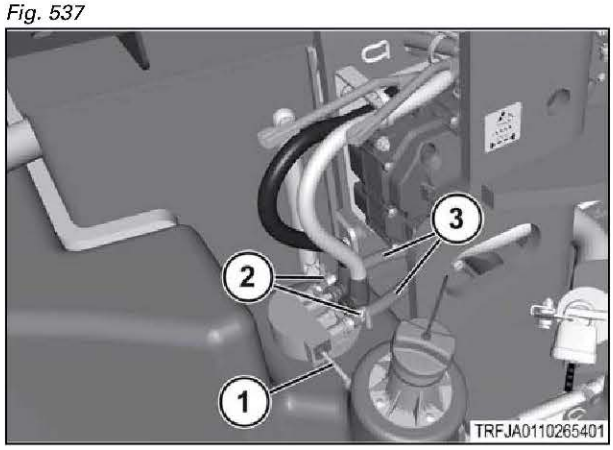


Fig. 538

10. Loosen the hose clamps (1) and remove the hoses (2).

11. Remove the elbow (3) and the adapter (4).

12. Remove the hardware and the line valve (5).

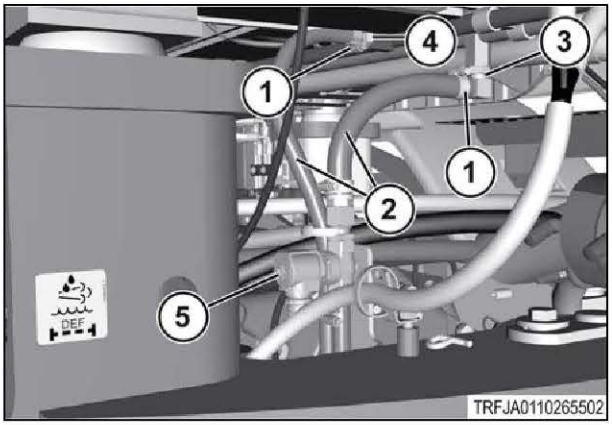


Fig. 539

13. Disconnect the harness (1) from the DEF module pump and sensor.

14. Remove the hose (2) from the DEF module pump.

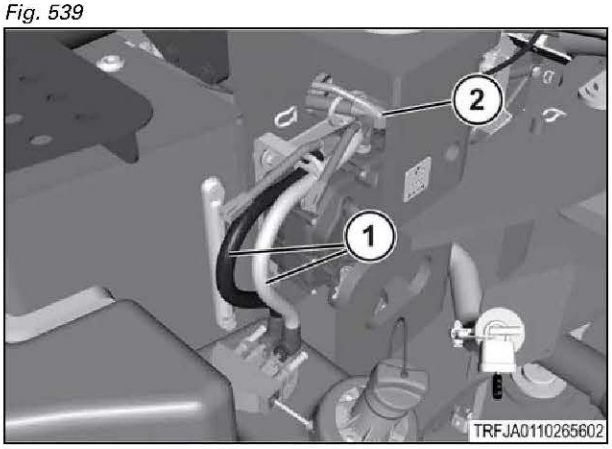


Fig. 540

15. Remove the hardware (1) and the DEF module pump.

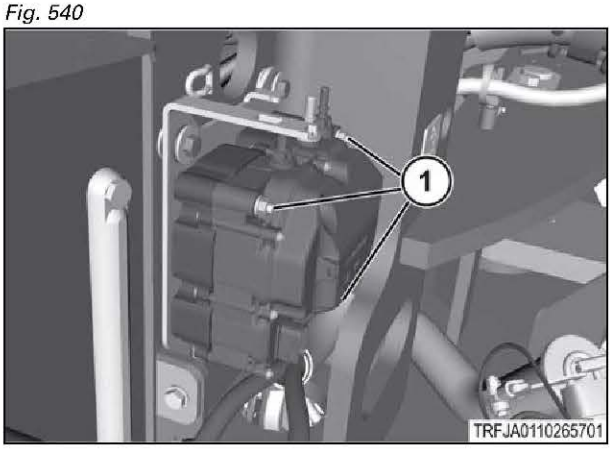


Fig. 541

16. Remove the hardware (1) and bracket (2).

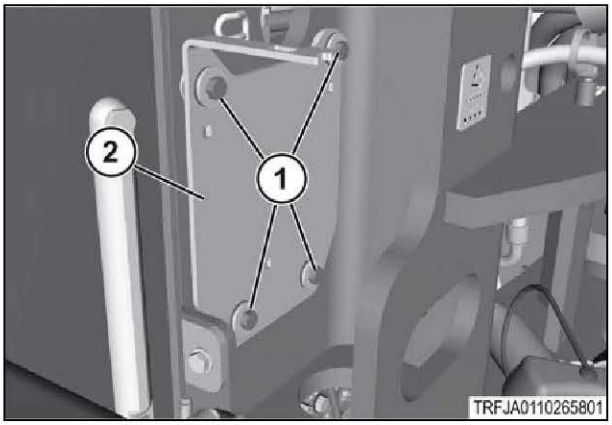


Fig. 542

17. Remove the hardware (1) and the DEF tank (2).

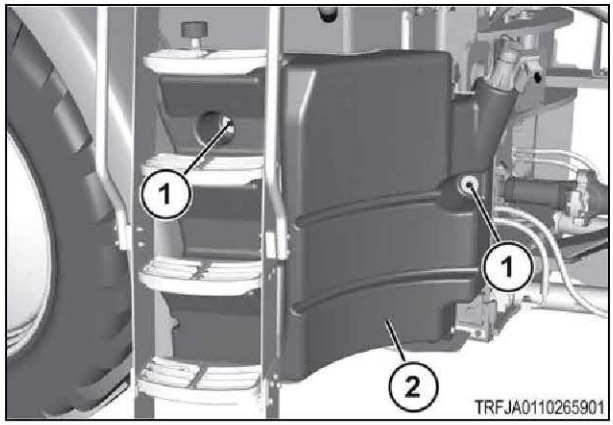


Fig. 543

18. Remove the hardware and clips (1).

19. Remove the hose (2).

20. Disconnect the hose from the dosing module.

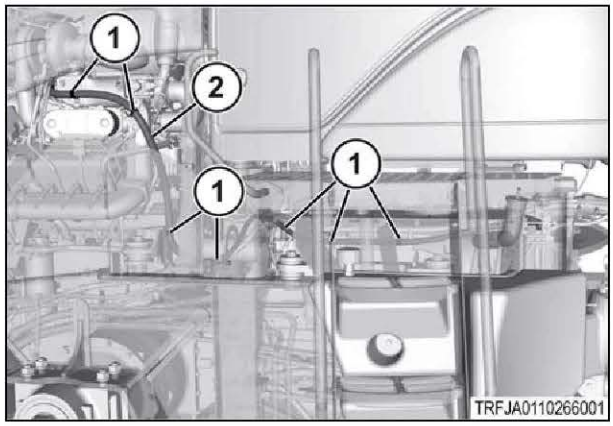


Fig. 544

2.5.11 Install the diesel exhaust fluid system

Procedure

1. Connect the hose (2) to the dosing module.

2. Put the hose along the engine and the transmission, and attach with the clips and hardware (1).

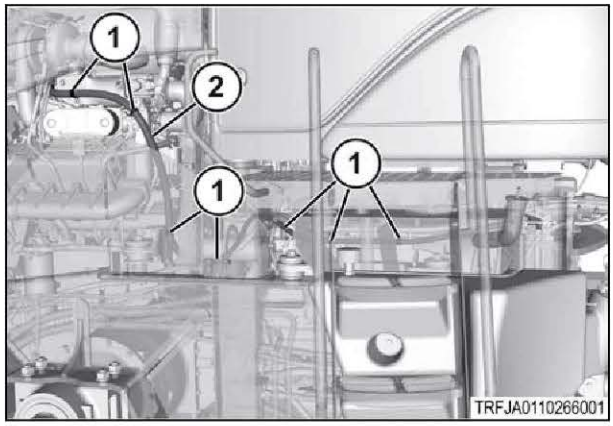


Fig. 545

3. Install the diesel exhaust fluid (DEF)/AdBlue® tank (2) with the hardware (1).

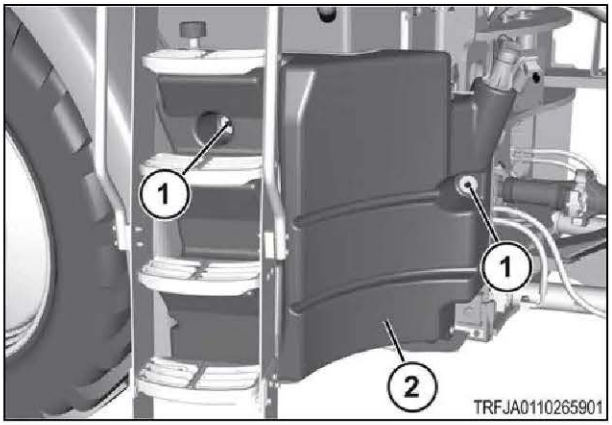


Fig. 546

4. Install the support bracket (2) with the hardware 1.

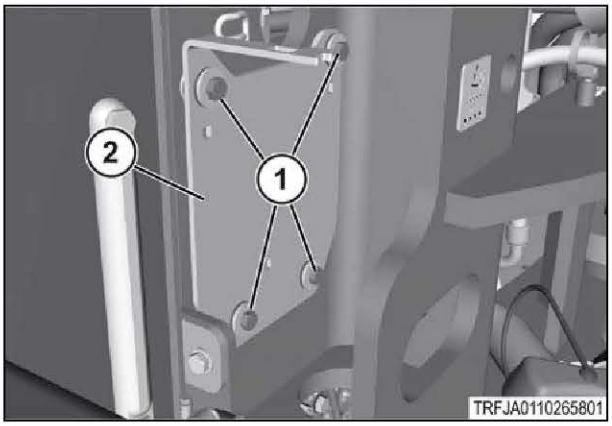


Fig. 547

5. Install the module pump with the hardware (1).

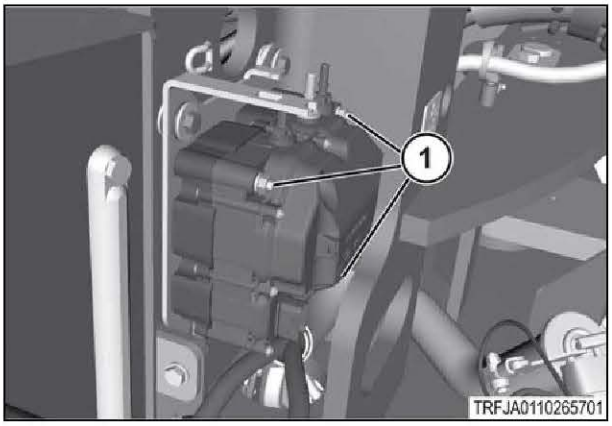


Fig. 548

6. Install the hose (2).

7. Connect the harness (1) from the module pump to the DEF tank sensor.

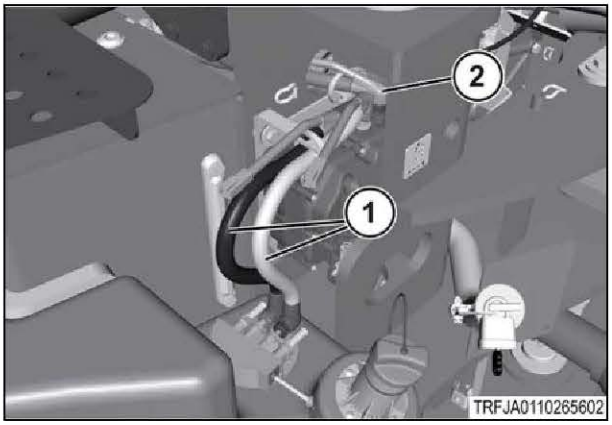


Fig. 549

8. Install the line valve (5) with the hardware.
9. Install the fitting (4) and the elbow (3).
10. Install the hoses (2) and the hose clamps (1).

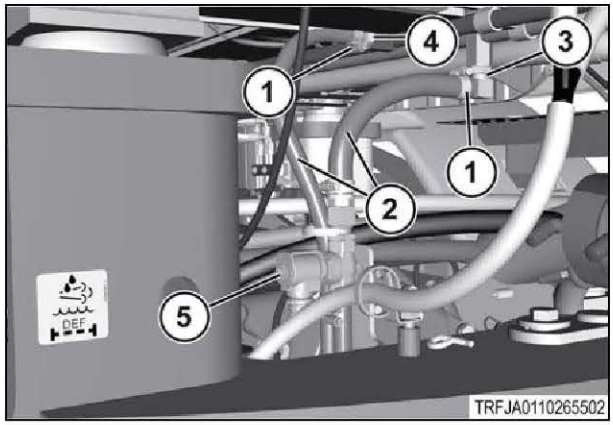


Fig. 550

11. Install the hoses (3) to the DEF tank sensor.
12. Tighten the hose clamps (2).
13. Connect the harness to the DEF tank sensor (1).
14. Fill the DEF tank.

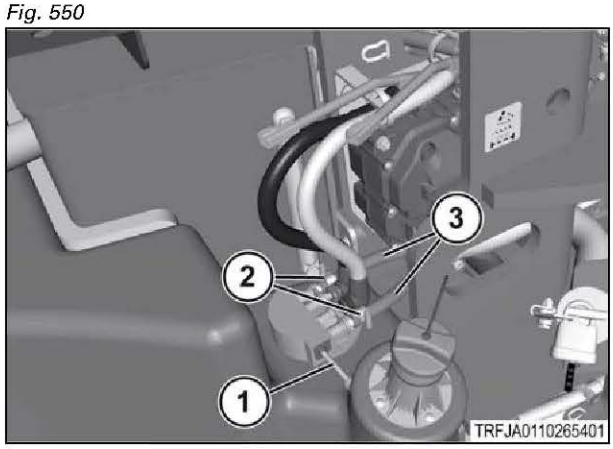


Fig. 551

Related Links

Fill capacities page 1-18
Fill the diesel exhaust fluid tank page 2-197

2.6 Exhaust system components

2.6.1 Remove the exhaust system with the diesel exhaust fluid system

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

Completely clean all components to prevent contamination.

Put caps and plugs on all hoses, fittings, ports, and openings to prevent contamination.

Contain all fluids during inspection, maintenance, testing, adjustment, and repair of the machine. Before opening or disassembling any component containing fluids, prepare to contain fluids by having the correct containers available. Discard fluids according to local regulations and laws.

Procedure

1. Park the machine on a solid, level surface.
2. Apply the parking brake, stop the engine, and take the key with you.
3. Block the wheels.
4. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.
5. Release the latches (1) and open the engine cover.
6. Remove the engine cover.

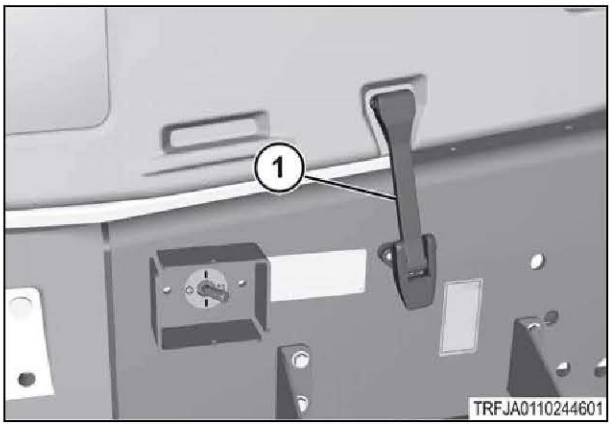


Fig. 552

7. Remove the hardware and the cover plate (1).
8. Install a drain hose to the radiator drain valve (2) through the access hole.
9. Put the correct container below the drain hose.
10. Open the radiator drain valve and drain the engine coolant.

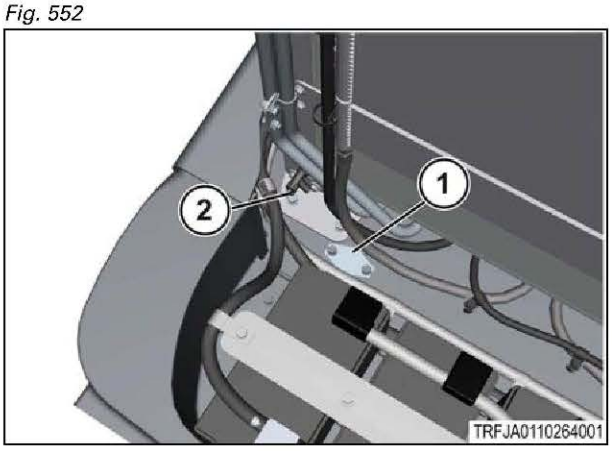


Fig. 553

11. Remove the hardware (1) and the right hand fan guard (2).

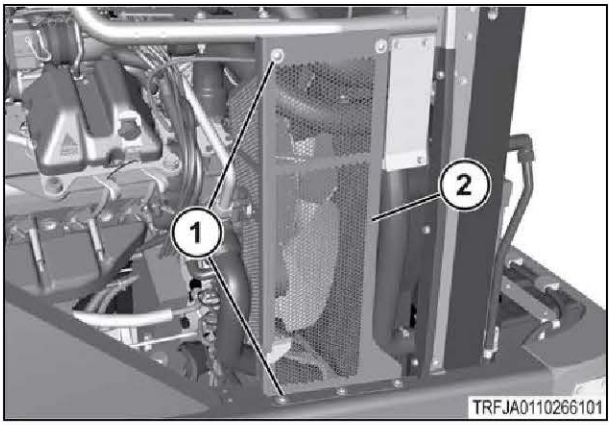


Fig. 554

12. Remove the hardware (1) and the left hand fan guard (2).

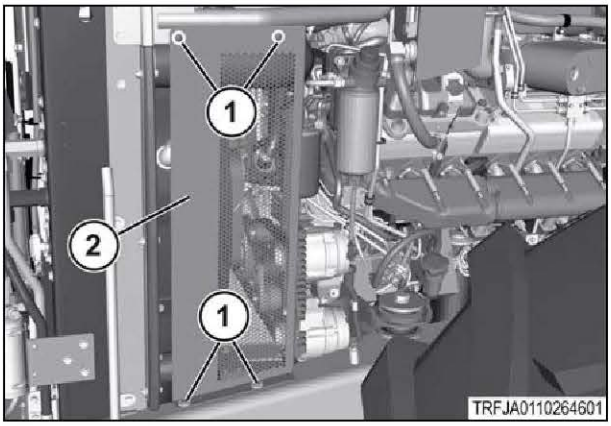


Fig. 555

13. Remove the hardware from the right-hand rear guard (1) and the frame (2).

14. Remove the engine guard (3).

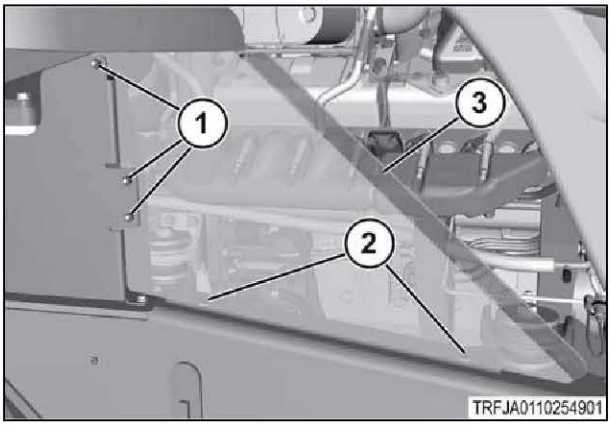


Fig. 556

15. Remove the hardware and clips (1).

16. Remove the hoses (2).

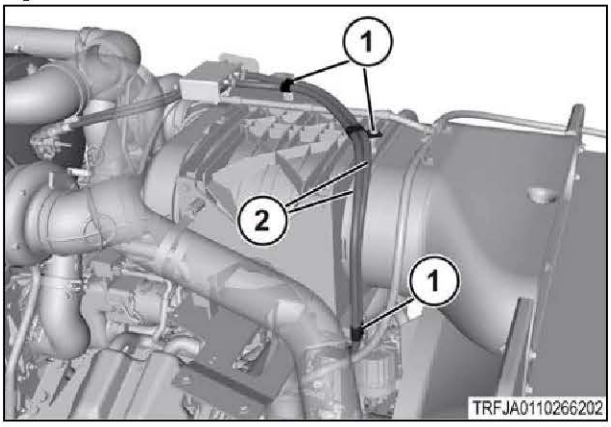


Fig. 557

17. Remove the hardware and the clips (1).

18. Disconnect the hoses (2).

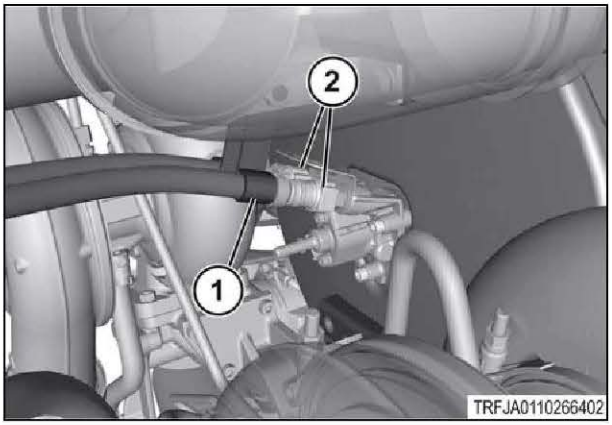


Fig. 558

19. Remove the hardware (1) and remove the urea tank (2).

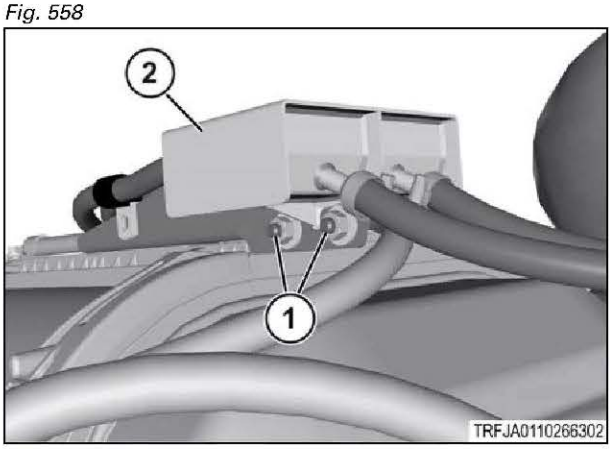


Fig. 559

20. Loosen the clamp (1) on the exhaust tube.

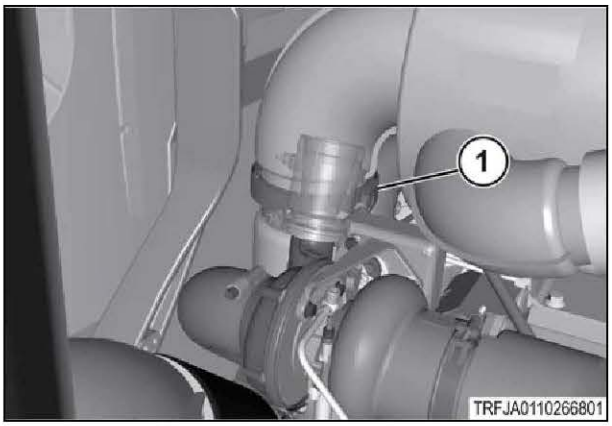


Fig. 560

21. Remove the hardware (1) from the support bracket below the exhaust tube.

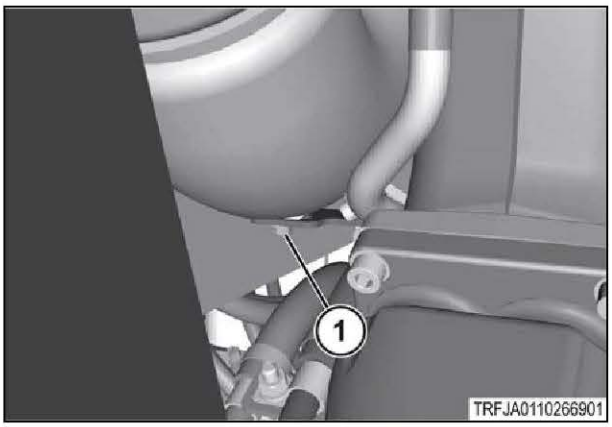


Fig. 561

22. Disconnect the harness (2) and loosen the clamp (1).

23. Remove the tube from the exhaust.

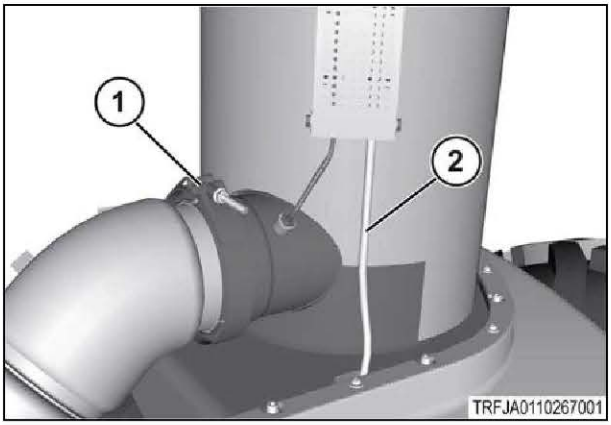


Fig. 562

24. Remove the hardware (1) and the tip of the exhaust.

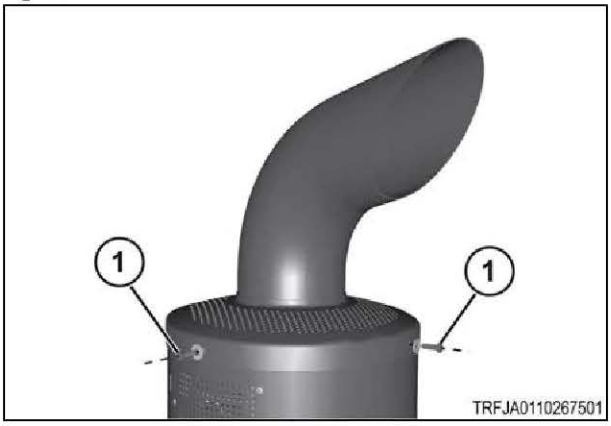


Fig. 563

25. Connect the correct lifting device to the exhaust hookup points (1).

WARNING: Components can be heavy.

Severe injury can result from improper lifting technique.

Use appropriate lifting equipment for heavy components.

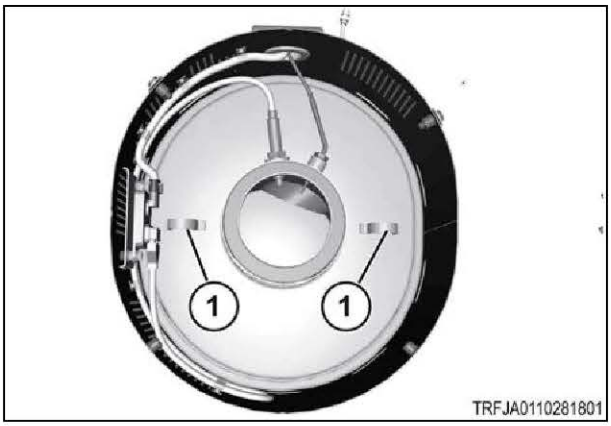


Fig. 564

26. Remove the hardware (1) from below the front fender.

27. Remove the exhaust.

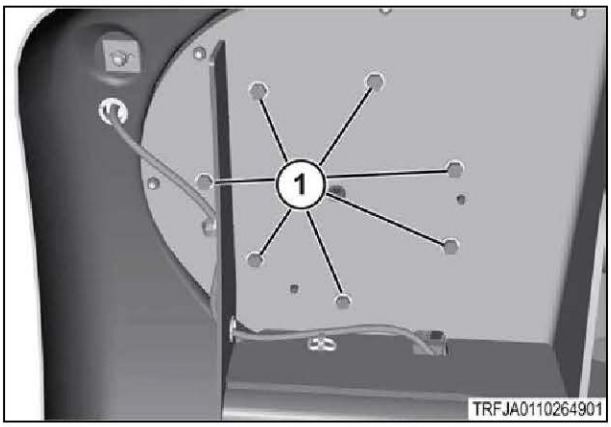


Fig. 565

28. Remove the hardware (1) and the plate (2).

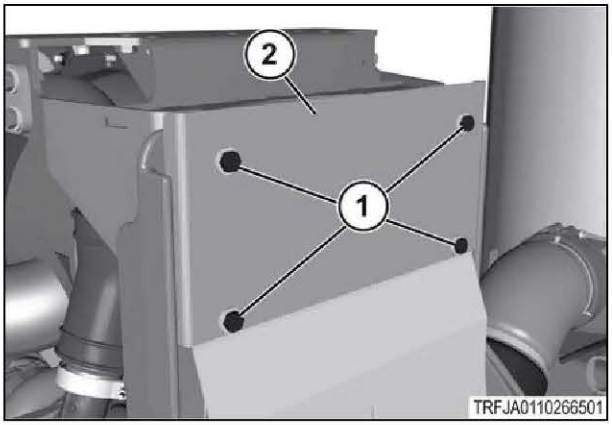


Fig. 566

29. Disconnect the nitrogen oxide (NOx) sensor (1) and remove the tie strap (3).

30. Remove the hardware (2) and the (NOx) sensor.

31. Remove the hardware (4) and the plate (5).

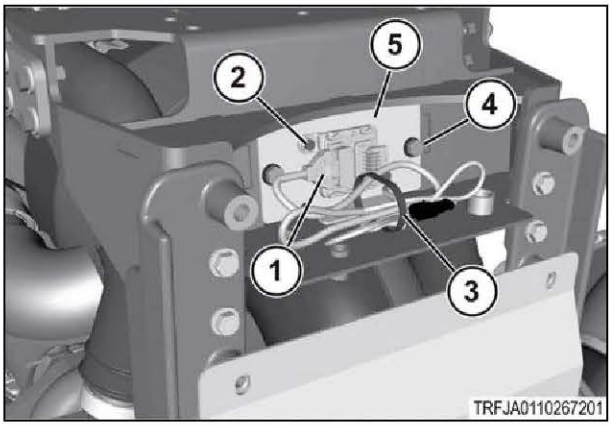


Fig. 567

32. Remove the hardware (1) from the left and right side tubes.

33. Remove the hardware (2) from the left and right side engine cover supports.

34. Remove the engine cover support (3).

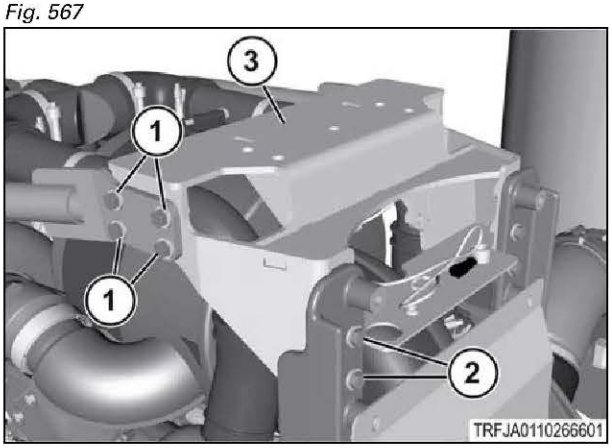


Fig. 568

35. Remove the hardware and the clip (1) on the left and right side of the machine.

36. Loosen the clamps (2) and remove the tubes (3) on the left and right side of the machine.

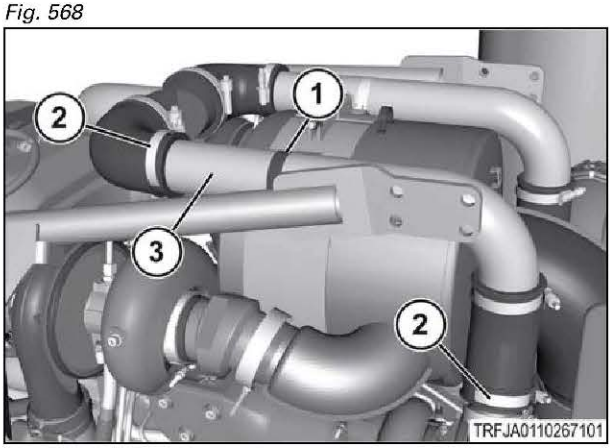


Fig. 569

37. Loosen the clamps (1) and remove the inlet tubes (2).

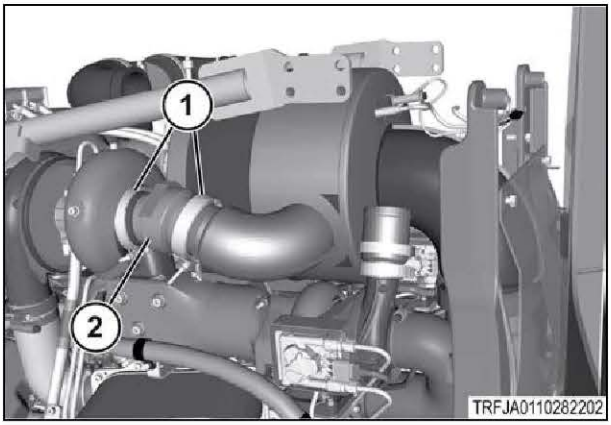


Fig. 570

38. Remove the bolt (1), and open the straps (2) away from the diesel oxidation catalyst (DOC) (3).

39. Attach the correct lifting device and remove the DOC.

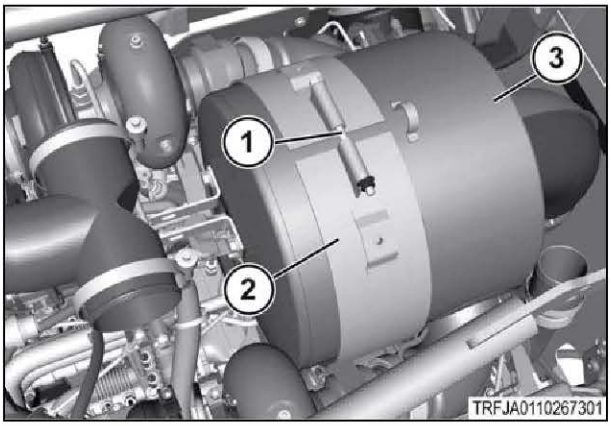


Fig. 571

40. Remove the hardware (1) and remove the DOC base (2).

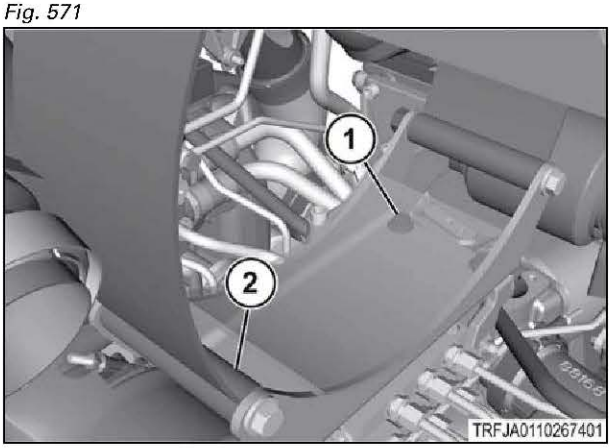


Fig. 572

41. Remove the EGT sensor (2), the nitrogen oxide (NOx) sensor (1), and the hardware (3).

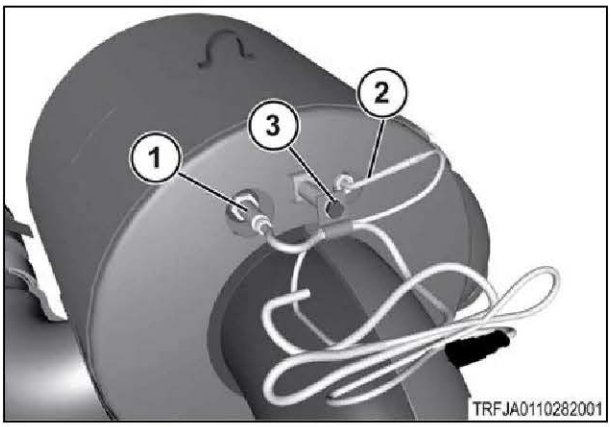


Fig. 573

42. Remove the tube support bracket (1) and the hardware (2).

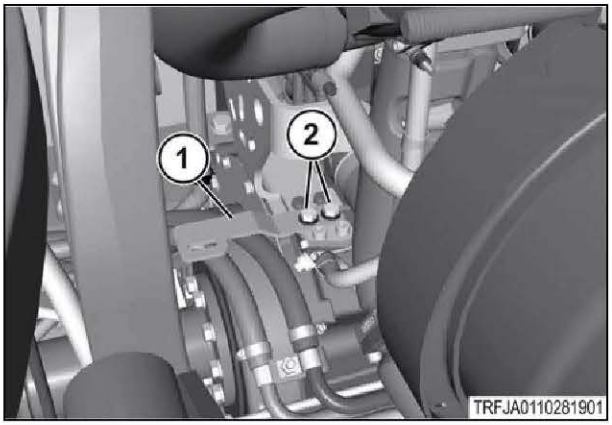


Fig. 574

Related Links

Remove the engine cover page 13-3

2.6.2 Install the exhaust system with the diesel exhaust fluid system

Procedure

1. Install the tube support bracket (1) with the hardware (2) onto the engine.

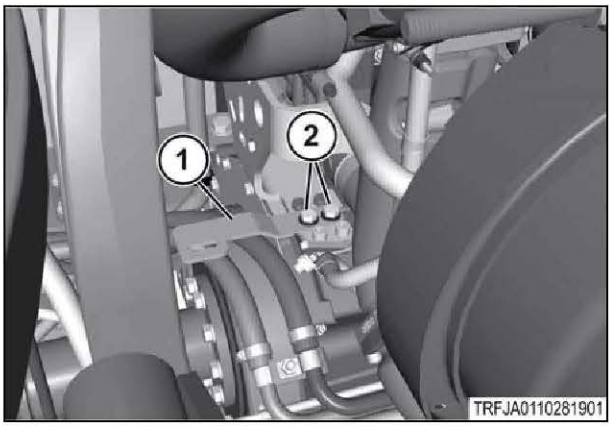


Fig. 575

2. Apply anti-seize to the exhaust gas temperature (EGT) sensor (2) and install into the diesel oxidation catalyst (DOC).

3. Torque the EGT sensor to 38 Nm to 52 Nm (28 lbf-ft to 38 lbf-ft).

4. Install the nitrogen oxide (NOx) sensor (1) and torque to 40 Nm to 60 Nm (30 lbf-ft to 44 lbf-ft).

5. Put the sensor wires through the clip (3) and install with the hardware.

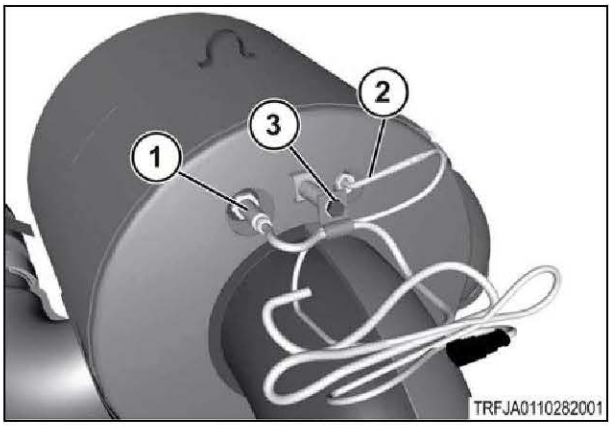


Fig. 576

6. Install the DOC base support (2) to the engine with the hardware (1).

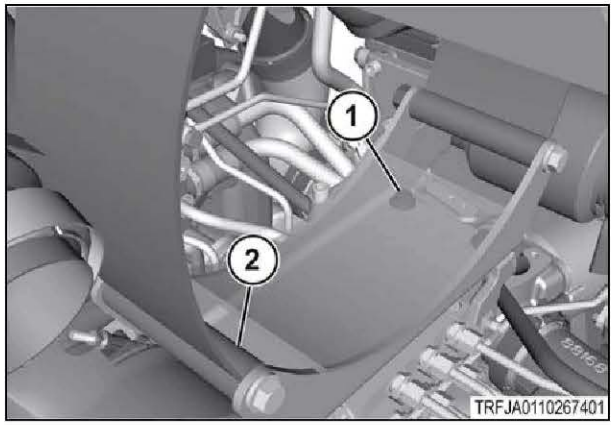


Fig. 577

7. Install the exhaust tube to the support bracket, but leave the bolt (1) loose.

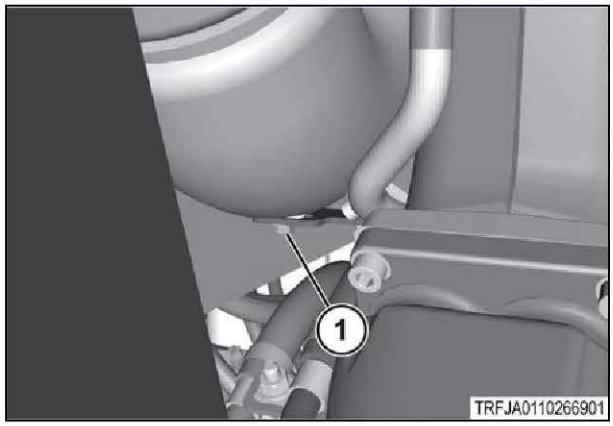


Fig. 578

8. Install the DOC (3) into the straps (2) and put the bolt in position, but do not tighten.

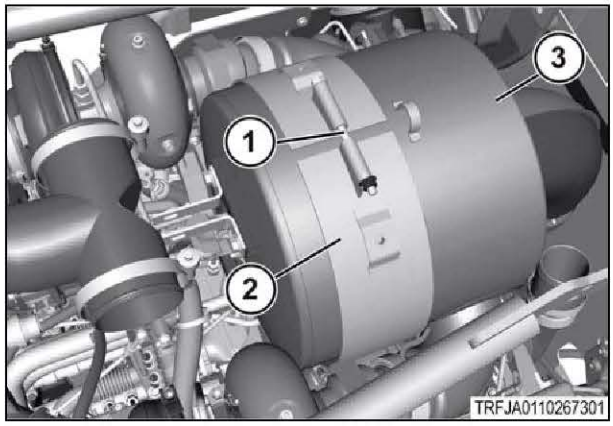


Fig. 579

9. Align the DOC with the exhaust tube (1), and the inlet tubes (2) with the turbos (4).

10. Install the clamps (3) on the inlet tubes and toruqe to 11 Nm to 17 Nm (8 lbf-ft to 12 lbf-ft).

11. Install the clamp (1) on the exhaust tube and torque to 23 Nm to 33 Nm (17 lbf-ft to 24 lbf-ft).

12. Torque the hardware on the DOC straps to 20 Nm to 34 Nm (15 lbf-ft to 25 lbf-ft).

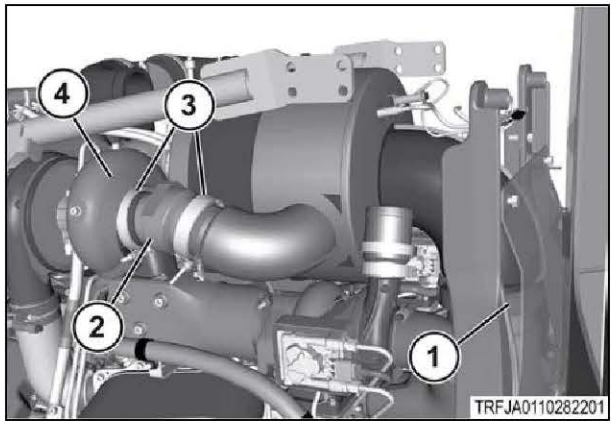


Fig. 580

13. Install the tubes (3) and clamps (2).

14. Install the clips and the hardware (1).

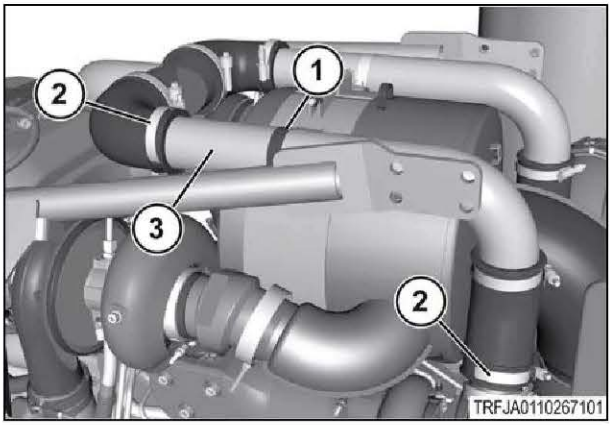


Fig. 581

15. Install the engine cover support (3) with the hardware (1, 2).

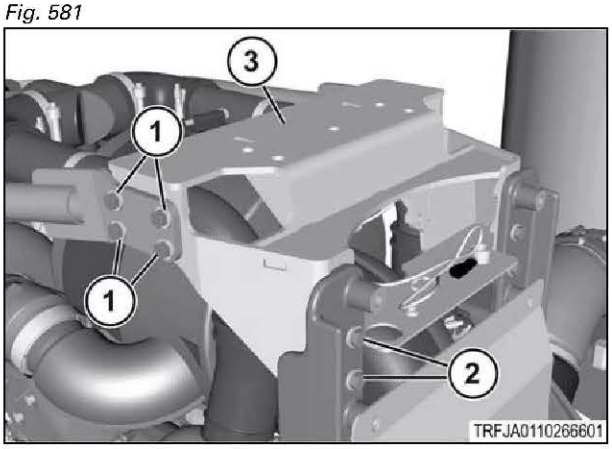


Fig. 582

16. Install the plate (5) and hardware (4).

17. Install the Nox sensor (1) with the hardware (2).

18. Attach a tie strap (3) around the wires.

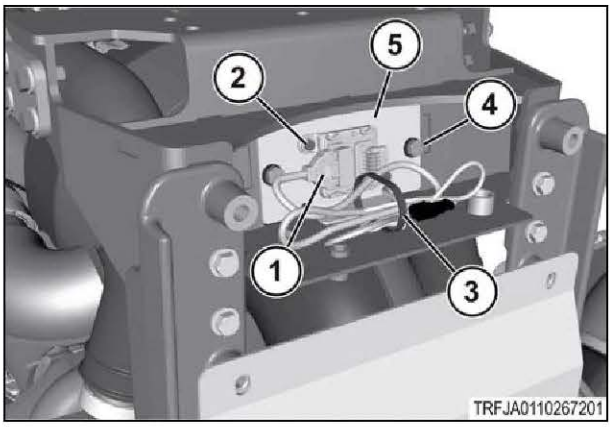


Fig. 583

19. Install the plate (2) with the hardware (1).

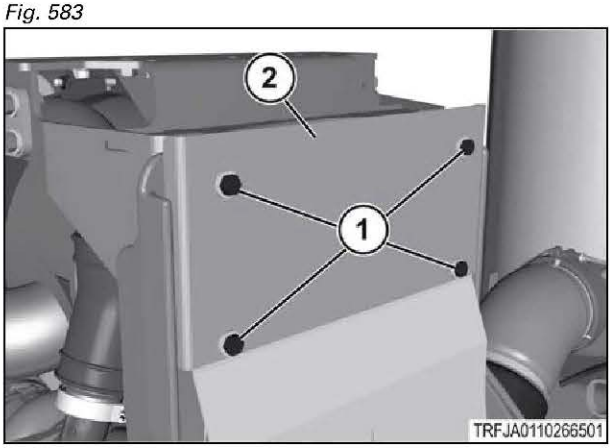


Fig. 584

20. Connect the correct lifting device to the exhaust hookup points (1).

WARNING: Components can be heavy.

Severe injury can result from improper lifting technique.

Use appropriate lifting equipment for heavy components.

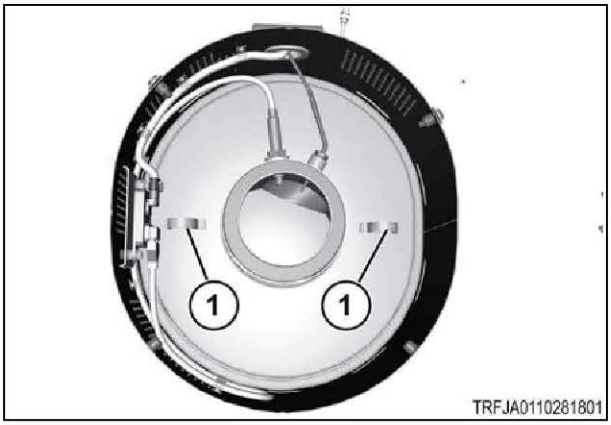


Fig. 585

21. Install the exhaust.

22. Install the hardware (1) below the front fender.

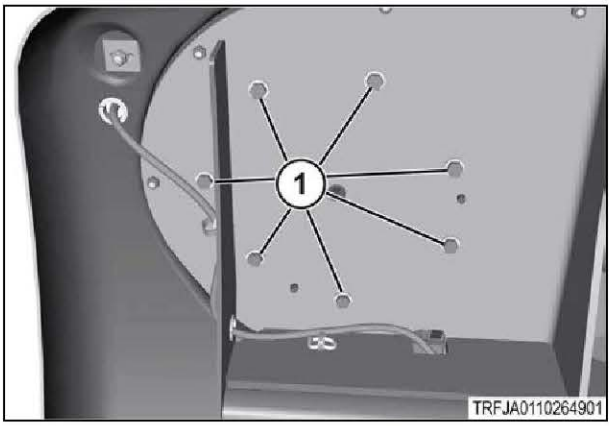


Fig. 586

23. Install the exhaust tip with the hardware (1).

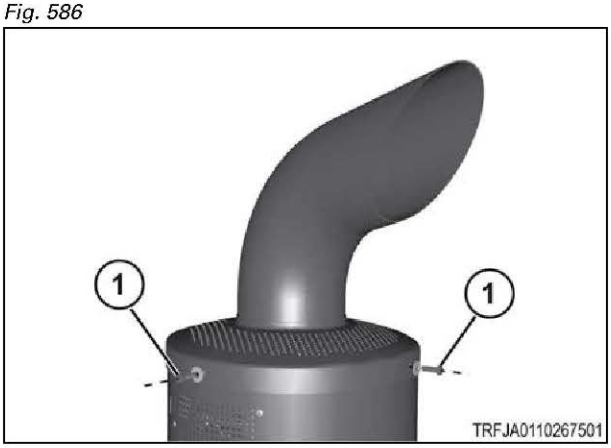


Fig. 587

24. Align the exhaust tube with the exhaust.

25. Install the clamp and torque to 23 Nm to 33 Nm (17 lbf-ft to 24 lbf-ft).

26. Connect the harness (2) to the main harness.

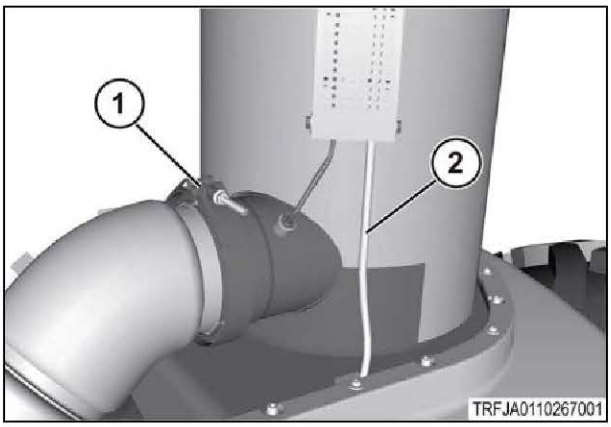


Fig. 588

27. Tighten the hardware (1) to the bottom of the exhaust tube.

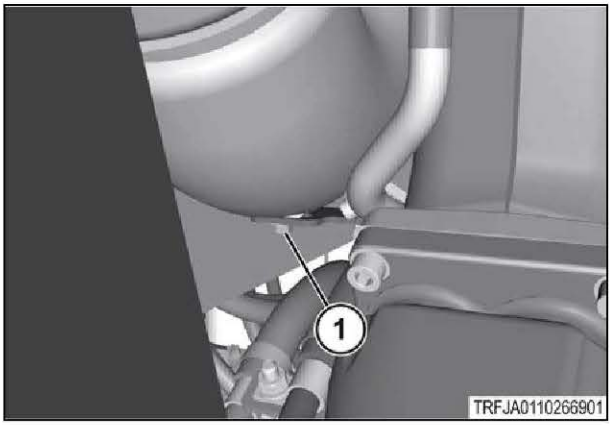


Fig. 589

28. Install the urea tank (4) with the hardware (3).

29. Install the tubes (2) and tight the clamps (1).

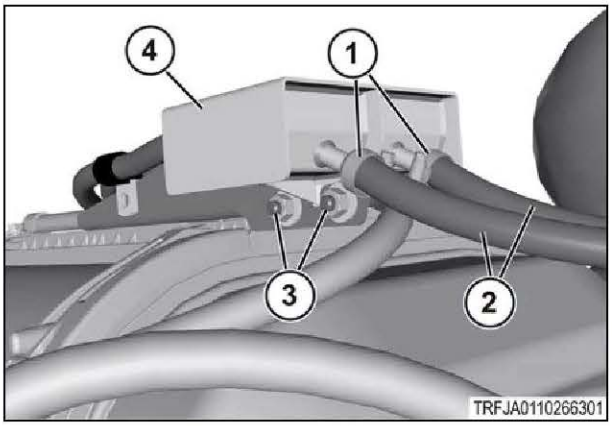


Fig. 590

30. Install the hoses (2) and attach with the clips and hardware (1).

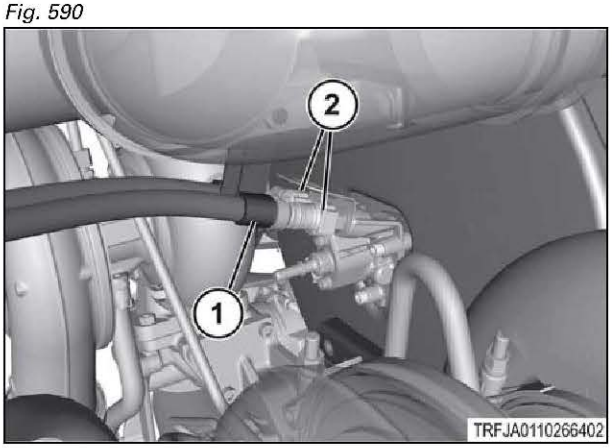


Fig. 591

31. Install the hoses (3) to the urea tank and the tighten the clamps (2).

32. Install the hoses to the water pump.

33. Install the clips and hardware (1).

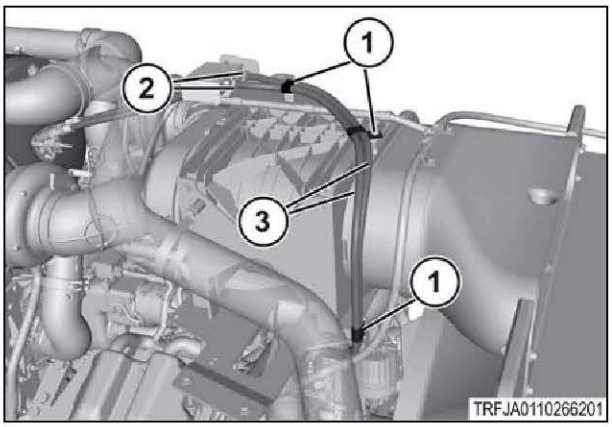


Fig. 592

34. Install the engine guard (3) with the hardware (1, 2).

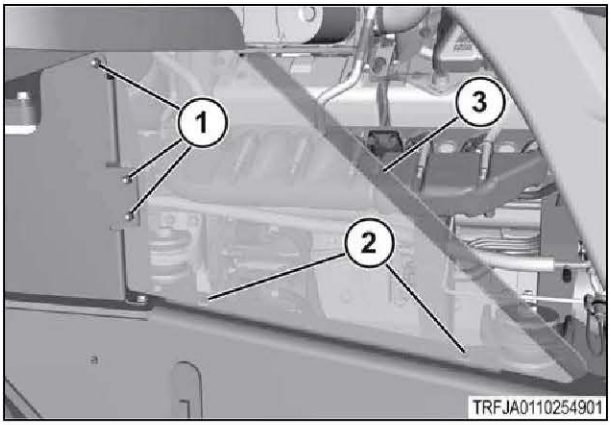


Fig. 593

35. Install the fan guard (2) with the hardware (1).

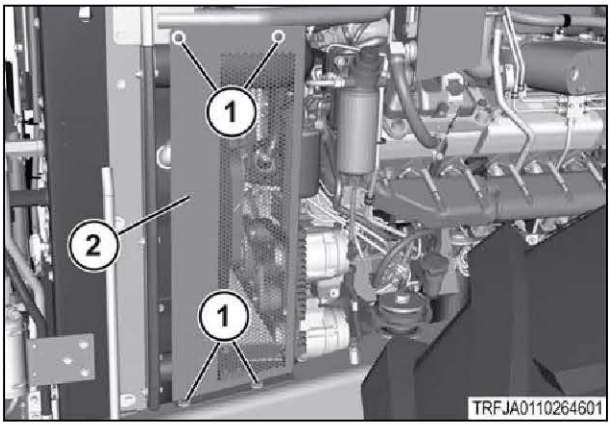


Fig. 594

36. Install the fan guard (2) with the hardware (1).

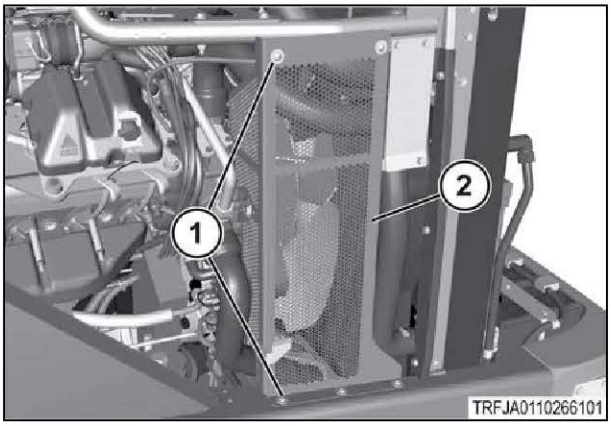


Fig. 595

37. Close the drain valve (2) and remove the drain valve.

38. Install the cover with the hardware (1).

39. Install the engine cover.

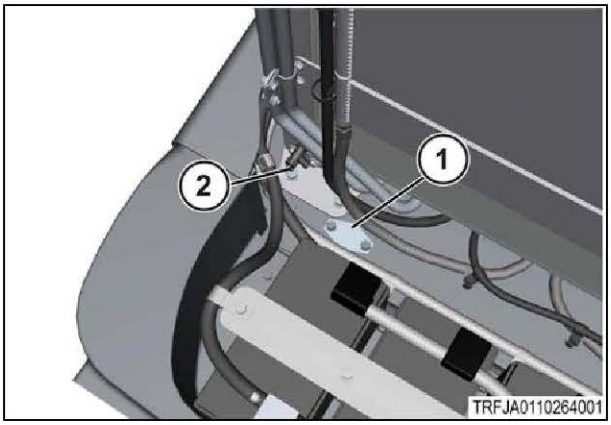


Fig. 596

40. Close the engine cover and attach the latches (1).

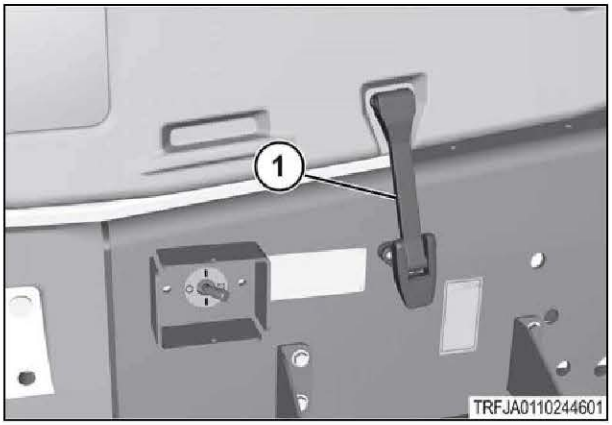


Fig. 597

Related Links

Install the engine cover (MY2015 and earlier) page 13-16

2.6.3 Remove the exhaust system

WARNING: Hot components can burn.

Severe personal injury can result.

Let the engine and components cool before doing maintenance.

WARNING: Fire hazard. Fuel safety.

Personal injury, death, or machine damage can occur.

Stop the engine and let the engine cool before fueling. Never smoke while fueling the machine.

Before removing the components, fasten identification tags on the components for correct assembly.

Contain all fluids during inspection, maintenance, testing, adjustment, and repair of the machine. Before opening or disassembling any component containing fluids, prepare to contain fluids by having the correct containers available. Discard fluids according to local regulations and laws.

Completely clean all components to prevent contamination.

Procedure

1. Park the machine on a solid, level surface.

2. Apply the parking brake, stop the engine, and take the key with you.

3. Turn the battery disconnect switch to the off position. Remove the key from the battery disconnect switch.

4. Release the latches (1) and open the engine cover.

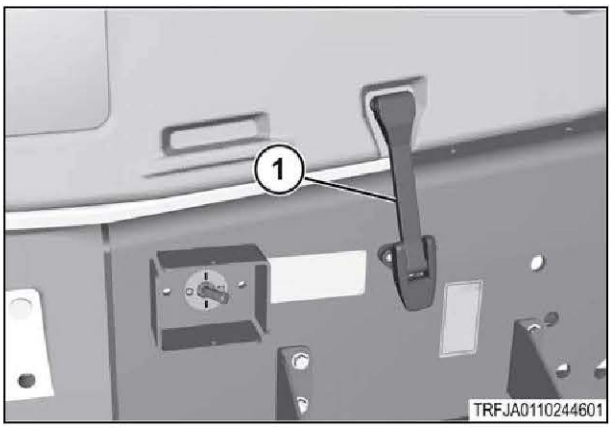


Fig. 598

5. Prop the engine cover (1).

CAUTION:
Engine cover can be a pinch point that can cause serious bodily injury.

6. Remove the right hand fan guard and the hardware.

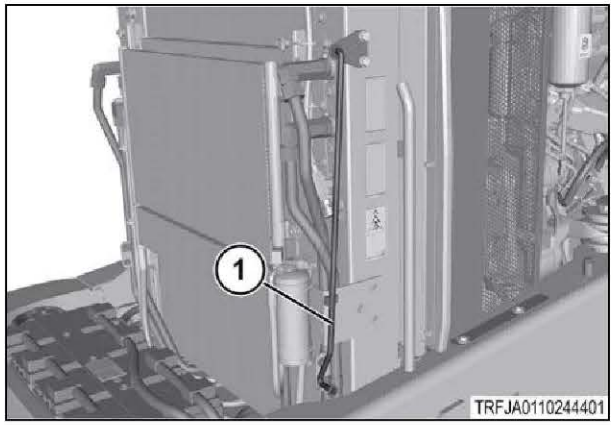


Fig. 599

7. Remove the hardware from the rear guard (1) and the frame (2).

8. Remove the engine guard (3).

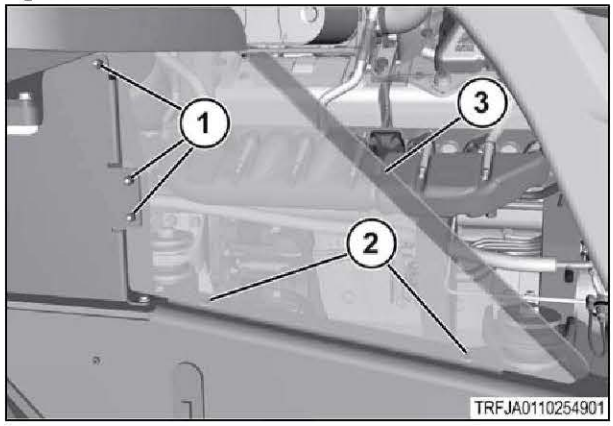


Fig. 600

9. Remove the hardware and clips (1).

10. Remove the hardware (2) and the support brackets (3).

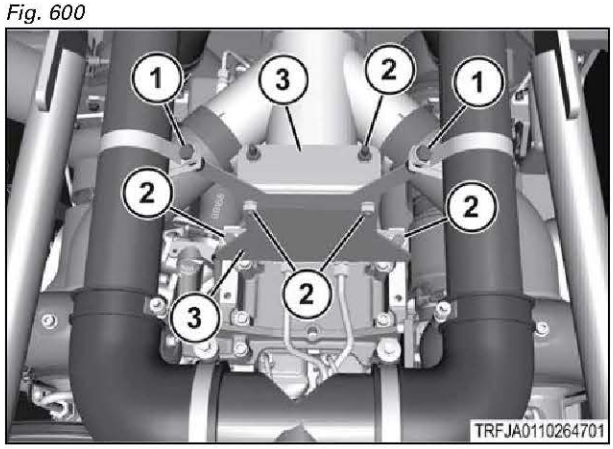


Fig. 601

11. Loosen the clamps on the turbo tubes.

12. Pull turbo tubes away from the engine.

NOTE: *Put a clean cloth in the turbocharger port.*

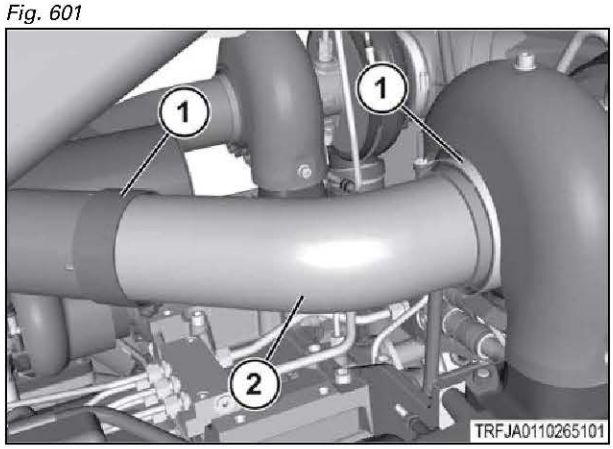


Fig. 602

13. Remove the hardware (1).

14. Loosen the exhaust clamp (2).

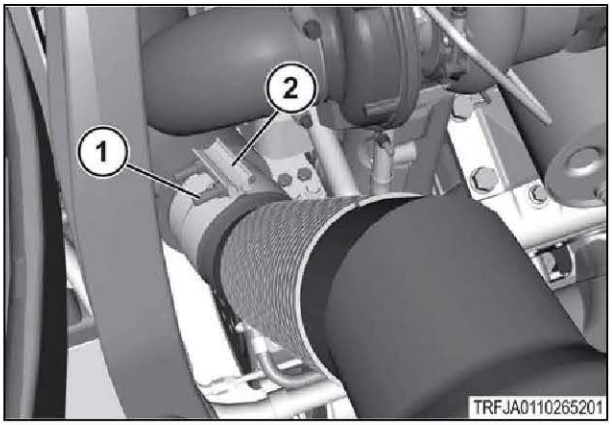


Fig. 603

15. Loosen the exhaust clamp (1) and remove the tube (2).

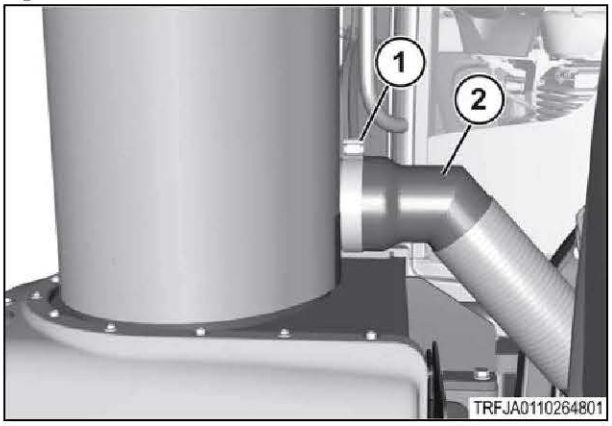


Fig. 604

16. Loosen the clamp (1) and remove the exhaust stack (2).

17. Connect the correct lifting device to the exhaust hooks (3).

WARNING: Components can be heavy.

Severe injury can result from improper lifting technique.

Use appropriate lifting equipment for heavy components.

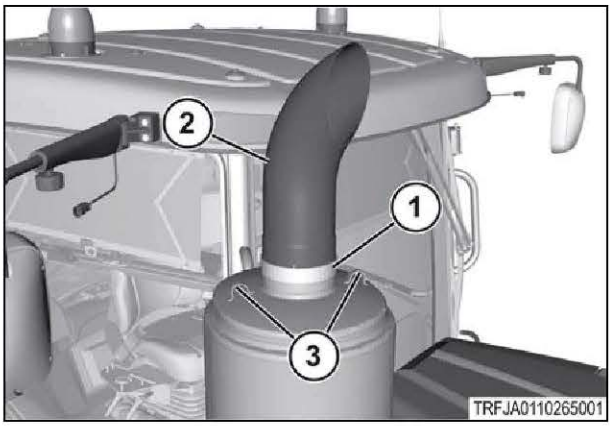


Fig. 605

18. Remove the hardware (1) below the fender.

19. Remove the exhaust.

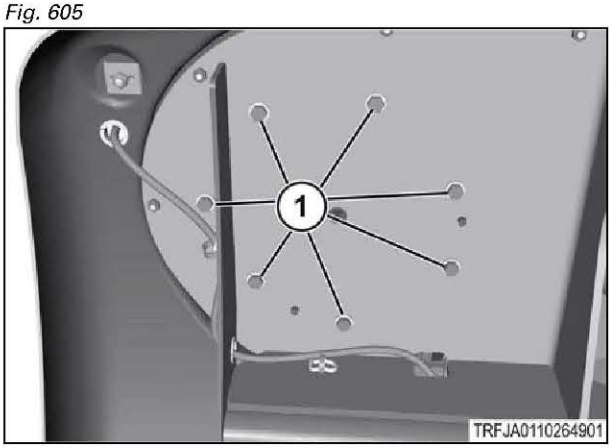


Fig. 606

2.6.4 Install the exhaust system

Procedure

1. Install the exhaust with the correct lifting device.

WARNING: Components can be heavy.

Severe injury can result from improper lifting technique.

Use appropriate lifting equipment for heavy components.

2. Install the hardware.

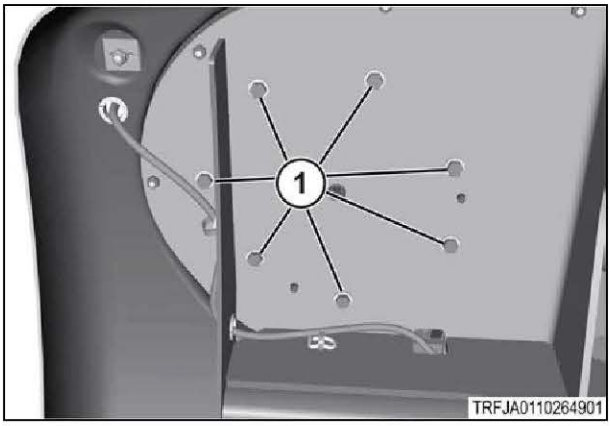


Fig. 607

3. Install the exhaust stack and the tighten the clamp.

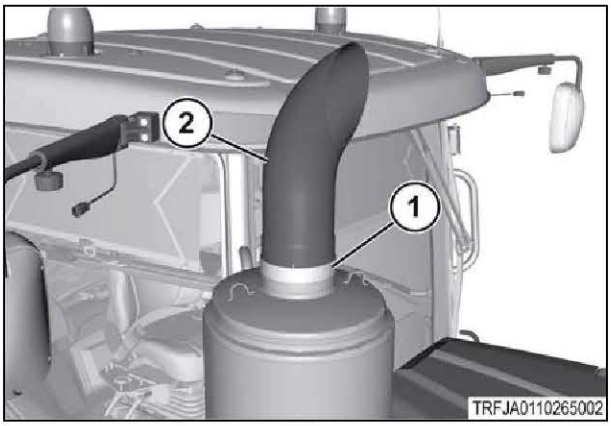


Fig. 608

4. Install the exhaust tube (2) to the exhaust and the exhaust tee.

5. Torque the clamp (1) to 60 Nm to 80 Nm (44 lbf-ft to 59 lbf-ft)

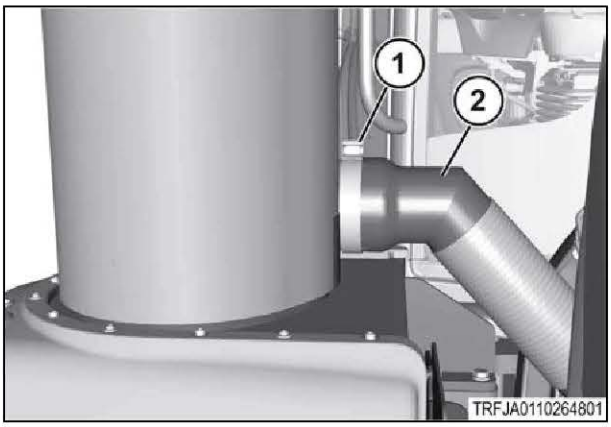


Fig. 609

6. Install the clamp (2) and the hardware (1).

7. Torque the clamp to 70 Nm to 90 Nm (52 lbf-ft to 66 lbf-ft).

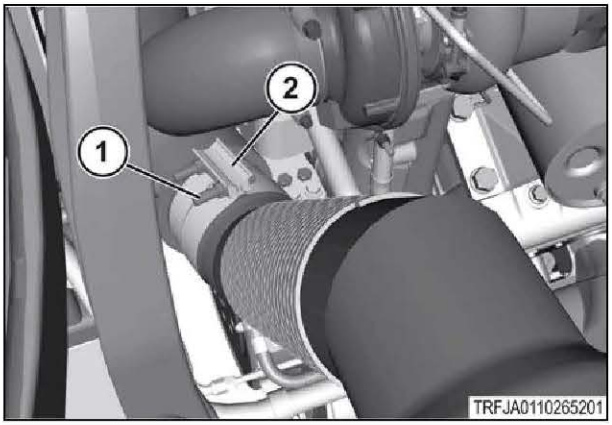


Fig. 610

8. Remove the cloth in the turbocharger port.

9. Install the turbo tubes (1) from the exhaust tee to the engine.

10. Torque the front clamps (2) to 11 Nm to 17 Nm (8 lbf-ft to 12 lbf-ft).

11. Torque the rear clamps (3) to 44 Nm to 50 Nm (32 lbf-ft to 37 lbf-ft).

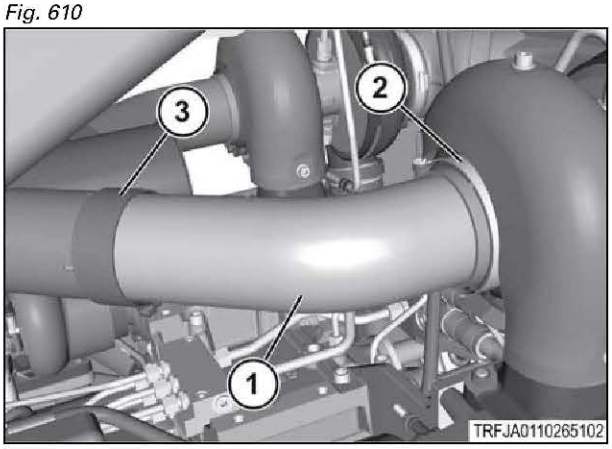


Fig. 611

12. Install the support brackets (3) with the hardware (2).

13. Install the clips (1) with the hardware.

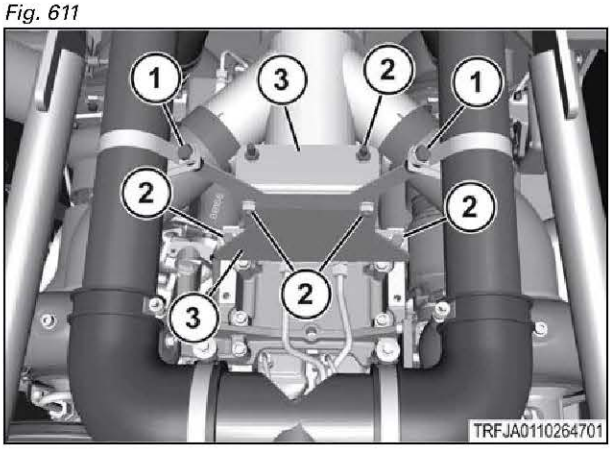


Fig. 612

14. Install the engine guard (3) to the rear guard (1) and the frame (2) with the hardware.

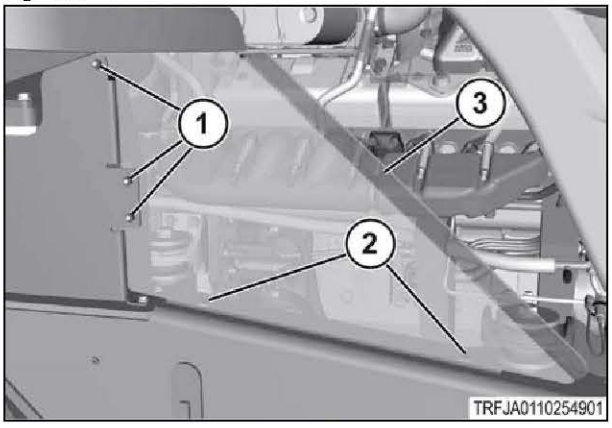


Fig. 613

15. Close the engine cover and attach the latches (1).

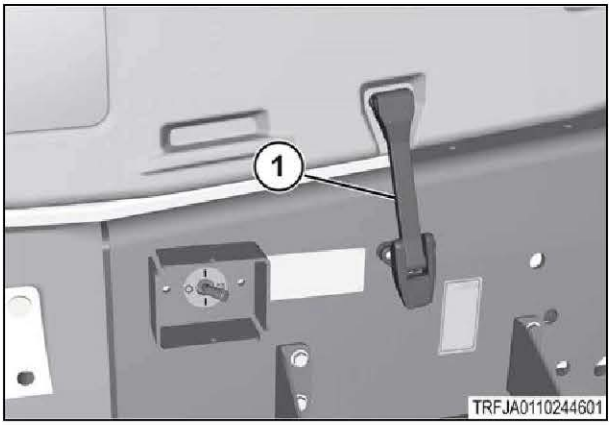


Fig. 614

2.7 SCR system

2.7.1 Selective catalytic reduction (SCR) System

These general instructions are necessary to be followed:

- The selective catalytic reduction (SCR) system must not be contaminated by diesel fuel, oil, or other hydrocarbons. Damage to the system will result.

  If a part of the system has been in touch with such material, the part must be cleaned very carefully. If you cannot be sure the part is clean from diesel, it must be replaced.

  IMPORTANT: *The selective catalytic reduction (SCR) system tolerates only small quantities of unwanted materials. If you question if the diesel exhaust fluid (DEF) tank has been contaminated with diesel fuel, the engine must not be started. Empty and clean the diesel exhaust fluid (DEF) tank, supply module (including new main filter), dosing module and the diesel exhaust fluid (DEF) lines. See the engine operator/service manual.*
- Do not use high pressure water to clean the selective catalytic reduction (SCR) components.
- As the diesel exhaust fluid (DEF) particles can cause corrosion, flush particles off with low pressure water.
- Always pay attention to cleanliness. Do not unnecessarily open the hydraulic or electrical connectors, in order to prevent dirt and diesel exhaust fluid (DEF) entering connectors.
- Using the compressed air for diesel exhaust fluid (DEF) lines, cleaning is not allowed, unless air is oil free. Oil can do damage to the system.
- After the engine shutdown, the remaining diesel exhaust fluid (DEF) in the system is automatically sent back to the diesel exhaust fluid (DEF) tank. During the removal process, continuous power supply must be supplied for the EEM4 electronic control unit (ECU). The pump for the after-run is supplied through the EEM4 electronic control unit (ECU), and will run without the key on or battery disconnect switch on.

CAUTION:
Diesel exhaust fluid (DEF) is pressurized when the system is in operation. Let pressure decrease in the system before a maintenance procedure.

2.7.2 Supply module

WARNING: *DEF is pressurized when system is in operation. Allow pressure to decrease in the system before any maintenance actions.*

IMPORTANT: *The SCR system tolerates only a small amount of impurities. If there is doubt that the DEF tank has been contaminated with diesel fuel, engine must not be started before emptying and cleaning DEF tank, supply module (including new main filter), dosing module and DEF lines. See Engine Operator/ Service manual for removing and installing the supply module.*

Access to the filter is below the supply module (1).

Change the supply module filter 1200 hours or annually, unless DEF tank has been contaminated. The supply module is under the left-hand rear side of cab.

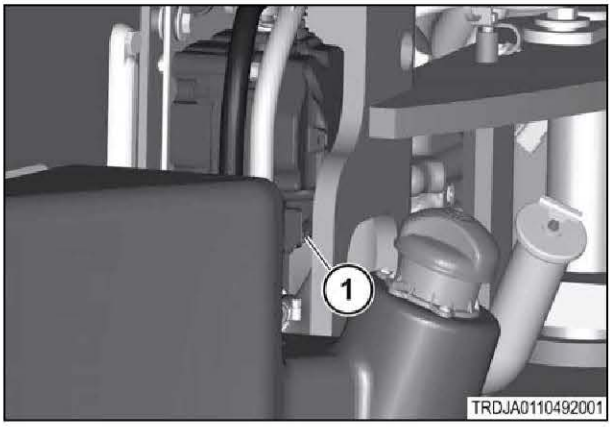


Fig. 615

2.7.3 Fill the diesel exhaust fluid tank

NOTE:
Keep the tools and the equipment clean to prevent the tank contamination.

IMPORTANT:
Even small amounts of diesel fuel in DEF tank can damage the selective catalytic reduction (SCR) system.

IMPORTANT:
Do not mix the DEF with other substances. Substances other than DEF can damage the SCR system.

Procedure

1. The DEF tank fill cap is blue displaying DEF and the symbol.
2. Remove the DEF fill cap (1) and add the DEF solution through the fill opening.
3. Remove the drain plug (2) to empty the DEF tank. Store the DEF in an approved DEF container.

   NOTE:
   For cold or long term machine storage, drain the DEF tank.

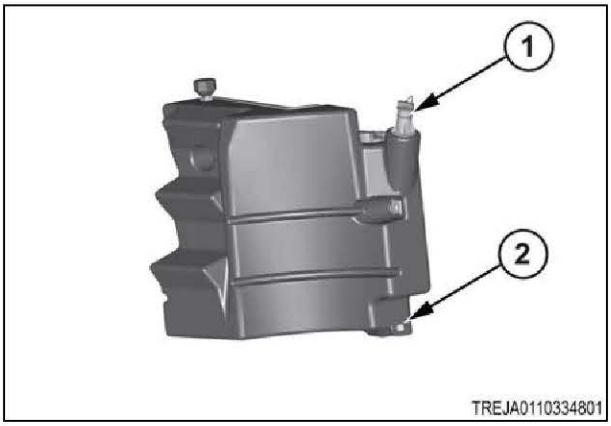


Fig. 616

2.7.4 DEF heater circuit fuse

The DEF heater circuit fuse relay, each fuse relay 35 AMPS. The fuse block is located right side of machine in cabinet.

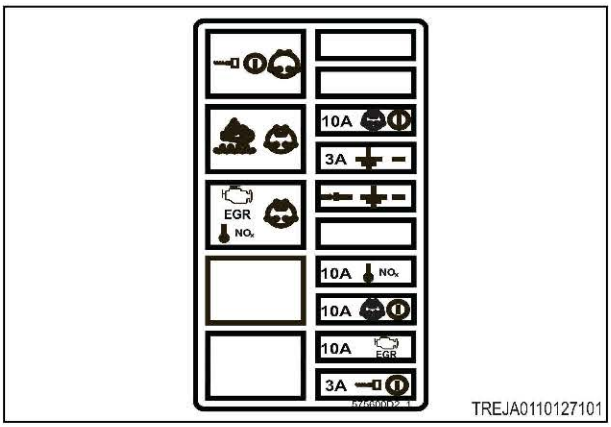


Fig. 617

2.7.5 DEF storage and shelf life

The following table provides information for the DEF shelf life as a function of temperature:

Constant ambient temperature	Minimum shelf life - months
less than or equal to 10°C (50° F)	36
less than or equal to 25°C (77° F) (Note 1)	18
less than or equal to 30°C (86° F)	12
less than or equal to 35°C (95° F)	6

Constant ambient temperature	Minimum shelf life - months
more than 35°C (95° F)	(Note 2)
NOTE: *Main factors taken into account to define shelf life in this table are ambient storage temperature and initial alkalinity of DEF. The difference in evaporation between vented and non-vented storage containers is an additional factor.*	
Note 1: To prevent decomposition of DEF, prolonged transportation or storage above 25°C (77° F) must be avoided.	
Note 2: Important loss of the shelf life: check every batch before use.	

DEF must only be stored in original or DEF approved containers.

The crystallization point or freezing point of DEF is -11° C (12.2° F).

2.7.6 Low diesel exhaust fluid (DEF) level

DEF tank level on CAN message	10 %	5 %	0 %	0% + after 1/2 hour
DEF symbol	Temporary, duration 10 sec	Continuous	Blinking, 1Hz	Blinking, 1 Hz
DEF symbol clearable	Yes	No (*)	No (*)	No (*)
MIL symbol	Off	Off	Off	Blinking, 1 Hz
Audible warning	Duration 2 secs, repeats at every restart	Duration 2 secs, repeats every 15 mins	Duration 2 secs, repeats every 5 mins	Duration 2 secs, repeats every 5 mins
Error code	No	No	Yes, SPN 1761, FMI 18	Yes, SPN 1761, FMI 1
DEF injections	Yes	Yes	Yes	No

(*) In mono-display cabins, DEF symbol may be temporarily disabled for displaying other data, but DEF symbol must re-activate after 10 seconds from last button press.

TRFJA0110298001

Fig. 618

- Visible and audible warnings.
- After warning L2(0%), engine ramping down to low idle speed and 50% idle torque in 30 minutes.
- Derate to final inducement before DEF runs out.
- Ramp is usable only once per refill.
- At engine startup, ramp continues from saved point.
- Heals only after refill

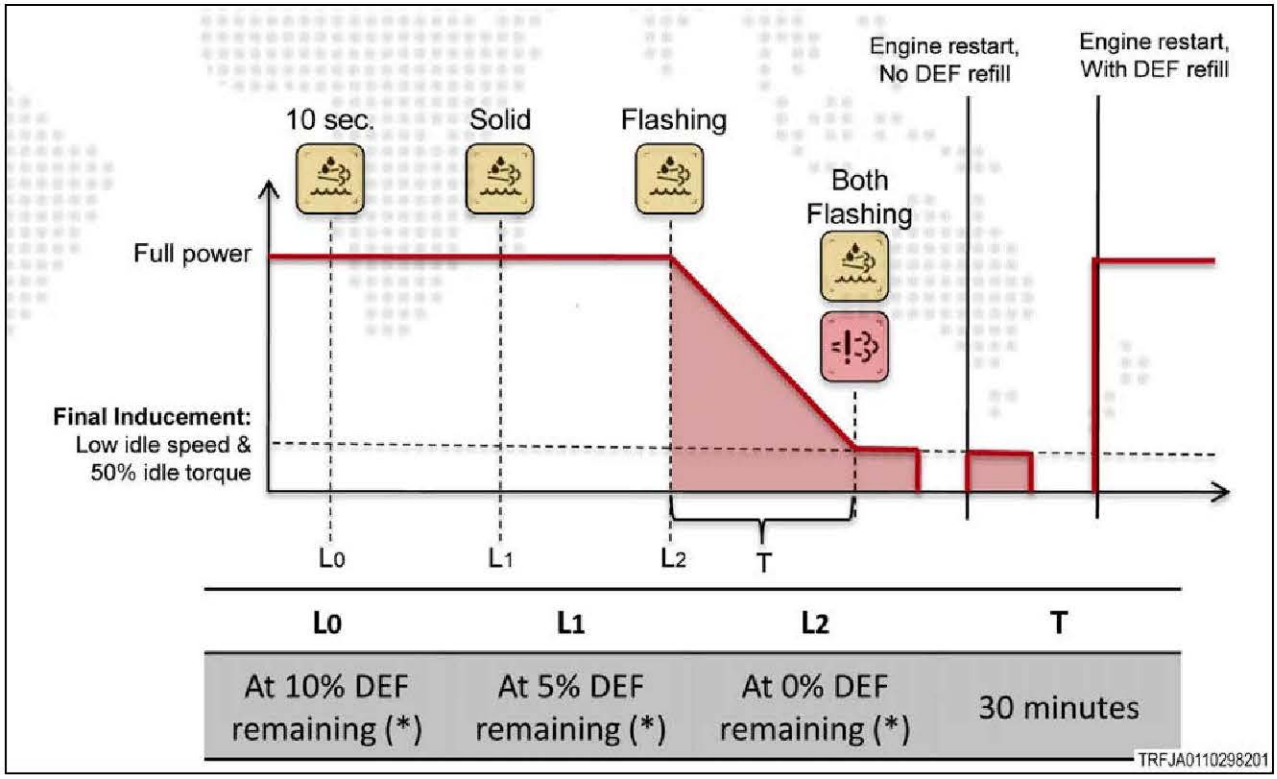

Engine restart,
No DEF refill
Engine restart,
With DEF refill
10 sec.
Solid
Flashing
Both
Flashing
Full power
Final Inducement:
Low idle speed &
50% idle torque
L0
L1
L2
T
L0
L1
L2
T
At 10% DEF remaining (*)
At 5% DEF remaining (*)
At 0% DEF remaining (*)
30 minutes
TRFJA0110298201

Fig. 619

2.8 Fluid specifications

2.8.1 Oil specification

The engine oil used must comply with the American Petroleum Institute (API)-grade CJ-4. Association des Constructeurs Europeens d'Automobiles (ACEA)-grade E9.

2.8.2 Fuel specifications

The fuel must be according to norm European Union (EN) 590:2009 or the American Society for Testing and Materials (ASTM) D 975-10b or newer, 1-D or 2-D with the following specifications:

Measurement	Description
0.82 to 0.84 kg/dm^3	density at +15° C
2 to 4.5 mm/sec^2	viscosity at +40° C
51	minimum cetane index
15 mg/kg	maximum sulphur content
200 mg/kg	maximum water content
460 µm	maximum lubricity/HFRR

2.8.3 Coolant specification

The engine coolant used must comply with the American Society for Testing and Materials (ASTM) d 3306 standard, or the British Standard (BS) 6580:1992. The required mixing ratio is 50% water to 50% antifreeze.

2.9 Safety instructions



WARNING: The engine has components that move and can be hot.

When the engine is in operation or use, injury is possible.

Read the safety instruction, before you start the engine or do maintenance.

- Do not start any repair work that you do not fully understand.
- Make sure that the location and surroundings in which you are carrying out the repair provide a safe environment in which to work.
- Always ensure the location is clean and free of clutter.
- Do not use faulty or otherwise unsuitable tools.
- Remove all rings, chains and watches before starting work.
- Use up-to-date protection equipment while you work. For example, eye protection, as you will be working with compressed air for cleaning, grinding, hammering or similar.
- Use a lifting device for lifting and transporting heavy (over 20 kg) pieces. Ensure all lifting hooks and chains are in good condition. The lifting eyes on the engine must not be subjected to side forces during lifting.
- Never work under an engine that is hanging from a lifting device or raised up on a jack. Always use strong supports before starting the work.
- Start the engine only by using the starting switch in the cabin.
- Do not start an engine if the protection covers are removed.

  NOTE: *The fan is difficult to see when the engine is running! Ensure that loose clothing or long hair does not get caught in the rotating parts of the engine.*
- If you start the engine indoors, ensure that there is proper ventilation.
- Never use an aerosol starting aid! (Risk of explosion, personal injuries and engine damage.)
- When you are operating the engine or working near it, use ear protection to avoid noise injuries.
- Always stop the engine before starting any servicing or repair work.
- Avoid touching the exhaust manifold, turbocharger and any other hot parts of the engine.
- Do not remove the thermal protection of the exhaust manifold.
- Open the radiator cap with care when the engine is hot, as the cooling system is pressurised. The cooling liquid and lubrication oil of a hot engine will cause injury if they come into contact with skin.
- Do not open high pressure pipe connectors of the fuel system when the engine is running. Wait at least 30 sec. after the stopping of the engine. If the jet of high pressure fuel contacts your skin, fuel penetrates the skin causing severe injuries. Get medical help immediately!
- Never allow a naked flame, smoking or sparks near the fuel system or batteries, especially when loading batteries, as these are explosive.
- Always disconnect the negative (-) battery cable when servicing or repairing the electric system.
- At temperatures in excess of 300°C, e.g. if the engine is burnt by a fire, the viton seals of the engine (i.e. the undermost cylinder liner O-ring) produce very highly corrosive hydrofluoric acid. Do not touch with bare hands when viton seals are subjected to abnormally high temperatures. Always use neoprene rubber or heavy-duty gloves and safety glasses when decontaminating. Wash the seals and the contaminated area with a 10% calcium hydroxide or other alkali solution. Put all removed material in sealed plastic bags and deliver them to the relevant disposal point provided by the authorities concerned.

  NOTE: *Never destroy viton seals by burning!*
- When checking fuel injectors do not allow the jet of high-pressure fuel to come into contact with your skin. The fuel penetrates the skin causing severe injuries. Get medical help immediately!
- The fuel, lubricating oil and coolant cause long-lasting irritation on contact with skin.
- If you are carrying out welding or similar high current operations for the appliance, we recommend that you disconnect the electronic control unit (ECU) main connector before starting work.

Important instructions

- **IMPORTANT:** *Do not idle the engine, if it is not necessary!*

  In general, running the engine at idle speed is not recommended. At idle speed the piston rings do not operate optimally, because of the low cylinder pressure. Do not idle the engine for more than 15 minutes in general.
- Do not let oil and other liquids to the environment when servicing the engine. Take them to a proper disposal point.
- The use of parts that are not equivalent in performance and durability to genuine parts may impair the effectiveness of the emission control system and prevent coverage under this warranty. If non-genuine AGCO parts are used for maintenance or replacement on this engine, you should assure yourself that such parts are warranted by their manufacturer to be equivalent to genuine parts in performance and durability.

  NOTE:
  Always replace the engine gaskets, seals and washers when you open joints.

  NOTE:
  Do a check for the condition of the pipes and hoses during maintenance work. After the installation, make sure that the pipes and hoses do not have a leak. Always replace damaged pipes and hoses.
- All the engine gaskets are made of non-asbestos material.
- Be careful when washing the engine with high-pressure washing machine equipment. Do not use high pressure to wash e.g. the electric and fuel equipment or the radiator because they can easily be damaged. To get humidity removed, it is recommended to run the engine after washing.

2.10 To the user

5th generation engines fulfil the emission requirements set by the authorities (AWF/ATF: EU97/68/EC Stage IV and EPA 40 CFR 1039 Tier 4 Final). The manufacturer guarantees that all engines of this type are equivalent to the engine that is officially approved.

Please note that the service schedule should be followed carefully, especially when performing periodical maintenance. Reimbursable warranty repairs must be performed by a dealer or service center authorized by AGCO or the manufacturer of this equipment. When performing any service or repair work use only replacement parts that are equivalent in performance and durability to genuine parts. Inadequate or delayed service and the use of other than replacement parts that are equivalent in performance and durability to genuine parts invalidates the responsibility of AGCO Power Inc. on the fulfilment of the emission requirements.

This Workshop Manual is intended to assist with workshop operations and repair work.

All measurements are in millimetres and valid when the temperature of the parts is +20°C, unless otherwise stated.

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Before starting any repair work, please read the safety instructions at the beginning of this book. Make sure that you have all the necessary tools, parts and accessories to hand. The special tools mentioned in the work instructions speed up and facilitate the work and contribute to successful execution of the work. An engine which has undergone repairs must be run in just like a new one.

Should the engine require work not described in this manual, please consult your local agent or vehicle manufacturer. To facilitate consulting, find out the following facts about the engine before contacting:

- engine type
- engine number
- model or equipment
- operating hours

This Workshop Manual does not cover the regular service procedure as this is explained in the 5th Generation series Operator's Manual.

As AGCO Power Inc. is continuously developing its products, all rights are reserved to alter the specifications, accessories and the service and repair procedure without separate notice.

NOTE:
AGCO POWER are not responsible for damage caused by possible incorrect information in this manual. Do not give this manual or part of it to others, printed or electronically, before you have the approval of AGCO POWER.

2.10.1 Engine type designations

(1) Basic type

74 = cylinder displacement, decilitres

A = aftertreatment system

(2) Turbocharged engine

W = wastegate turbo

T = standard turbo

(3) F = Tier 4 Final engine control technology

(4) C = medium duty engine

G = generating set engine

M = marine engine

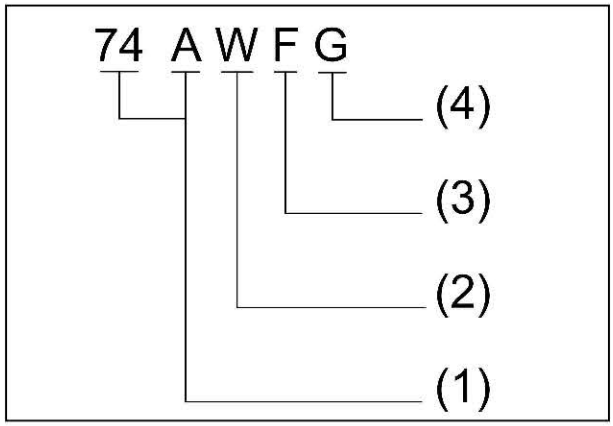


Fig. 620

2.10.2 Location of the engine serial number

The engine serial number is always stamped on the cylinder block.

The serial number is also marked on the type plate.

Engines have an electronic serial number data, which is readable with electronic service tool. The data includes also detailed specification, operation history and service information.

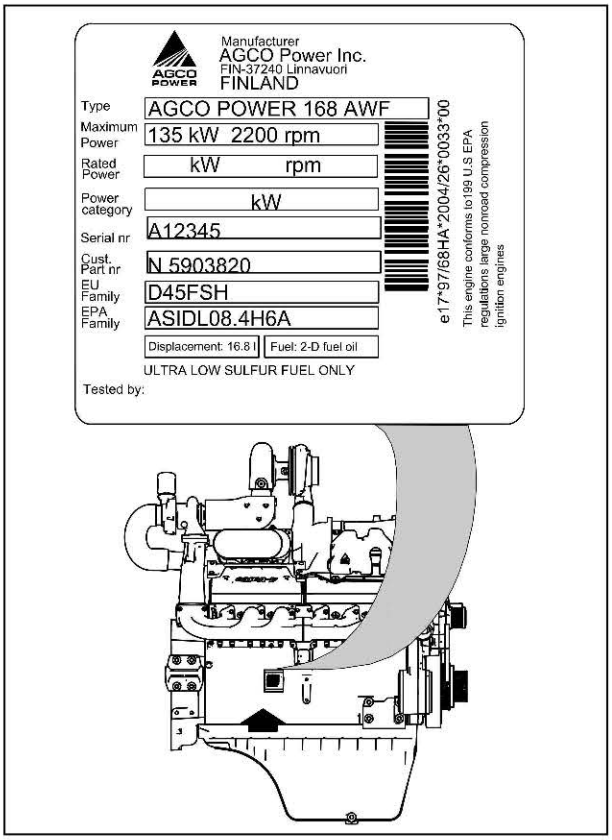


Fig. 621

2.10.3 Type plate of the electronic control unit

Always inform the engine serial number and the electronic control unit (ECU) serial number when ordering a pre-loaded spare part ECU or asking for adjusting settings.

NOTE: *The contents of the type plate is different between spare part ECU and production installed ECU.*

NOTE:
Engines with the aftertreatment system are in compliance with EU97/68/EC Stage IV and EPA 40 CFR 1039 Tier 4 final emission regulations.

Do not fit any components on the engine other than those originally intended for it. The use of other than replacement parts that are equivalent in performance and durability to genuine parts invalidates the responsibility of AGCO Power Inc. on the meeting of the emission requirements.

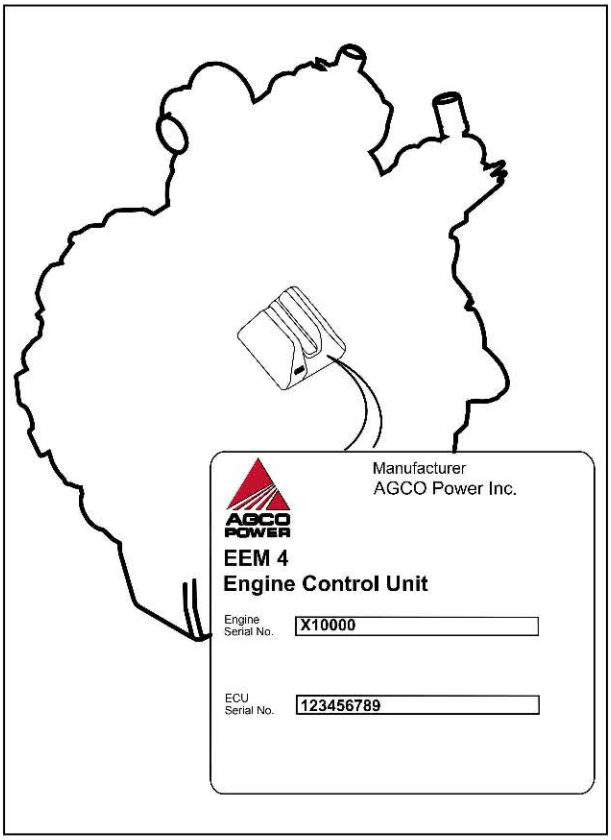


Fig. 622

2.10.4 Lifting the engine

DANGER: The engine is a heavy component.

If components fall they can cause injury or machine damage.

Make sure that you apply a vertical pull to the lift eyes for a safe engine lift.

A = Engine lifting eyes

Weight of the engine

Approximate dry weight of the engine is **1800 kg**.

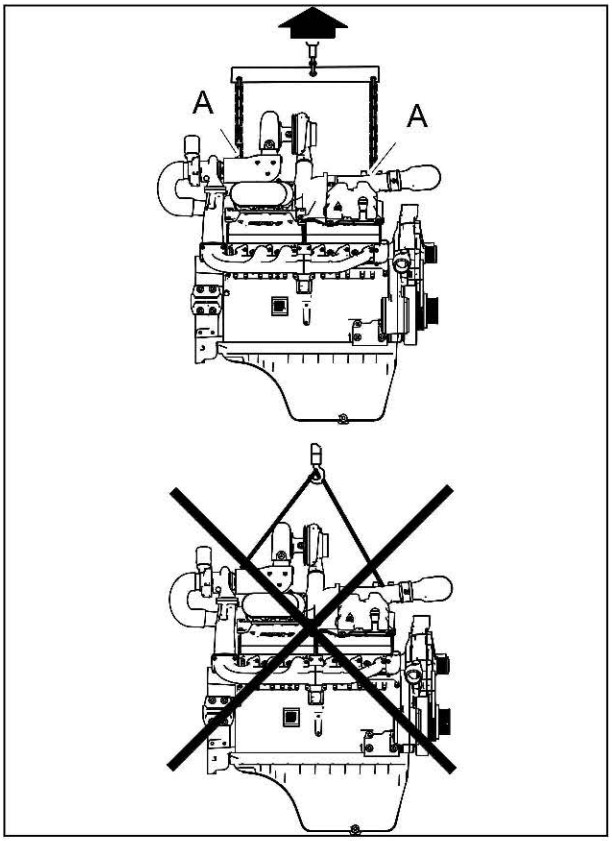


Fig. 623

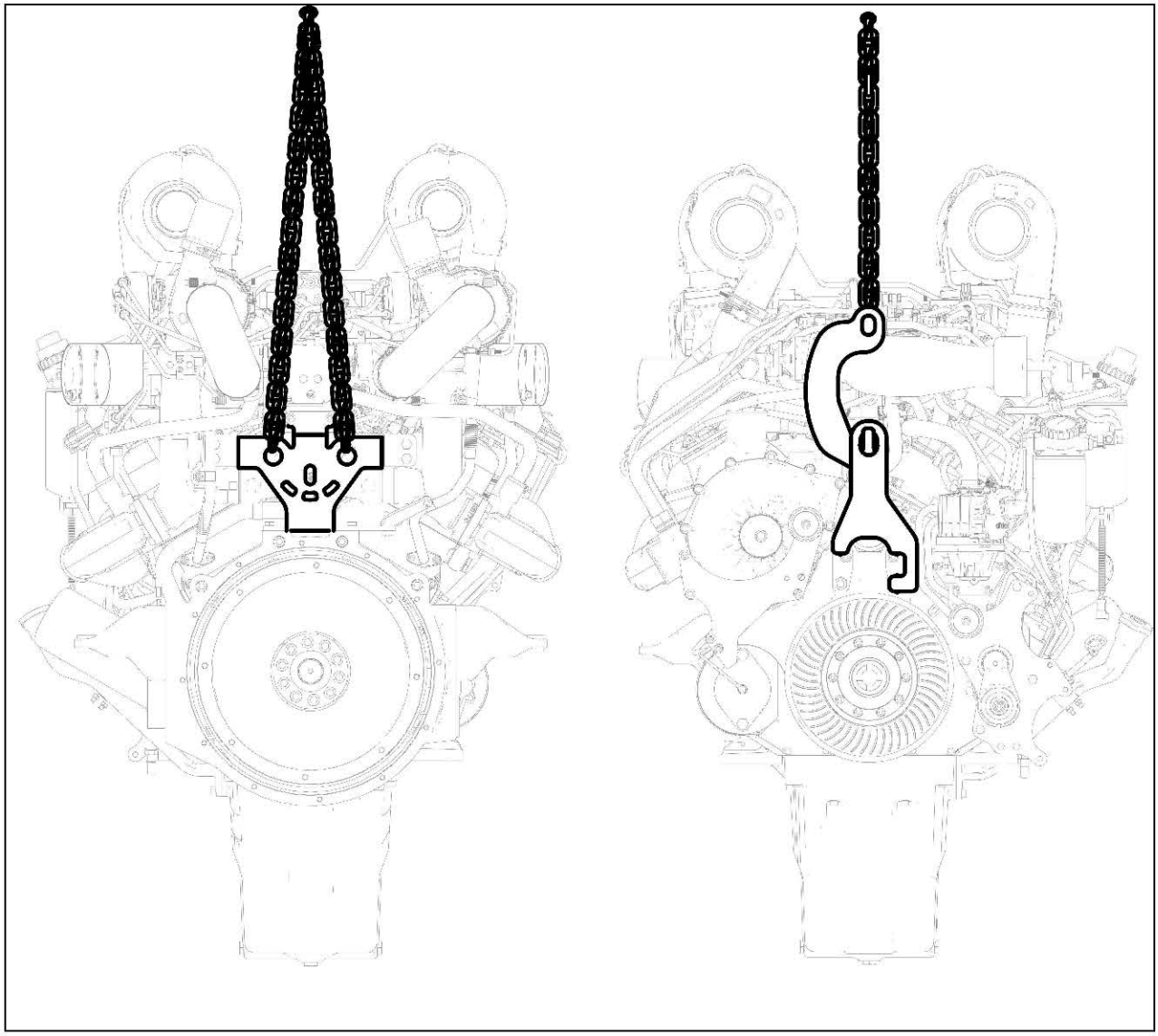


Fig. 624

DANGER: The engine is a heavy component.

If components fall they can cause injury or machine damage.

Make sure that you apply a vertical pull to the lift eyes for a safe engine lift.

Use the proper lifting tools when lifting the engine.

2.11 Engine construction

2.11.1 Engine overview

The AGCO POWER 168 AWF engine is water-cooled, turbocharged four-stroke diesel engine. The 60° V-angle engine is equipped with wet cylinder liners, which are supported at the middle. The engine has double Interstage charge air cooling (ICAC), double 2-stage turbocharging and double Exhaust gas recirculation (EGR) system.

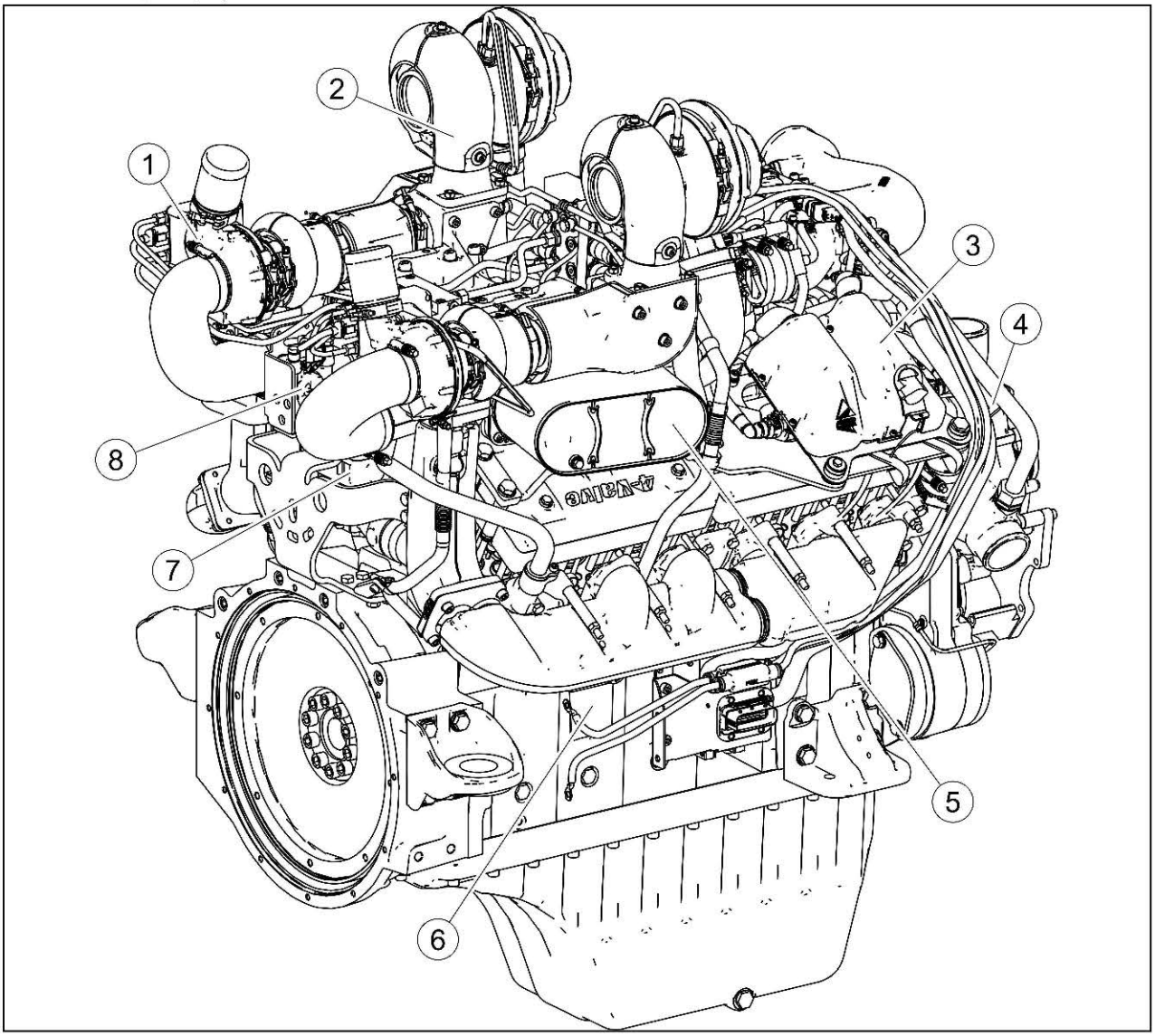


Fig. 625 AGCO POWER 168 AWF engine, right side

(1) High-pressure turbocharger
(2) Low-pressure turbocharger
(3) Primary ECU (electronic control unit)
(4) Thermostats
(5) Interstage charge air cooler (ICAC)
(6) Engine type plate
(7) EGR valve
(8) EGR actuator

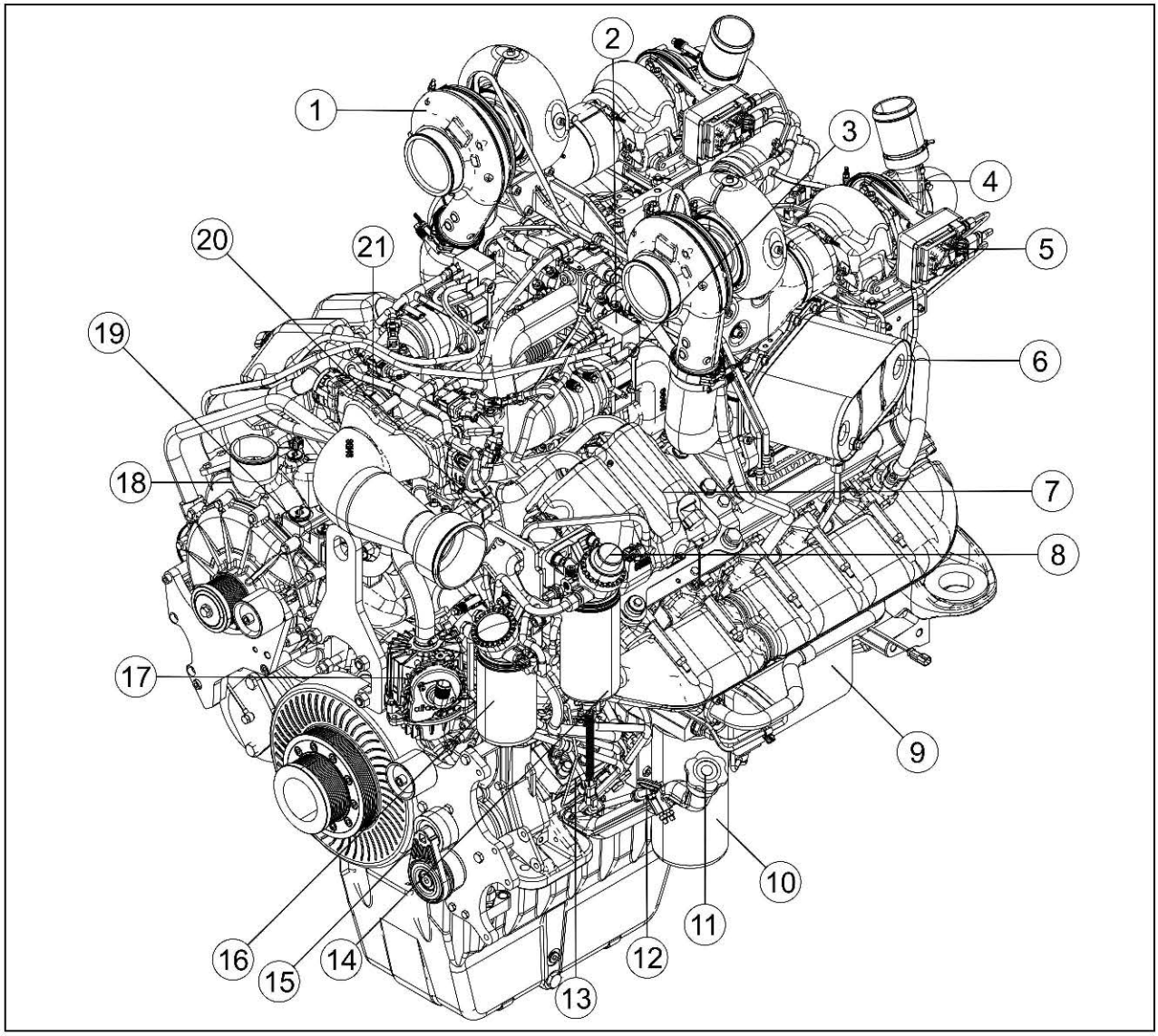


Fig. 626 AGCO POWER 168 AWF engine, left side

(1) Low-pressure turbocharger
(2) Air-intake heater solenoid
(3) Air-intake heater
(4) High-pressure turbocharger
(5) Actuator of the high-pressure turbocharger (wastegate actuator)
(6) Interstage charge air cooler (ICAC)
(7) Secondary ECU (electronic control unit)
(8) Hand pump
(9) Oil cooler
(10) Oil filter
(11) Oil filler plug
(12) Oil dipstick
(13) High-pressure pump
(14) Fuel pre-filter
(15) Belt tightener
(16) Fuel filter
(17) CCV filter
(18) Coolant pump
(19) Thermostats
(20) Mass air flow (MAF) sensor
(21) Throttle valve

2.11.2 Technical data

2.11.2.1 Principal dimensions and data

Engine type	168
Number of cylinders	12
Displacement (ltr)	16,8
Cylinder bore (mm)	111
Stroke (mm)	145
Fuel feed	Direct injection
Injection advance	Automatic adjusted
Direction of rotation from the engine front	Clockwise

2.11.2.2 Fuel system

Engine type	168
Fuel injection system	Bosch Common Rail
Fuel	The fuel must be according to norm EN 590:2009 or ASTM D975 1-D/2-D , see the information for fuel quality requirements
Injection order	1-12-2-11-4-9-6-7-5-8-3-10
Maximum injection pressure	Max. 2000 bar
Fuel filter: Pre-filter	10 µ
Fuel filter: Main filter	5 µ
Maximum continuous fuel inlet temperature	80°C

2.11.2.3 Lubrication system

Lubrication system	
Oil pressure in hot engine at running speed	3 - 6 bar
Oil pressure at idle speed, minimum	3 bar
Oil sump capacity	55 - 62 litres

Oil quality requirements	
API-grade	CJ-4
ACEA-grade	E9
Viscosity	5W - 40 or 10W - 40 or 15W - 40

2.11.2.4 Cooling system

Engine type	168
Number of thermostats	2
Starts to open at temperature	79 ° C and 82 ° C
Coolant quality requirements	See information for coolant quality requirements

2.11.2.5 Electrical system

System	Voltage
Electrical system	12 V
SCR system	12 V

2.11.2.6 Selective Catalyst Reduction (SCR) system technical data

Principal data	
Selective Catalyst Reduction (SCR) system	Bosch DENOXTRONIC 2.2+ (12 kg / h)
Minimum operation temperature	-40 °C
Maximum Diesel Exhaust Fluid (DEF) temperature	70 °C

Dosing system	
Diesel Exhaust Fluid (DEF) fluid type	DIN70070/ISO22241 certified Diesel Exhaust Fluid (DEF), for example AdBlue
Diesel Exhaust Fluid (DEF) consumption	Approximately 6-8% of fuel consumption[1]
Inlet filter	100 µ
Main filter	10 µ

[1] The type of operation and the use of the engine can increase the use of Diesel Exhaust Fluid (DEF).

Low Diesel Exhaust Fluid (DEF) level				
Diesel Exhaust Fluid (DEF) tank level on CAN message:	**10%**	**5%**	**0%**	**0% + after 1/2 hour**
Diesel Exhaust Fluid (DEF) symbol 	Temporary • Duration 10 seconds	Solid	Flashes	Flashes
Diesel Exhaust Fluid (DEF) symbol clearable	Yes	No	No	No
MIL[1] symbol 	Off	Off	Off	Flashes
MIL[1] symbol clearable	N/A	N/A	N/A	No
Error code	No	No	Yes • SPN 1761, FMI 18	Yes • SPN 1761, FMI 1
Audible warning 	• Duration 2 seconds • Repeats every restart	• Duration 2 seconds • Repeats every 15 minutes	• Duration 2 seconds • Repeats every 5 minutes	• Duration 2 seconds • Repeats every 5 minutes
Diesel Exhaust Fluid (DEF) injection	Yes	Yes	Yes	No

IMPORTANT: *Ignoring the operator warning signals will lead to the activation of the operator inducement system, resulting in an effective disablement of non-road mobile machinery operation.*

The ECU decreases the engine power.

Read and obey the operator warning signals.

[1] Malfunction indicator lamp.

2.11.3 Cylinder block

The cylinder block is the main body of the engine, to which other engine parts are attached. Wet and replaceable cylinder liners are supported at the middle, which reduces vibrations and directs coolant circulation mainly to the upper part of the liners.

The seal between the lower part of the cylinder liner and the cylinder block is achieved by three O-rings.

The O-rings are fitted in grooves in the cylinder block. The upper part is sealed by the cylinder head gasket.

The camshafts are located in the cylinder block. There are separate bearing sleeves in all camshaft bearing locations and the drilling for the camshaft rear end is covered with a plug.

There are spaces on both sides of the rear main bearing for guide bearing shims (the crankshaft thrust bearings).

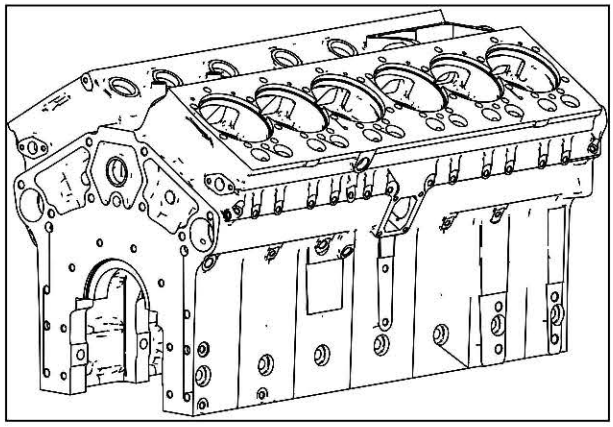


Fig. 627

2.11.4 Flywheel housing

The flywheel housing is fitted at the rear end of the cylinder block. The seal for the crankshaft rear end is placed in a bore in the housing. The starter motor fixing points are fitted in the flywheel housing.

The lower face of the flywheel housing functions as a sealing surface for the oil sump gasket. This means that the lower face of the cylinder block must be level with the flywheel housing. When fitting the flywheel housing, its position is determined by tension pins.

The flywheel housing is delivered according to the requirements set by the engine model and different flywheel housings can be mounted on all engine types.

2.11.5 Valve mechanism

The valve mechanism is operated by the camshaft which is located in the cylinder block. The drive is transferred with the help of tappets and push rods. The camshaft gear wheel is fitted with a nut and guided with a key. Each bearing is lubricated by the force feed lubrication system through drilled oilways in the cylinder block. The valve mechanism has hydraulic lift adjusting.

2.11.6 Cylinder head

The 168 engine has four cylinder heads. All the cylinder heads are for three cylinders. Every cylinder has four valves and in the middle of the valves there is a place for the injector. The injector is located vertically in the centre of the cylinder and in the middle of the combustion chamber. This ensures accurate and homogenous mixing of fuel and air and leads to clean and low emission combustion with good efficiency.

Each cylinder has its own inlet and exhaust ports located on either side of the head. Every inlet valve has its own inlet port but there is only one exhaust port for every two of the cylinder's exhaust valves. There are no water holes on the inlet side of the cylinder head. This eliminates the possibility of water entering the inlet air.

Cylinder head bolts are high tensile bolts, which are tightened up to yield limit using the angle tightening method. Due to the large stretch, the tightening forces are kept constant during the whole lifetime and retightening is unnecessary.

The injector and its side feeding pipe locations are machined directly into the cylinder head. The port for the side feeding pipe is located between the inlet ports. The inlet and exhaust valve guides are identical and can be interchanged. Inlet and exhaust valves are fitted with separate valve seat rings.

2.11.7 Crank mechanism

The crankshaft is forged from chrome alloy special steel and is induction hardened at the bearing and sealing surfaces. This makes it possible to grind bearings without a new heat treatment. Gear wheels are located at the front end of the crankshaft. They are a press fit, and drive the idler wheel and oil pump. The belt pulley/vibration damper is fastened to the crankshaft with a cone joint. An oil deflector ring is fitted between the hub and gear wheel.

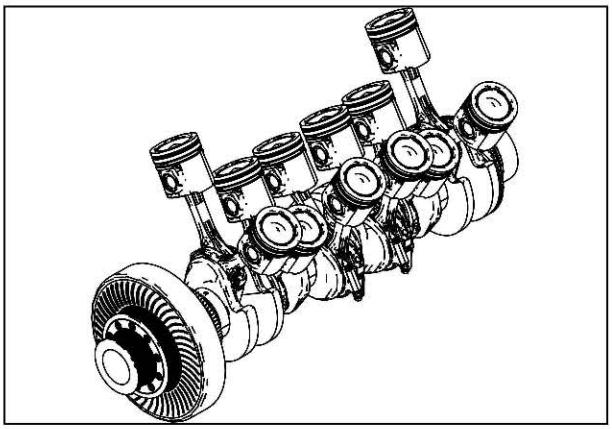


Fig. 628

The crankshaft is supported on the cylinder block by main bearings, which are placed on both sides of each cylinder. There is therefore one main bearing more than there are cylinders. The fourth main bearing (the main bearing in the middle) is wider than the other main bearings. The crankshaft thrust washers are placed in both sides of the rearmost main bearing.

A flywheel, on which there is a press-fit starter ring gear, is fitted at the rear end of the crankshaft. The forged connecting rod has an I-cross-section. The bearing location at the bottom end of the connecting rod is fracture-split, and the bearing cup is secured by two special elongated screws. The upper part has a wedge-shaped bearing location, in which the piston pin bearing bushing is fitted with a press fit.

The piston is made of a eutectic aluminium alloy. In the upper face of the piston there is a combustion chamber. The shape of the chamber is intended to maximise the mixture of air and fuel. The upper ring location is formed in a cast iron ring, which is cast in the piston. In addition, the piston is graphite-coated to ensure correct running-in.

The piston has three rings. The upper molybdenum-coated ring has a wedge-shaped cross-section. The middle ring is tapered and it fits into its groove. The taper takes up the clearance. The oil control ring is spring-loaded and it has a two-stage, chromed scraping edge.

2.11.8 Timing gears

(1) Camshaft gear
(2) Idler gear
(3) High-pressure pump gear
(4) Crankshaft gear
(5) PTO gear

The timing gear drives the camshaft, high-pressure pump and oil pump. The timing gear train consists of hardened, helically cut gear wheels. The gears are encased by the timing gear housing, which is fitted in the front of the engine.

The idler gear is supported with a ball bearing on the shaft on the front face of the cylinder block.

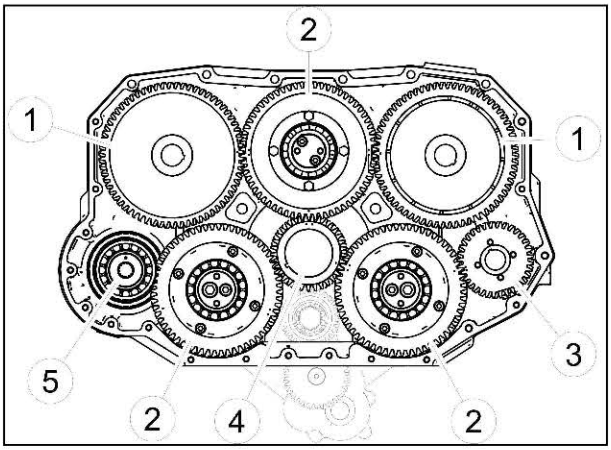


Fig. 629

2.11.9 Lubrication system

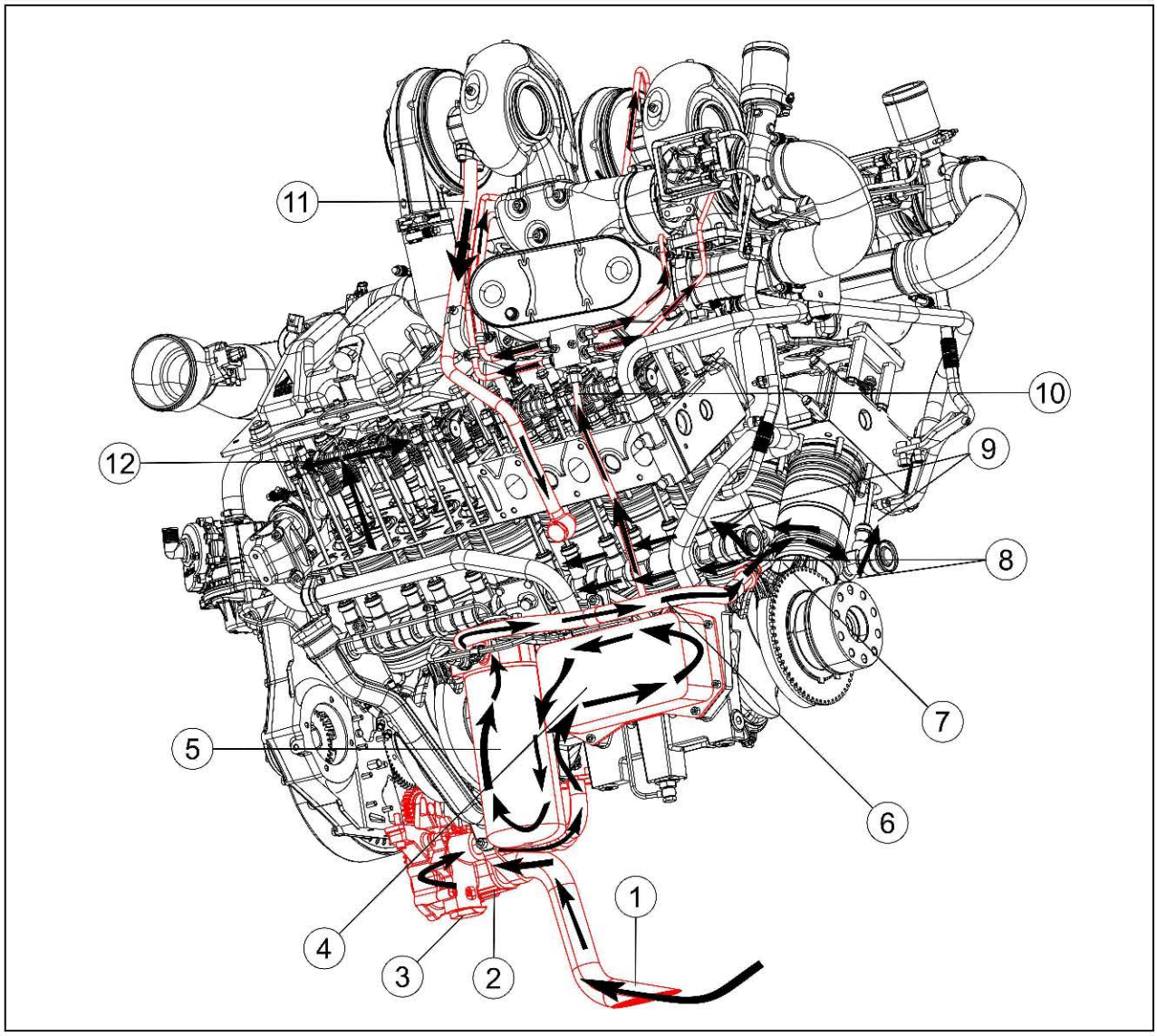


Fig. 630

(1) Oil pick-up
(2) Oil pump
(3) Oil pressure regulating valve
(4) Oil cooler
(5) Oil filter
(6) Oil pipe
(7) Main oil gallery (crankshaft)
(8) Camshaft + piston cooling oil gallery
(9) Valve lifter oil gallery
(10) Oil pipes to turbochargers
(11) Oil return from turbochargers
(12) Lubrication to cylinder heads

The engine has a pressure lubrication system with the gear oil pump fitted to the lowest level of the engine. The oil pump is driven by the gear at the front end of the crankshaft. Nearly all the lubrication points and auxiliary equipment are connected to the pressurised lubrication system by oil galleries or pipes.

Cylinder block has a main oil gallery in the middle for crankshaft lubrication. Camshafts and piston cooling nozzles have their common oil galleries on each cylinder bank. Valve mechanism gets the lubrication via 2nd and 4th camshaft bearing. Hydraulic valve lifters have their own oil galleries on each cylinder bank.

The lubrication of the gears in the gear housing, the upper end of the connecting rods and the pistons is mainly realized by splash lubrication. The undersides of the pistons are cooled by the oil spray.

The engine is equipped with closed crankcase ventilation (CCV) system. The CCV system is of centrifugal oil separator type. The CCV system is maintenance free.

NOTE: *Always change the oil and oil filter according to the maintenance chart.*

2.11.9.1 Oil pump

(1) Nut
(2) Lock plate

The oil pump is driven by the crankshaft gear via an idler gear attached to the oil pump. The oil pump is a gear type of pump. The pressure is produced by two contra-rotating gears.

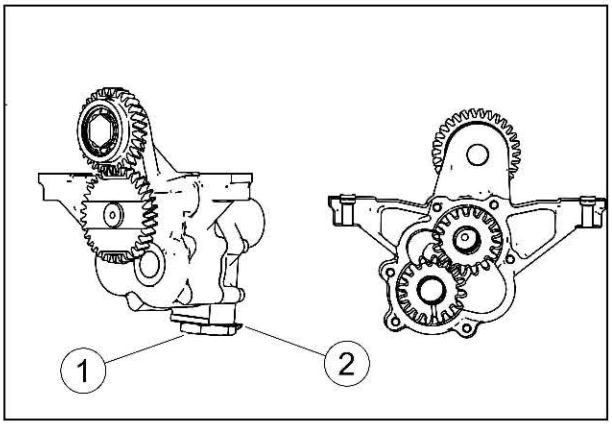


Fig. 631

(1) Nut
(2) Lock plate
(3) Larger spring
(4) Smaller spring

The oil pressure regulating valve is in the oil pump. The regulating valve keeps the oil pressure constant and independent of the engine speed.

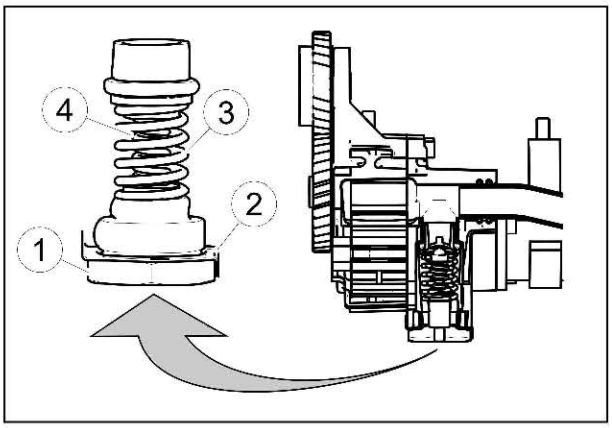


Fig. 632

2.11.9.2 Oil filter and oil cooler

(1) Oil cooler
(2) Oil filter
(3) Oil filler plug
(4) Oil dipstick

The engine has an oil filter of main flow type. It has a replaceable cartridge mounted on the left side of the engine.

The engine is equipped with a plate type oil cooler. The oil cooler is situated next to the oil filter on the left side of the engine. The oil cooler is cooled by the engine coolant circulating in the oil cooler. All oil that circulates through the oil filter goes also through the oil cooler. The oil cooler is of main flow type.

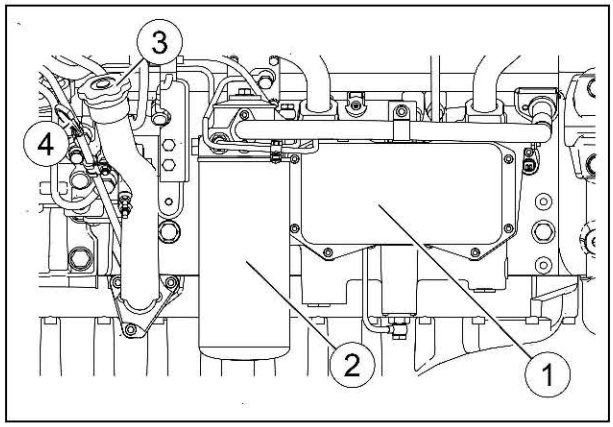


Fig. 633

2.11.10 Cooling system

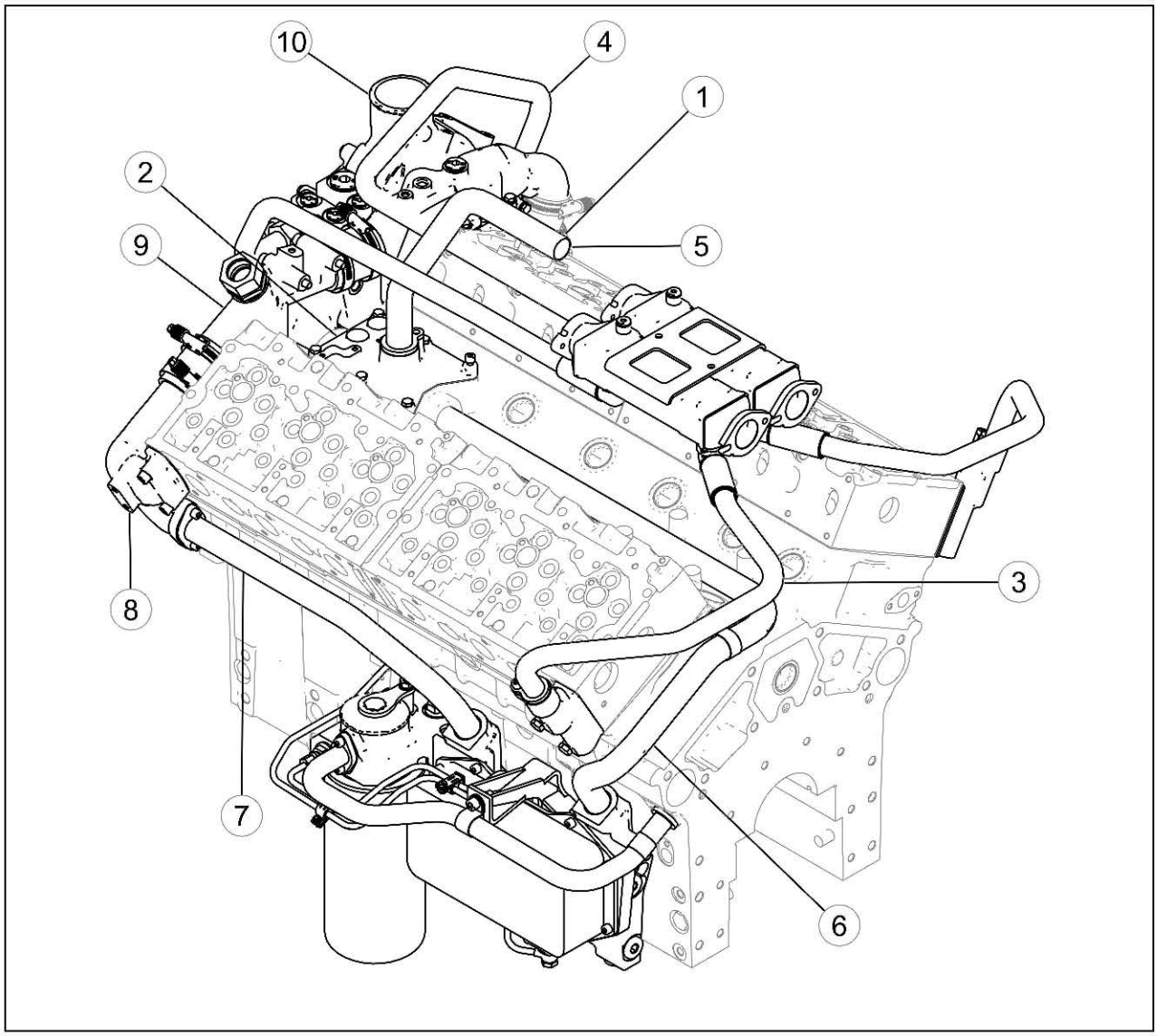


Fig. 634

(1) From the radiator
(2) Distribution unit
(3) Coolant pipe to the EGR cooler
(4) Return pipe
(5) Coolant pipe
(6) Coolant pipe to the oil cooler
(7) Return pipe
(8) From the cylinder head
(9) Return pipe
(10) To the radiator

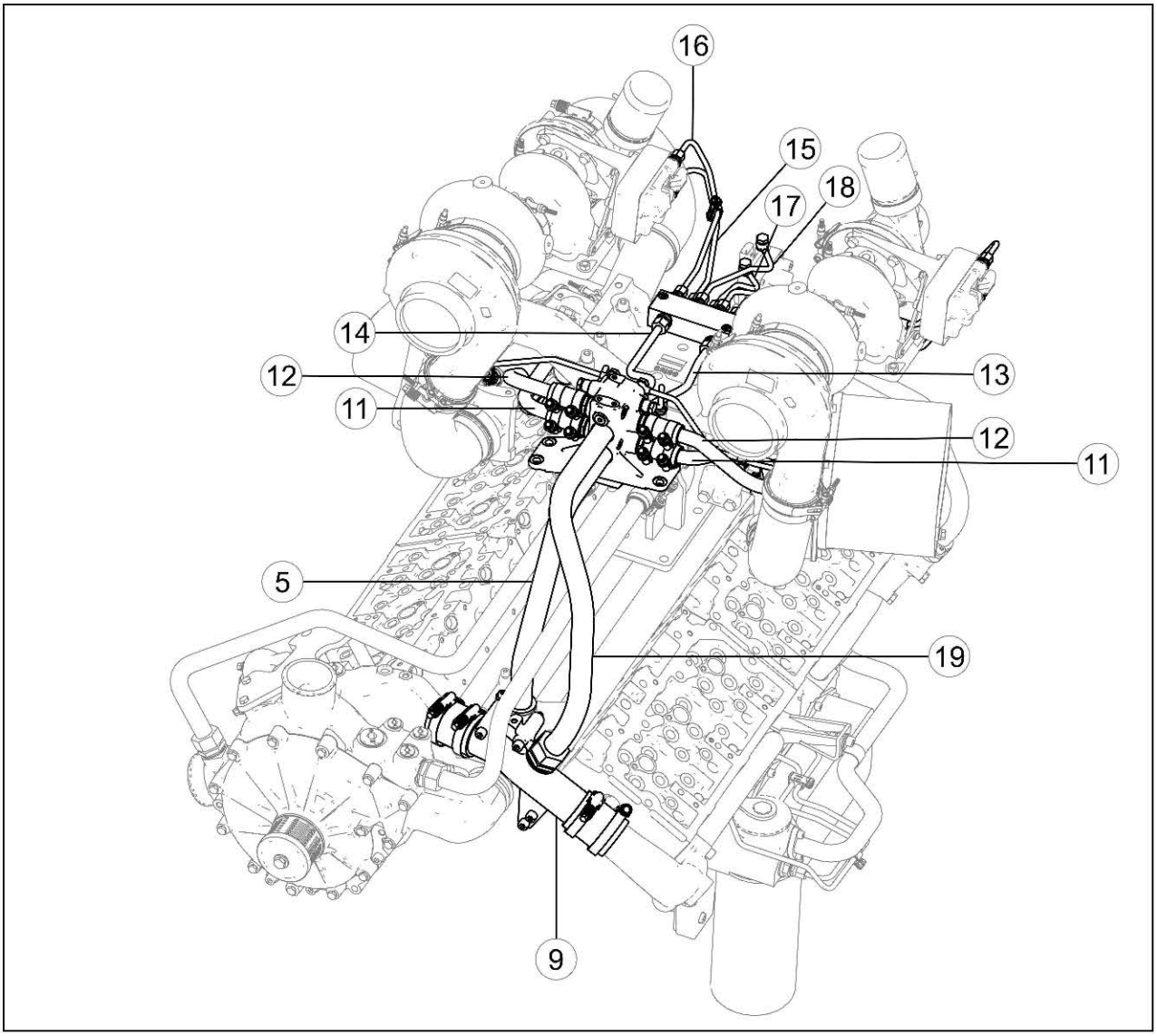


Fig. 635

(5) Coolant pipe
(9) Return pipe
(11) Coolant pipe to the ICAC
(12) Return pipe
(13) Coolant pipe
(14) Return pipe
(15) Coolant pipe to the actuator of the high-pressure turbocharger (wastegate actuator)
(16) Return pipe
(17) Coolant pipe to the EGR actuator
(18) Return pipe
(19) Return pipe

The coolant pump is attached to the front face of the cylinder block. The thermostat housing is mounted on the backside of the coolant pump.

The coolant system has an internal liquid circulation. The liquid circulation is regulated by the 2-way thermostats. This arrangement ensures a steady warming-up of the engine under all conditions.

The coolant circulates from the coolant pump to the distribution unit (2), which is on the cylinder block. The distribution unit divides the coolant to the cylinder block, to the oil cooler (6) and forward (5) to the front distribution unit. The coolant circulates through the cylinder block to the cylinder heads. In the rear end of

the engine the coolant flows from the cylinder heads to the EGR coolers (3). In the front end of the engine the coolant circulates back to the coolant pump from the cylinder heads.

Above the cylinder block, the coolant pipe (5) leads the coolant to the front distribution unit. The front distribution unit divides the coolant to the ICACs (Interstage charge air coolers) (11) and through one coolant pipe (13) to the rear distribution unit. The rear distribution unit divides the coolant to the coolant pipes of the actuators of the high-pressure turbochargers (15) and EGR actuator (17).

NOTE:
Use only coolant that is a mixture of 40-60% water and antifreeze. Refer to the engine specification for the machine, for the specified ratio and the quantities necessary. Do not use water only for the coolant.

2.11.10.1 Coolant pump

(1) Thermostat 82°C
(2) Thermostat 79°C
(3) From the cylinder head
(4) From the radiator
(5) From the EGR cooler
(6) To the radiator
(7) From the cylinder head
(8) To the cylinder block

The coolant circulates from the coolant pump (8) to the distribution unit, which is on the cylinder block. The coolant flows back to the coolant pump from the EGR coolers (5) and direct to the thermostat housing from the cylinder head (3). Direct to the thermostat housing the coolant flows also through the return pipe (7), which gathers coolant from cylinder head, oil cooler, ICACs (Interstage charge air coolers), EGR actuator and actuators of the high-pressure turbochargers (wastegate actuators).

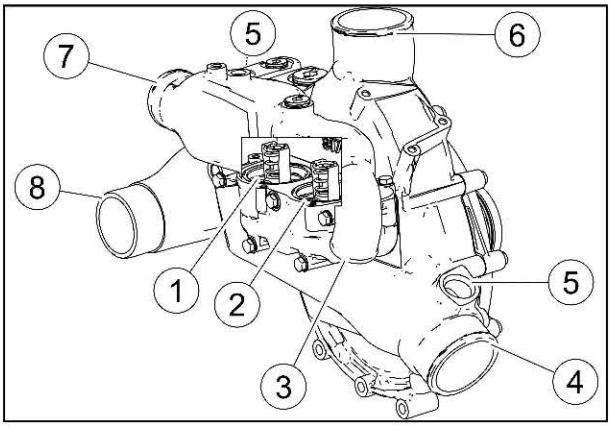


Fig. 636

2.11.10.2 Thermostats

(1) Thermostat 82°C
(2) Thermostat 79°C
(A) Cold coolant circuit
(B) Hot coolant circuit

There are two separate thermostats, which differ in opening temperature. The first thermostat (2) opens at temperature of 79°C and the second thermostat (1) opens at temperature of 82°C.

There are no separate winter-type thermostats.

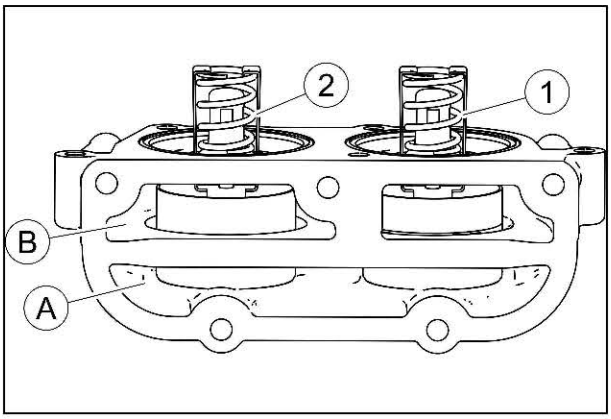


Fig. 637

(A) Cold coolant circuit
(B) Hot coolant circuit

When the coolant temperature is below the thermostat opening temperature, the coolant circulates through the thermostat into the coolant pump (A). When the thermostat opens, it closes the coolant circulation into the coolant pump (A) and directs the coolant into the radiator (B).

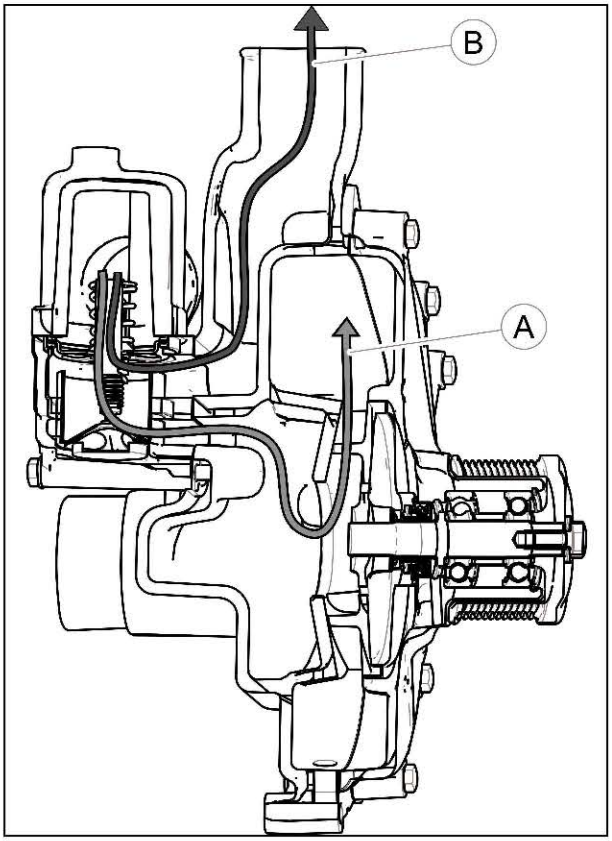


Fig. 638

2.11.11 Air control system

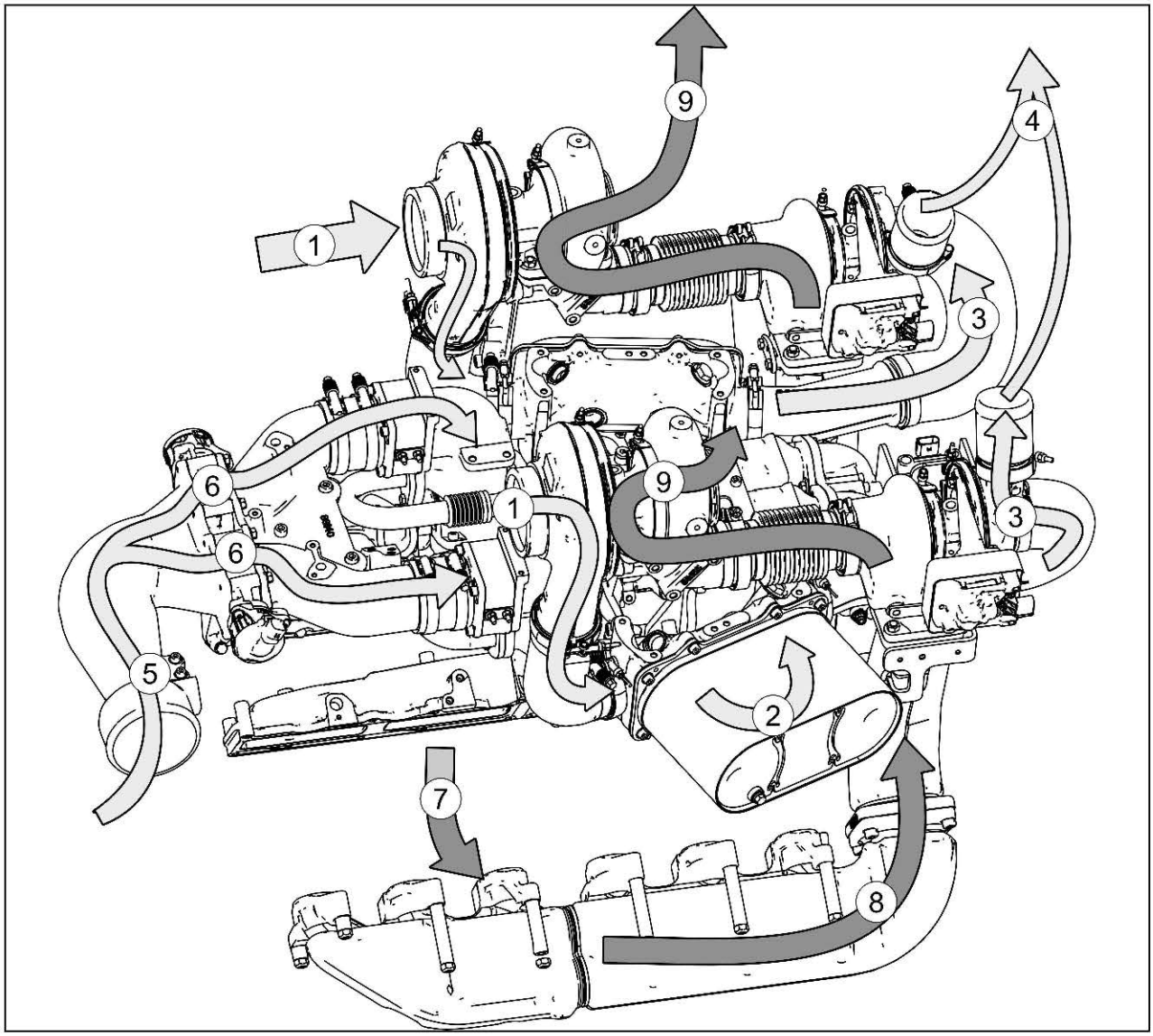


Fig. 639

The air control system includes pre-filter (or cyclone, if installed), air filter, turbochargers, intercooler, interstage charge air cooling (ICAC), mass air flow (MAF) sensor, throttle valves, intake manifolds, exhaust manifolds, EGR valve, EGR cooler and air pipes.

The air comes from the air filter to the low pressure turbochargers (1) and is cooled in ICACs (2). From ICACs the air flows through high pressure turbochargers (3) to the air to air intercooler (4). After MAF sensor (5) the air flows through throttle valves (6) to intake manifolds. From intake manifolds (7) the air flow continues to the combustion chambers. After combustion process exhaust gases are passed through exhaust manifolds (8) to high pressure turbochargers and low pressure turbochargers (9) and eventually to DOC and SCR system. Part of the exhaust gases is led from exhaust manifold through exhaust gas recirculation (EGR) system.

A mechanical or electric sensor can be fitted to indicate the service point of the air filter. It the engine is operating in very dusty conditions (for example spreading lime) it must be equipped with a special pre-filter and oil bath air filter.

2.11.11.1 2 stage turbocharging

The turbocharger is a turbo-compressor driven by exhaust gas. The compact design of the turbocharger is fast to react even at low engine speeds. The turbocharger is lubricated and cooled by the lubrication system of the engine. The engine has 2 stage turbocharging. Benefits from 2 stage turbocharging are increased low speed torque, better specific fuel consumption and decreased exhaust temperature. The 2 stage charging uses two turbochargers: Bigger low pressure turbocharger raises pressure to 1 - 1,5 bar (relative), Smaller high pressure turbocharger has boost pressure of 2,1 - 3 bar (relative). Boost pressure is controlled by a wastegate. Traditional wastegate is replaced with a wastegate operated by actuator controlled by the electronic control unit (ECU). ECU-controlled Wastegate is used to control acceleration smoke and exhaust temperatures.

2.11.11.2 Interstage charge air cooling

In 2 stage turbocharged engines the charge air is cooled between the turbochargers to increase the efficiency and reliability. The charged air is cooled by engine coolant in the interstage charge air cooler (ICAC). The compressed air from the high-pressure turbocharger is cooled on the air-to-air basis. The air coming from the turbocharger has a temperature of approximately 150°C, which is cooled by the cooling air of the engine. The cooling of the compressed air stabilizes the combustion, irrespective of the temperature, and minimises the thermal and mechanical load of the engine thus lowering nitric oxides (NOx) and particles (PT).

2.11.11.3 Throttle valve

The throttle valve is used to manage temperatures in the exhaust gas aftertreatment system. The throttle valve controls Air/Fuel -ratio to speed up engine warming, to increase exhaust temperatures at low loads and to decrease exhaust temperatures at high loads. The throttle valve is controlled by the electronic control unit (ECU) with the PWM current (pulse width modulation). The throttle valve has an integrated actuator.

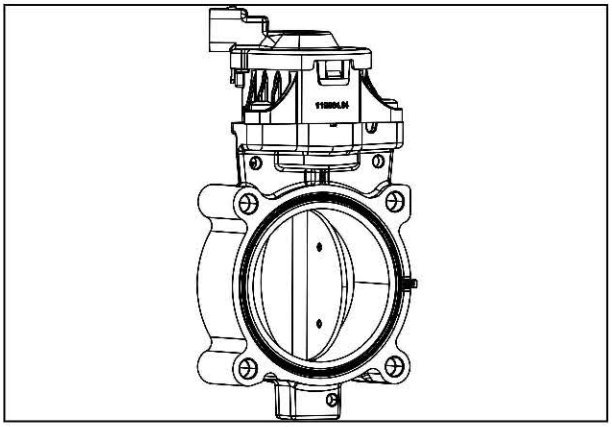


Fig. 640

2.11.11.4 Exhaust gas recirculation system

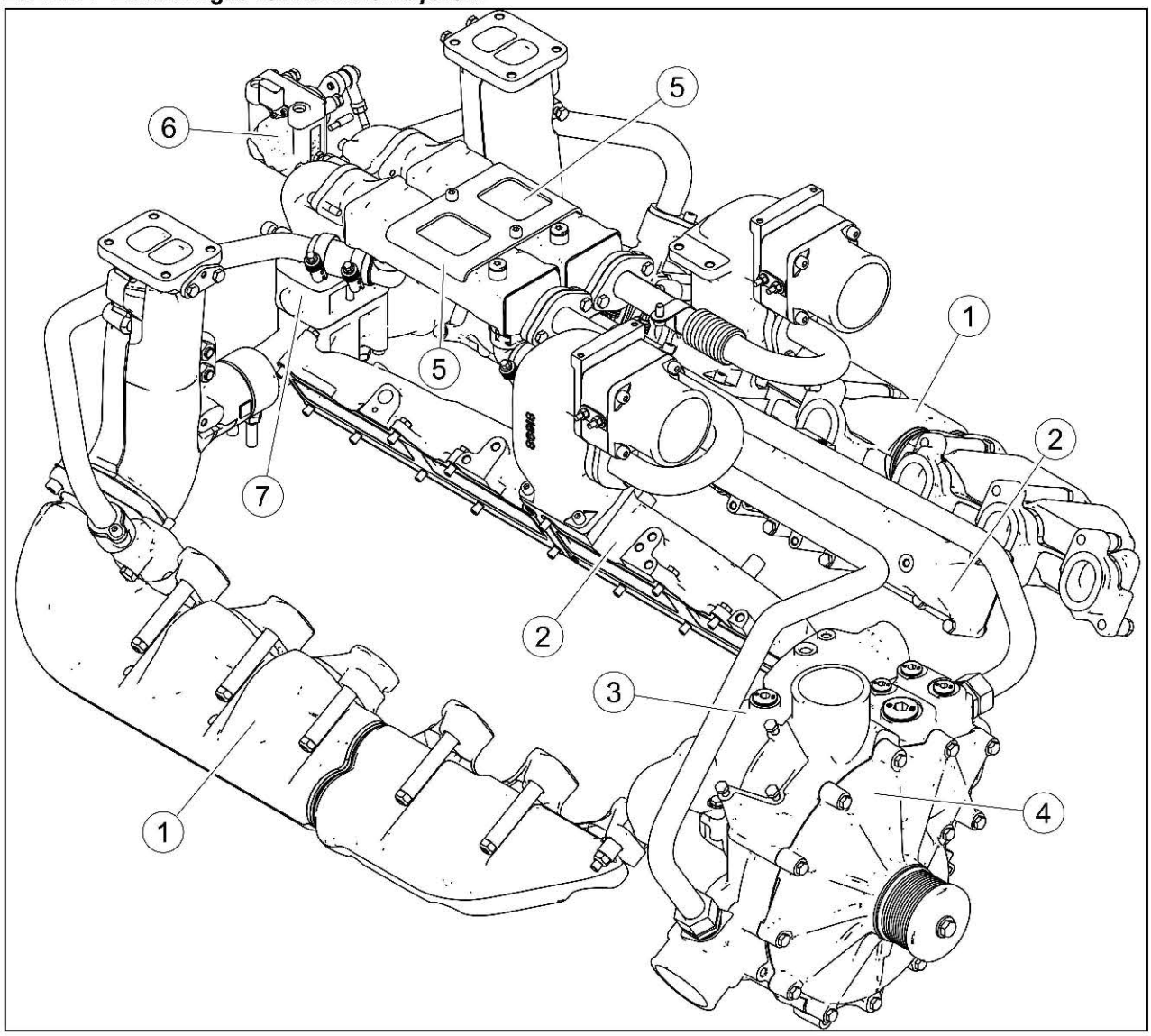


Fig. 641

(1) Exhaust manifold
(2) Intake manifold
(3) Thermostats
(4) Coolant pump
(5) EGR cooler
(6) EGR actuator
(7) EGR valve

The cooled exhaust gas recirculation system (EGR) used on AGCO POWER engines is controlled by electronic engine control unit (ECU) and EGR actuator. Part of exhaust gases is led from exhaust manifold through EGR valve to EGR cooler where they are cooled with engine coolant. The cooled exhaust gas is mixed with fresh intake air in intake manifold before it flows to combustion chamber. The cooled EGR system decreases the temperature in combustion chamber, which in turn results as lower nitrogen oxide (NOx) emissions. All EGR engines have air mass flow meter. Its main functions are to measure EGR/fresh air ratio for EGR control and to enable accurate DEF dosing to the catalyst.

2.11.12 Fuel system

The engine is equipped with common rail system which is controlled by electronic control unit (ECU).

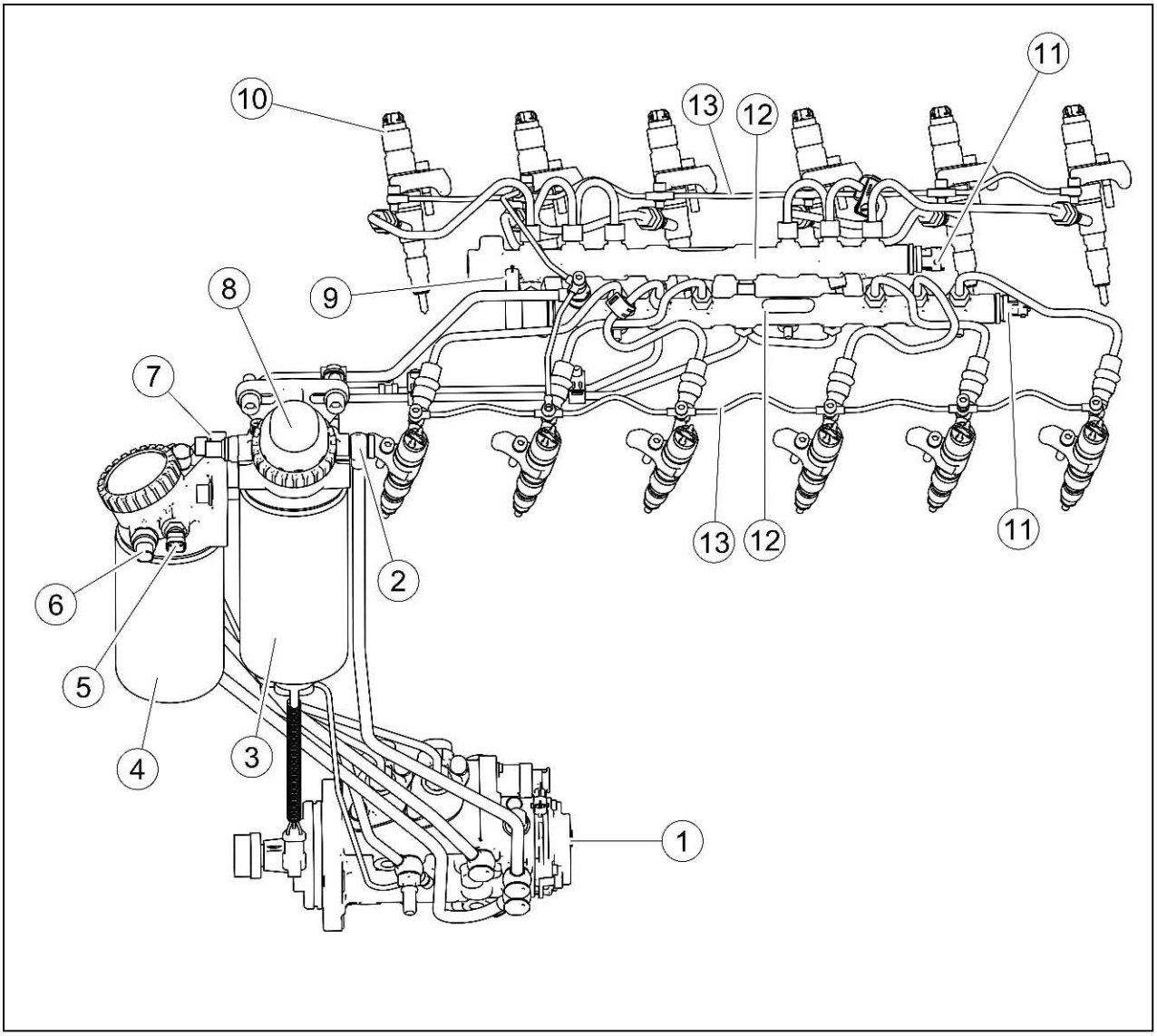


Fig. 642

(1) High-pressure pump
(2) Fuel inlet
(3) Fuel pre-filter
(4) Fuel filter
(5) Fuel temperature sensor
(6) Fuel pressure sensor
(7) Fuel pressure sensor
(8) Hand pump
(9) Pressure control valve (PCV)
(10) Injector
(11) Pressure sensor
(12) Rail
(13) Overflow pipe

Fuel is drawn from the tank via the pre-filter, through the main fuel filter to the high-pressure pump. From the high-pressure pump, fuel is pumped up into the rail. This high pressurized fuel is lying in a high-pressure pipe where it is controlled and injected through electronic injectors that are controlled by ECU. The injection is optimized in terms of emissions, efficiency and operation noise and takes place in four steps (maximum). Excess fuel returns from the injectors and pressure regulating valves of the high pressure pump and rail back to the fuel tank. The overflow pipe from the filter helps the bleeding of the system. The fuel is diesel fuel according to the norm EN 590:2009 or ASTM D975 and it must be clean and free from water after storage (see the information for fuel quality requirements).

NOTE:
Use of anti-freeze solution is not allowed and not useful at all!

IMPORTANT: *Common rail fuel system components are always attached to the engine control system.*

Error log / EEM data is always mandatory to examine all types of common rail fuel system faults.

Do a check for the error log.

WARNING: High pressure fuel during and after engine operation.

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

2.11.13 Selective Catalyst Reduction (SCR) system overview

The AGCO POWER engines have exhaust gas treatment with Selective Catalyst Reduction (SCR) technology. The Selective Catalyst Reduction (SCR) technology injects a Diesel Exhaust Fluid (DEF) into the exhaust gases. Diesel Exhaust Fluid (DEF) is specified in standards DIN 70070 and ISO 22241. The common Diesel Exhaust Fluid (DEF) trademarks are:

- AdBlue
- Air1
- Greenox.

The heat of exhaust gases changes the Diesel Exhaust Fluid (DEF) to ammonia and carbon dioxide. The ammonia reacts with the nitrogen oxides in the catalyst and changes them to nitrogen and water.

The DEF consumption is approximately 6 - 8 % of the fuel consumption. The Diesel Exhaust Fluid (DEF) tank and pipes are heated, so the Selective Catalyst Reduction (SCR) system works can operate at low temperatures. The Diesel Exhaust Fluid (DEF) freezes at -11 °C. If the Diesel Exhaust Fluid (DEF) freezes, it is automatically heated when the engine is started.

CAUTION: Decreased engine power because of a fault in the Selective Catalyst Reduction (SCR) system.

When the Diesel Exhaust Fluid (DEF) quality sensor identifies a problem with the Diesel Exhaust Fluid (DEF) quality, it send a CAN signal to the ECU. The ECU decreases the engine power output.

Make sure that Diesel Exhaust Fluid (DEF) (DIN 70070 or ISO 22241 certified) is used in the Selective Catalyst Reduction (SCR) system.

See the manual for the machine for information on how to fill, location and capacity of the Diesel Exhaust Fluid (DEF) tank.

CAUTION: Decreased performance.

Engine is not in compliance with emission regulations.

Make sure that the Diesel Exhaust Fluid (DEF) in storage is at a temperature of less than 30°C, and away from sunlight.



CAUTION: Make sure that you use Diesel Exhaust Fluid (DEF) (DIN 70070 or ISO 22241 certified) in the Selective Catalyst Reduction (SCR) system.

The engine is not in compliance with emission regulations.

Do not mix the Diesel Exhaust Fluid (DEF) with other materials, this can cause damage to the Selective Catalyst Reduction (SCR) system.



CAUTION: The diesel fuel can cause damage to the gaskets of the Selective Catalyst Reduction (SCR) system.

The engine is not in compliance with emission regulations. The Selective Catalyst Reduction (SCR) system does not operate correctly.

Do not put diesel fuel in Diesel Exhaust Fluid (DEF) tank.



CAUTION: Diesel Exhaust Fluid (DEF) is corrosive to some metals and materials. Diesel Exhaust Fluid (DEF) changes to crystals when in contact with air.

If Diesel Exhaust Fluid (DEF) spills, clean the area immediately with water and then fully dry the area.

Be careful when you move Diesel Exhaust Fluid (DEF) and when you fill the Diesel Exhaust Fluid (DEF) tank.

NOTE:
Engines with the aftertreatment system are in compliance with EU97/68/EC Stage IV and EPA 40 CFR 1039 Tier 4 final emission regulations.

When you do maintenance you must use replacement parts that are equivalent in performance and specification to AGCO Parts. The responsibility of AGCO POWER on the correct compliance of the emission specification is removed when:

- You do not use AGCO Parts
- The maintenance is incorrect or not done on time.

NOTE: *This manual only contains general information relating to Selective Catalyst Reduction (SCR) system. All maintenance must be done by a dealer or service center approved by AGCO or the manufacturer of the equipment. When maintenance is done on the Selective Catalyst Reduction (SCR) system, make sure that the Selective Catalyst Reduction (SCR) system components are fully clean.*

2.11.13.1 Selective Catalyst Reduction (SCR) system components and their functions

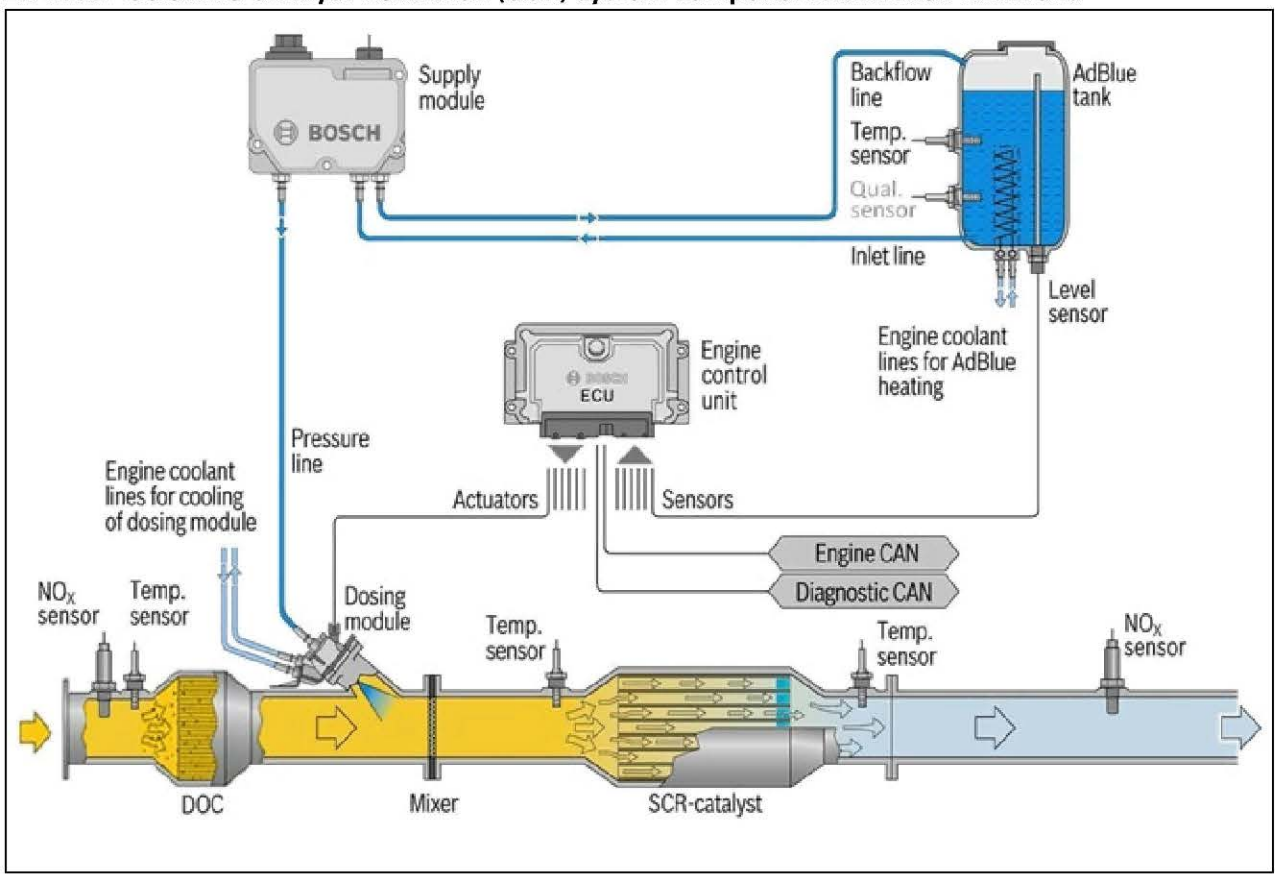


Fig. 643

The exhaust gas aftertreatment system used is the Bosch DENOXTRONIC 2.2+ (DNOX2.2+). DNOX2.2+ uses Selective Catalyst Reduction (SCR) to decrease the exhaust emissions from the engine.

The AGCO POWER Selective Catalyst Reduction (SCR) system uses the engine control system and the DNOX2.2+ Selective Catalyst Reduction (SCR) system. A CAN bus connects the two systems.

See the manual for the machine for the location and the instructions for removal and installation of the Selective Catalyst Reduction (SCR) system components.

Supply module

The supply module pressurizes and moves the Diesel Exhaust Fluid (DEF) from the Diesel Exhaust Fluid (DEF) tank to the Diesel Exhaust Fluid (DEF) dosing module. The supply module contains two filters, the inlet filter and the main filter.

Dosing module

The Diesel Exhaust Fluid (DEF) dosing module is installed in the exhaust pipe between the turbocharger and Selective Catalyst Reduction (SCR) catalyst. The Diesel Exhaust Fluid (DEF) dosing module contains an electrically operated solenoid valve, controlled by the ECU. It sprays Diesel Exhaust Fluid (DEF) into the exhaust system in quantities calculated by the ECU for satisfactory reduction of NOx.

Sensors

DNOX2.2+ system includes these sensors:

- NOx sensors
- Exhaust temperature sensors
- Diesel Exhaust Fluid (DEF) tank level sensor

- Pressure sensor (inside the Supply Module)
- Diesel Exhaust Fluid (DEF) tank temperature sensor
- Supply Module internal temperature sensor.

2.11.14 Engine control system

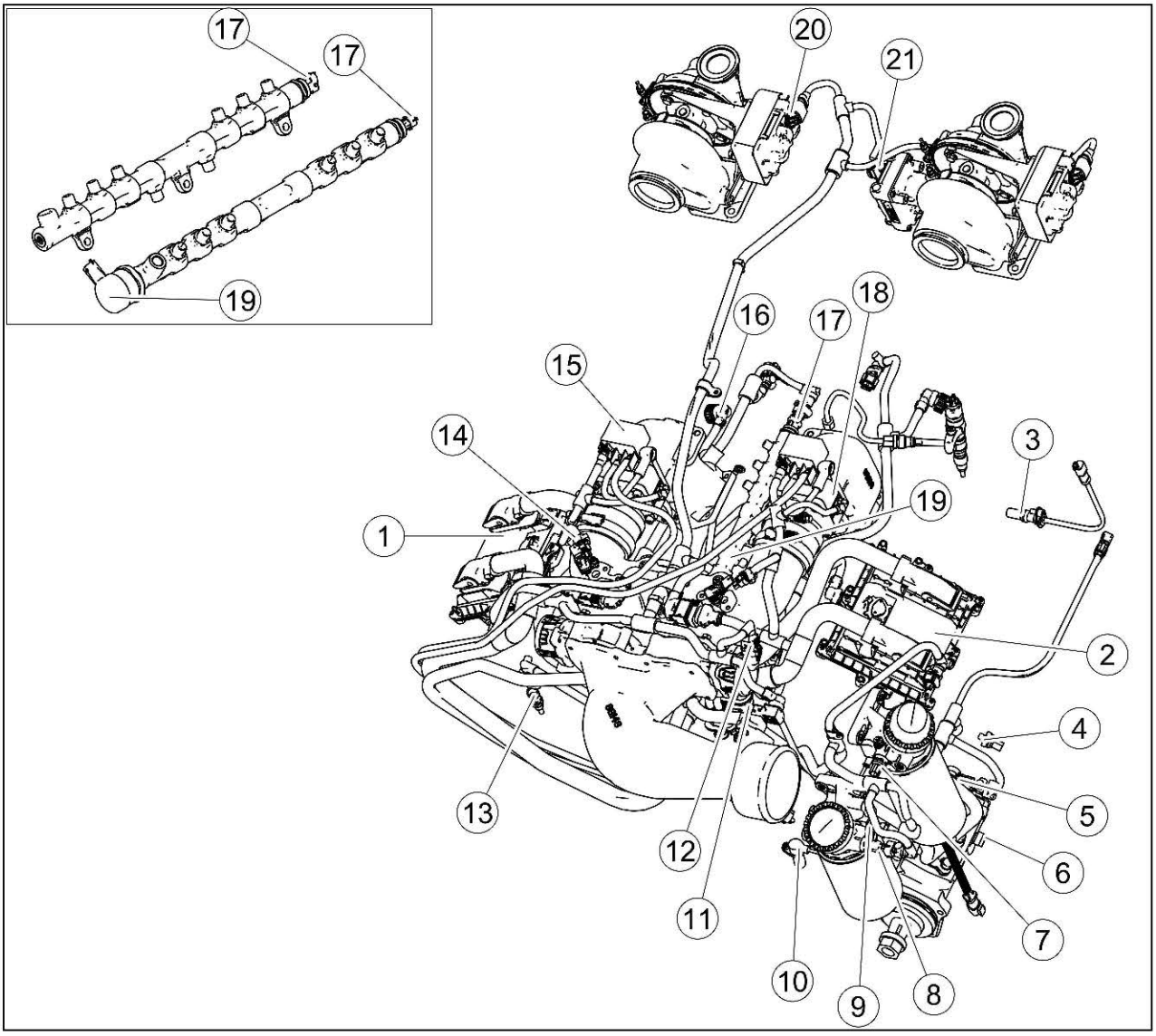


Fig. 644

(1) Primary ECU
(2) Secondary ECU
(3) Speed sensor (crankshaft)
(4) Oil pressure sensor
(5) Fuel pressure sensor
(6) Magnetic proportional valve (MPROP)
(7) Fuel pressure sensor
(8) Fuel pressure sensor
(9) Fuel temperature sensor
(10) Speed sensor (camshaft)
(11) Mass air flow (MAF) sensor
(12) Throttle valve
(13) Coolant temperature sensor
(14) Boost pressure sensor
(15) Air-intake heater solenoid
(16) Inlet air temperature sensor
(17) Rail pressure sensor
(18) Air-intake heater
(19) Pressure control valve
(20) Actuator of the high-pressure turbocharger (wastegate actuator)
(21) EGR actuator

The basic function of the electronic control of the engine is continuous adjustment and measuring of the load, quantity of the fuel and rotating speed. Other additional functions are for example cold start automatics, engine protecting automatics and SCR system control.

The engine has two electronic control units (ECU). Both primary ECU and secondary ECU receive continuous signals from sensors that measure different functions in the engine like rotating speed, oil pressure, boost pressure, coolant and fuel temperature. The primary ECU receives the relevant information about the engine load need from the transmission or cabin through the CAN bus. The primary ECU shares the information to the secondary ECU. The primary ECU controls the functions (like fuel injection) of the right side of the engine and the secondary ECU controls the functions of the left side of the engine.

ECU makes it also possible to have a wide diagnostics through error codes.

See the information for the different sensors in the troubleshooting document in the diagnostic tool.

2.11.14.1 Engine wiring

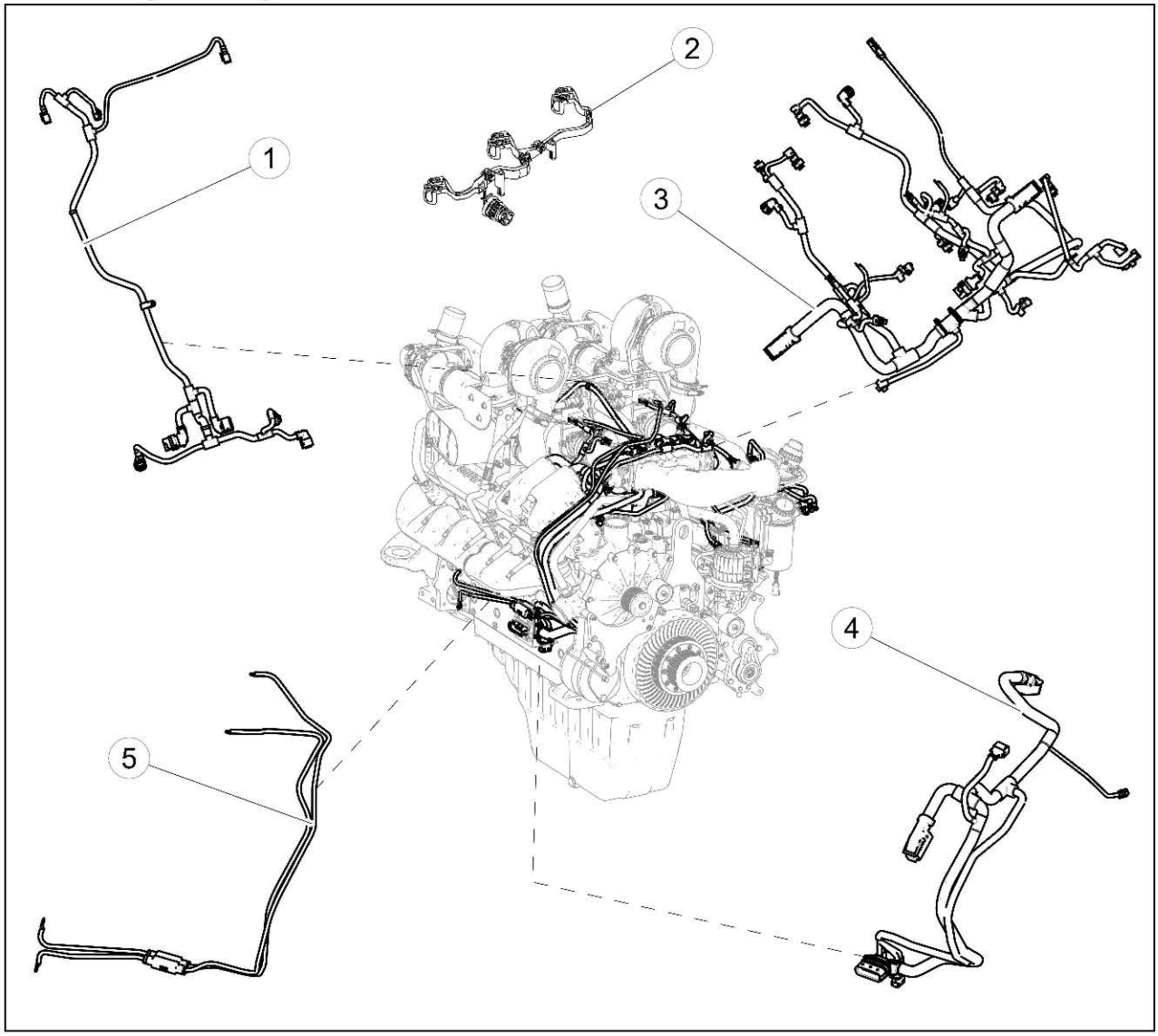


Fig. 645

(1) Wiring for actuators
(2) Wiring for injectors
(3) Engine wiring set
(4) Wiring for machine connector
(5) Wiring for intake air heaters

The wiring sets are delivered as complete sets; the connectors are not available as separate spare parts.

See the information for fault codes and circuit diagrams in the Troubleshoot documentation in the diagnostic tool.

2.12 Technical data

2.12.1 Cylinder block

Cylinder block	
Holes for guide pins:	
• Both ends	• 13.250 - 13.320 mm
Main bearing housing diameter	121.000 - 121.025 mm
Cylinder liner location, diameter:	
• upper end	• 125.014 - 125.054 mm
• lower end	• 121.000 - 121.040 mm
Inner diameter of camshaft bushing no. 1 (fitted)	50.040 - 50.060 mm
Inner diameter of camshaft bearing bushings others (fitted)	50.010 - 50.070 mm
Height of cylinder block:	
• From top to bottom	• 541.500 - 544.500 mm
• From the crankshaft line to the cylinder head level	• 378.900 - 379.100 mm
Width of cylinder block:	
• Between cylinder banks	• 605.400 - 610.600 mm
• Between machined surfaces at the bottom of the cylinder block	• 369.400 - 370.600 mm (front) • 389.600 - 390.400 mm (middle) • 357.000 - 359.000 mm (rear)

2.12.2 Cylinders of the 12 cylinder engine

Cylinders 1-6 are on the right side of the engine and cylinders 7-12 are on the left side of the engine.

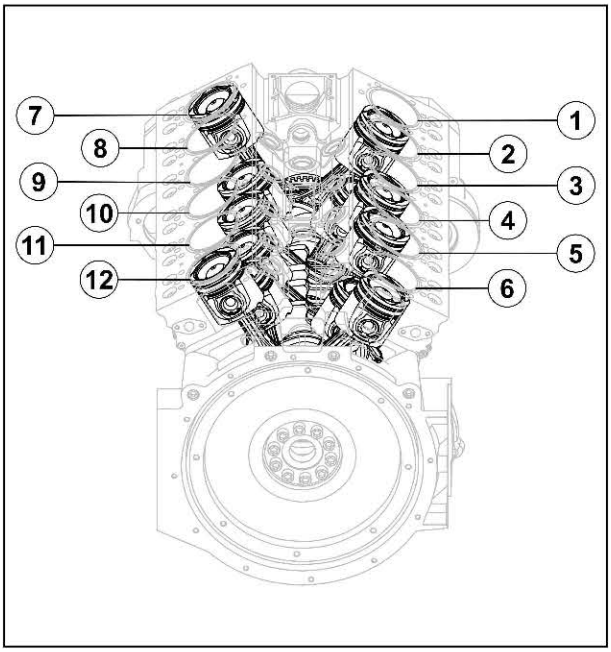


Fig. 646

168 engines	
Injection sequence	1 - 12 - 2 - 11 - 4 - 9 - 6 - 7 - 5 - 8 - 3 - 10
Valves rock in cylinder number	6 - 7 - 5 - 8 - 3 - 10 - 1 - 12 - 2 - 11 - 4 - 9

2.12.3 Cylinder liners

Cylinder liners	
Protrusion of cylinder liner above cylinder block top face	0.030 - 0.080 mm
Max. permissible height difference between liners (under same head)	0.02 mm
Height of cylinder liner flange, std	9.03 - 9.05 mm
Height of cylinder liner flange, 1st oversize	9.08 - 9.10 mm
Height of cylinder liner flange, 2nd oversize	9.13 - 9.15 mm
Height of cylinder liner flange, 3rd oversize	9.23 - 9.25 mm
Outer diameter of cylinder liner flange	131.700 - 131.800 mm

Cylinder liners	
Outer diameter of cylinder liner guide:	
• at upper end of liner	• 124.975 - 125.000 mm
• at lower end of liner	• 120.966 - 120.991 mm
Liner bore	111.000 - 111.022 mm

2.12.4 Cylinder head

Cylinder head	
Height of cylinder head	109.900 - 110.000 mm
Height of cylinder head after repair grinding (minimum)	109.500 mm
Length of cylinder head bolts	148 mm (maximum 150 mm)
Length of cylinder head studs (overall length)	186 + 1 mm (maximum 188.5 mm)
Inner diameter of valve guide	8.000 - 8.015 mm
Outer diameter of valve guide	16.028 - 16.039 mm
Diameter of valve guide bore in cylinder head	16.000 - 16.018 mm
Position of valve guide top above cylinder head surface	13.000 mm
Depth of valve head face below cylinder head surface:	
• inlet valve	• 0.65 - 0.85 mm (maximum 2.20 mm)
• outlet valve	• 0.45 - 0.65 mm (maximum 2.20 mm)
Angle of valve seat:	
• inlet valve	• 35° +20'
• outlet valve	• 45° +20'
Width of valve seat:	
• inlet valve	• 2.200 mm
• outlet valve	• 2.000 mm
Diameter of exhaust valve seat ring	36.060 - 36.122 mm
Diameter of exhaust valve seat ring recess	36.000 - 36.025 mm
Diameter of inlet valve seat ring	41.070 - 41.132 mm
Diameter of inlet valve seat ring recess	41.000 - 41.025 mm

2.12.5 Valves and rockers

Valves and rockers	
Angle of valve face:	
• inlet valve	• 35°-20'
• exhaust valve	• 45°-20'
Outside diameter of valve head:	
• inlet valve	• 39 mm

Valves and rockers	
• exhaust valve	• 35 mm
Inlet valve stem diameter	7.960 - 7.975 mm
Exhaust valve stem diameter	7.925 - 7.940 mm
Inlet valve stem clearance	0.025 - 0.055 mm
• Reject limit	• 0.30 mm
Exhaust valve stem clearance	0.060 - 0.090 mm
• Reject limit	• 0.35 mm
Depth of valve head face below cylinder head surface:	
• inlet valve	• 0.65 - 0.85 mm (maximum 2.20 mm)
• exhaust valve	• 0.45 - 0.65 mm (maximum 2.20 mm)
Valve spring free length	75.1 mm
Spring pressure when spring compressed to a length of:	
• 41.0 mm	• 300 ± 10 N
• 31.0 mm	• 420 ± 15 N
Rocker arm shaft diameter	24.970 - 24.990 mm
Diameter of rocker arm bore	25.000 - 25.021 mm
Free length of rocker arm spring	88 mm
Spring pressure when spring compressed to a length of 66 mm	75 - 95 N

2.12.6 Tappets and push rods

Tappets and push rods	
Outside diameter of tappet	29.939 - 29.960 mm
Diameter of tappet bore in cylinder block	30.000 - 30.043 mm
Max. permissible push rod deflection (when free)	0.4 mm
Overall length of push rod	241 - 242 mm

2.12.7 Camshaft

Camshaft	
Diameter of camshaft bearing journal no. 1 (both sides)	49.875 - 49.900 mm
Diameter of camshaft bearing journals nos. 2-4 (both sides)	49.865 - 49.890 mm
Diameter of camshaft bearing journal no. 5 (both sides)	49.885 - 49.910 mm
Camshaft clearance in bearing bush no. 1	0.11 - 0.195 mm
Camshaft clearance in bearing bush nos. 2-4	0.1 - 0.185 mm
Camshaft clearance in bearing bush no. 5	0.08 - 0.165 mm
Camshaft end play	0.2 - 1.2 mm
Cam height (distance between back of cam and tip of cam):	
• inlet valve	• 43.180 - 43.680 mm
• outlet valve	• 41.700 - 42.200 mm
Cam lift:	
• inlet valve	• 6.18 mm
• outlet valve	• 7.70 mm
Width of cam	19.70 - 20.30 mm
Camshaft maximum permissible deflection (total indicator reading)	0.03 mm

2.12.8 Crankshaft

Crankshaft	
Crank pin diameter:	
• standard	• 86.978 - 87.000 mm
Crank pin length	59.300 - 59.490 mm
Main bearing journal diameter:	
• standard	• 114.985 - 115.020 mm
Main bearing housing diameter (in cylinder block)	121.000 - 121.025 mm
Main bearing shell thickness:	
• standard	• 2.964 - 2.976 mm

Crankshaft	
Main bearing clearance	0.054 - 0.139 mm
Length of thrust bearing journal (journal nearest to flywheel):	
• standard (2 standard thrust plates)	• 37.100 - 37.108 mm

Rounded corner of crank pins and journals	Not applicable
Crankshaft end float	0.100 - 0.260 mm
Maximum permissible ovality and other deformity of crank pins	0.025 mm
Maximum permissible ovality and other deformity of crank journals	0.030 mm
Crankshaft unbalance	max. 500 g
Number of teeth on trigger wheel	60-2

2.12.9 Flywheel

Flywheel	
Interference fit between ring gear and flywheel	0.425 - 0.600 mm
Before fitting the ring gear, heat up to a temperature of	180 - 200 °C
Maximum permissible axial wobble of flywheel clutch face, measured at inner edge of clutch face on diameter 410	0.12: Ø 410

2.12.10 Timing gears

Timing gears	
Tooth backlash	0.05 - 0.25 mm
Maximum permissible side wobble of gears	0.05 mm

Timing marks	
Timing marks on gears are in alignment when the 1st cylinder piston is at its top, dead center between compression and power strokes.	
On crankshaft gear :	
• against left idler gear	• 1 dot on notch
• against middle idler gear	• 2 dots on tooth
On left idler gear:	
• against crankshaft gear mark	• 2 dots on notch
• against high-pressure pump mark	• 1 dot on tooth
On middle idler gear:	

Timing marks	
• against left camshaft gear mark	• 2 dots on tooth
• against right camshaft gear mark	• 2 dots on tooth
• against crankshaft gear mark	• 1 dot on tooth
On high pressure pump gear	2 dots on notch
On camshaft gear (both sides)	1 dot on tooth

2.12.11 Connecting rod

Connecting rod	
Big-end bearing shell thickness:	
• standard	2.332 - 2.341 mm
Big-end bearing clearance	0.066 - 0.129 mm
End float (side clearance) at big-end on crankshaft	0.30 - 0.69 mm
Piston pin bushing location perpendicular to longitudinal axis of connecting rod to be within	0.15 at 100 mm length
Piston pin bushing location and big-end bearing location to be parallel to within	0.05 at 100 mm length
Maximum permissible weight difference between connecting rods in the same engine	20 g
Weight marking (letter) at lower end.	

Inside diameter of piston pin bush (with bush pressed into connecting rod)	44.025 - 44.040 mm
Outside diameter of piston pin bush (std)	48.080 - 48.120 mm
Interference fit: connecting rod small end bushing-connecting rod	0.057 - 0.120 mm
Connecting rod small end bore	48.000 - 48.025 mm
Connecting rod big-end bore	91.730 - 91.752 mm

2.12.12 Piston, rings and pin

Piston, rings and pin	
Piston diameter:	
• 15 mm from lower edge	110.863 - 110.877 mm
Pin bore in piston	44.003 - 44.009 mm
Piston pin diameter	43.994 - 44.000 mm
Width of ring grooves:	
• 1st groove	wedge shaped ring

Piston, rings and pin	
• 2nd groove	2.570 - 2.590 mm
• 3rd groove	3.040 - 3.060 mm
Side clearance of piston rings in their grooves:	
• 1st ring	wedge shaped ring
• 2nd ring	0.03 - 0.062 mm
• 3rd ring	0.05 - 0.082 mm
• Reject limit	0.15 mm
Piston ring height (in direction of cylinder):	
• 1st ring	wedge shaped ring
• 2nd ring	2.470 - 2.490 mm
• 3rd ring	2.970 - 2.990 mm
Piston ring gap (with piston fitted in cylinder):	
• 1st ring (wedge shaped ring)	0.35 - 0.50 mm
• 2nd ring	0.80 - 1.00 mm
• 3rd ring	0.35 - 0.60
• Reject limit 1st and 3rd ring	1.0 mm
• Reject limit 2nd ring	1.3 mm
Maximum permissible weight difference between pistons in same engine	25 g
Piston must be heated up to 100°C before fitting gudgeon pin.	

2.12.13 Lubrication system

Lubrication system	
Oil pressure at normal running temperature	
• at idling speed (minimum)	• 3 bar
• at running speed (warm engine)	• 3 - 6 bar
Oil pressure regulating valve	
• Free length of oil pressure regulating valve spring (Ø 29 mm)	• 70 mm
• Free length of oil pressure regulating valve spring (Ø 15 mm)	• 50 mm

Lubrication system	
• Assembly length / load of oil pressure regulating valve spring (Ø 29 mm)	• 37.5 mm / 197.5 Nm
• Assembly length / load of oil pressure regulating valve spring (Ø 15 mm)	• 58.5 mm / 136.85 Nm
Oil filter by-pass valve opens at a pressure difference of	2 ± 0.5 bar

2.12.13.1 Oil pump

Oil pump	
Backlash between gears when crankshaft lies firmly against the lower side of the main bearings	
• crankshaft gear and idle gear	• 0.1 - 0.25 mm
• idle gear and oil pump gear	• 0.08 - 0.25 mm

2.12.14 Thermostat

Type	Opening begins at	Fully open at	Maximum stroke
79°C	79°C ± 2°C	92°C	9,5 mm
82°C	82°C ± 2°C	95°C	9,5 mm

2.12.15 Turbocharger

	168 (High pressure)	168 (Low pressure)
Axial clearance maximum (mm)	0,1	0,1
Radial clearance maximum (mm)	0,5	0,5

2.13 Liquid quality requirements

2.13.1 Oil quality requirements

Oil quality requirements	
API-grade	CJ-4
ACEA-grade	E9
Viscosity	5W - 40 or 10W - 40 or 15W - 40

2.13.2 Coolant quality requirements

AGCO Power Inc. recommends to use coolants that follow in all AGCO POWER engines:

- Arteco, Havoline XLC
- BASF, Glysantin G30

In addition, coolants under other brand names, which can be proved to use exactly the same inhibitor package as Arteco Havoline XLC or BASF Glysantin G30, are recommended to be used.

If Arteco Havoline XLC, BASF Glysantin G30 or coolant which uses the same inhibitor package is used, the coolant change interval can be extended from two years up to five years. If any other coolant is used, the coolant change interval is two years.

Requirements

The coolant used must meet the demands of standard ASTM D 3306 or BS 6580:1992.

- The cooling mixture must consist 40 - 60 % of ethylene/propylene-glycol based antifreeze and water. The best proportion is 50 % of antifreeze liquid and 50 % of water.
- The water used must be mechanically clean and not too acid (e.g. swamp water) or too hard (calciferous well water).
- Check periodically the proportion of antifreeze (the frost resistance) in the coolant.
- Do not mix ethylene- and propylene-glycol based antifreeze.
- Change the coolant every two years.

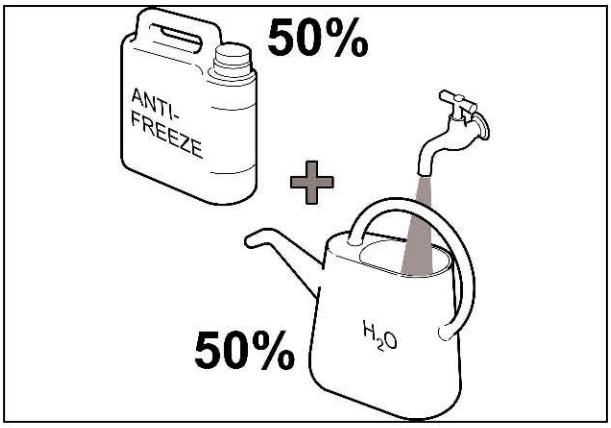


Fig. 647

NOTE:
Use only coolant that is a mixture of 40-60% water and antifreeze. Refer to the engine specification for the machine, for the specified ratio and the quantities necessary. Do not use water only for the coolant.

DANGER: Antifreeze is dangerous to health.

Injury to persons.

Do not let antifreeze touch the eyes and skin.

2.13.3 Fuel quality requirements

The use of fuels that are not permitted can cause faults in the engine and the exhaust gas aftertreatment system. These faults can cause:

- Damage to the engine components and decrease the engine life

- The engine to not be in compliance with the emission regulations.

AGCO POWER (and AGCO Corporation) is not responsible for failures or faults caused by the incorrect quality or storage of the fuel.



CAUTION: Risk of fuel system damage.

Diesel Exhaust Fluid (DEF) in the diesel fuel, will cause damage to the fuel system.

If you think that there is Diesel Exhaust Fluid (DEF) contamination in the diesel fuel tank, do not start the engine. Drain the fuel tank and clean the fuel tank before you start the engine.

Fuel standards

Fuel must be in compliance with the sulphur requirements, the biodiesel requirements and the standards that follow:

Fuel standards		
European standard	EN 590	2009 or newer
North American standard	ASTM D 975	10b or newer
Japanese standard	JIS K2204	2007 or newer
Chinese standard	GB 252 or GB 19147	≥2018

Use only ultra low sulphur (≤ 15 mg/kg) diesel fuels that are in compliance with:

- EN 590 (:2009 or newer)
- ASTM D 975 (-10b or newer)
- GB 19147 Stage V.



CAUTION: Engine and emission system damage.

The engine is not in compliance with emission regulations.

Do not use additives or admixtures.

IMPORTANT:
Fuels or mixtures that include ethanol, gasoline or kerosene are not permitted for use in AGCO POWER engines. These fuels decrease the life of the engine and cause system failure.

Permitted sulfur quantity

The permitted sulphur quantity is related to:

- Emission level
- Fuel system components and materials
- Aftertreatment components and materials.

For engines with a Selective Catalyst Reduction (SCR) system and engines with cooled external Exhaust Gas Recirculation (EGR) system, fuels with higher sulphur quantity are not permitted. Fuels with a high sulphur quantity will cause the engines not to be in compliance with particulate emission regulations.

Sulphur is also a catalyst poison, which can cause failure of the catalyst. Failure of the catalyst will cause a malfunction in the aftertreatment system.

IMPORTANT: *Use of high sulphur fuel in Selective Catalyst Reduction (SCR) engines and cooled external Exhaust Gas Recirculation (EGR) engines will cause damage to the aftertreatment system and cause the machine to loose performance. If you use high quantity sulphur fuels the warranty will be removed from the engine and aftertreatment system.*

Permitted sulphur quantities				
Emission level	**Fuel injection system**	**Aftertreatment system (Diesel Oxidation Catalyst (DOC), Selective Catalyst Reduction (SCR), Exhaust Gas Recirculation (EGR))**	**Diesel Particulate Filter (DPF)**	**Maximum permitted sulphur content**
Stage V	Common rail	Yes	Yes	10 mg/kg [1]
Tier 4 Final, Stage IV	Common rail	Yes	No	15 mg/kg
Tier 4 Interim, Stage IIIB	Common rail	Yes	No	15 mg/kg
Tier 3, Stage IIIA	Common rail	Yes	No	15 mg/kg or 500 mg/kg[2]
	Mechanical	Yes	No	
Tier 2, Stage II	Common rail	Yes	No	15 mg/kg or 500 mg/kg[2]
	Common rail	No	No	2000 mg/kg
	Mechanical	No	No	2000 mg/kg
Tier 0, Stage 0	Common rail	No	No	2000 mg/kg
	Mechanical			

[1] Within the European Union fuel with sulphur content not greater than 10 mg/kg (20 mg/kg at point of final distribution) shall be used.

[2] If the engine does not have a Selective Catalyst Reduction (SCR) system or a cooled external Exhaust Gas Recirculation (EGR) system, the maximum permitted sulphur quantity is 500 mg/kg.

Cetane number

The cetane number must be a minimum 43. We recommend a cetane number more than 47, specially for temperatures less than -20°C (-4°F) and elevations above 1500 m (5000 ft) from the sea level.

2.13.3.1 Biodiesel blends

1st generation biodiesel blends

It is not necessary to change the engine or its maintenance if you use 1st generation biodiesel. (less than 10% Fatty Acid Methyl Esters (FAME) / Fatty Acid Mono-Alkyl Esters (FAAE))

Permitted fuels	Maximum permitted 1st generation biodiesel quantity	Standard for biodiesel blend
EN 590 - Europe	0 - 10% Fatty Acid Methyl Esters (FAME) / Fatty Acid Mono-Alkyl Esters (FAAE)	EN 14214
ASTM D 975 - North America		ASTM D 6751
JIS K2204 - Japan		JIS K2390
GB 19147 St5 - China		-
EN 15940 EU BTL/HVO		EN 14214

It is necessary to change the engine and its maintenance if you use higher (10-20%) biodiesel quantities. The changes in the engine and its maintenance as follows:

- You must change the oil, oil filter and fuel filter more frequently than with less than 10% biodiesel.
- The engine must have 1 more fuel pre-filter or water separator in the fuel line between the fuel tank and the engine. It is necessary to do a frequent check of the water separator.
- The added fuel pre-filter (this includes the water separator) must have approval byAGCO POWER.

NOTE:
Do not use diesel fuel with higher proportions of biodiesel.

Risks of fuels with 1st generation biodiesel blends

If you use biodiesel blends from 10% to 20%, you must think about the risks.

- Possible power and fuel economy reduction up to 6%
- Decreased fuel flow in cold environments
- Possible decreased flow through the fuel filter(s) and risk that they become clogged
- Possible damage to the seals and hoses can cause fuel leaks
- Carbon can collect on the fuel injector nozzles
- Fuel can mix with the engine oil
- Possible high acid levels in the fuel system
- It is possible that it is not compatible with other materials (including copper, lead, zinc, tin, brass and bronze)
- Decrease in life of the engine and the exhaust system (Selective Catalyst Reduction (SCR) and Exhaust Gas Recirculation (EGR))
- Increase of engine emissions that can lead engine to de-rate on Selective Catalyst Reduction (SCR) engines.

All the above mentioned risks increase with higher than 20% biodiesel blends. Higher biodiesel blends cause other problems.

- Blockage of injector nozzles, causes a decrease of power and engine malfunction
- Oil soot in the crankcase, which decreases the oil and oil filter life
- Corrosion of the fuel system
- Failure of the engine or internal components of the fuel system.

2nd generation biodiesel

The use of the paraffinic diesel BTL/HVO (renewable diesel) equivalent to the standard EN 15940 Directive 98/70/EC is permitted in all AGCO POWER engines. Fuel filtration and maintenance intervals stay the same as usual.

2.13.3.2 Engine output depending on fuel quality

Different fuel qualities like temperature, density and viscosity affect the actual output of the engine. Our outputs are specified by fuel with a density of 0.84 kg/dm3 and specific heat rate of 42,7 Mj/kg at a fuel temperature of +15°C.

The correction in % caused by the change of fuel qualities is seen in the attached figures.

FIG. A. Engine output dependence on fuel temperature. +35°C is the reference temp (correction 0%). The fuel temperature is not only a function of ambient conditions but also varies according to the fuel system of the application (tank size and location, return flow etc.).

FIG. B. Engine output dependence on fuel density. Normal value is 0,84 kg/dm3 at +15°C.

FIG. C. Engine output dependence on fuel viscosity. Normal value is 3 cSt at +20°C.

Note figure B and C only if the fuel quality is changed.

In fig. A there are all the quality dependencies caused by the change of the temperature. The fuel density and viscosity can be seen in the produce declaration given by the manufacturer.

The output correction is made as follows: Correction percentages from figures A, B and C are summed up. The given rated power is then corrected with the resulting percentage.

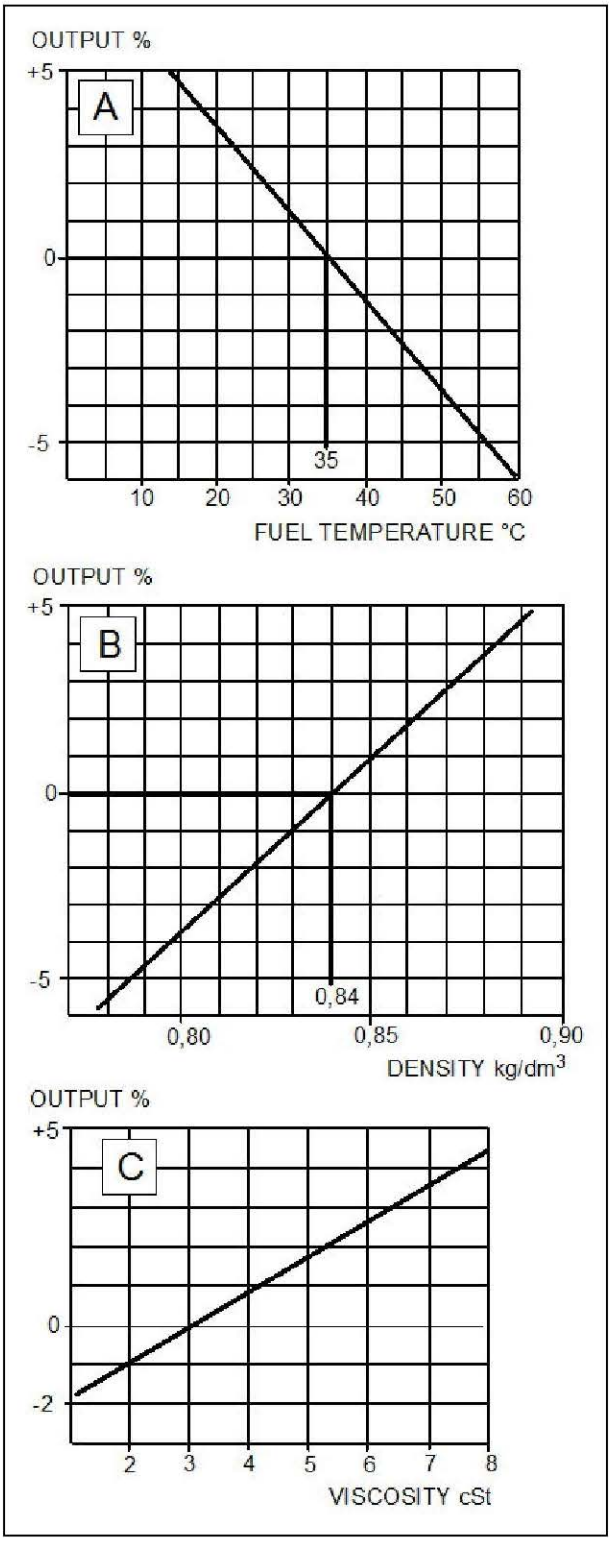


Fig. 648

2.14 Tightening torques

Object	Nm
Crankshaft screw	$1100^{\pm 50}$
Crankshaft pulley screws	
• M10	80
• M14	200
Flywheel screws (M16)	350
Flywheel housing screws	
• M14	200
• M12	150
Idler gear screws	
• M14	200
• M10	80
• M8	40
Small idler gear screws (shaft, 2 pcs), M8	45
Small idler gear screws (thrust ring), M8	32
Camshaft gear nut	200
Rocker arm shaft bracket screw and nuts	45
Valve cover and frame screws	25
Oil pump retaining screws	80
Oil sump drain plug M18	80
Oil pump regulating valve nut	210 ± 10
Oil sump screws M10	80
Oil sump screws M12	120
Coolant pump pulley screw M10	50
Belt tightener screw	48
Exhaust manifold screws	50
EGR valve screws (M8)	40
Injector fastening screw	See the correct tightening procedure from the work instructions.
Injector Fastening nut	See the correct tightening procedure from the work instructions.
Injector wire nuts (M4)	1,5
High pressure pump gear nut	280
High pressure pump fixing screws	37.5 ± 2.5

Object	Nm
Low pressure fuel pipes to high-pressure pump M16	30 ± 3
High pressure fuel pipes to high-presure pump and rail	
• M14	30
• M16	40
Pre-filter water detector	6
Rail pressure sensor	70
Rail pressure control valve	Tighten 80 ± 4 Loosen 90° Tighten 85 ± 6
Compressor gear nut (1 and 2 cylinder)	160 (LH thread)
Mounting bracket of LP turbochargers	
• M10	80
• M12	120
Dosing module M6	8
NOx sensor	50
Exhaust gas temperature sensor	40
ECU mounting bracket	30
ECU mounting bracket	10
Oil and fuel pressure sensor M10	25
Coolant and fuel temperature sensor M14	25
Engine mount	300

General torque values

Always use the torque values in the following table when specific torque values are not available.

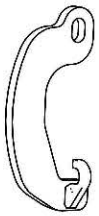
Thread	Strength class		
	8.8	10.9	12.9
M8	25 Nm	35 Nm	40 Nm
M10	50 Nm	75 Nm	85 Nm
M12	85 Nm	125 Nm	145 Nm
M14	135 Nm	200 Nm	235 Nm
M16	210 Nm	310 Nm	365 Nm

Use a washer with the aluminum parts.

2.15 Special tools

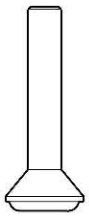
2.15.1 Engine lifting tools

Reference	V837081831
Description	Lifting tool for engine front end



2.15.2 Cylinder block tools

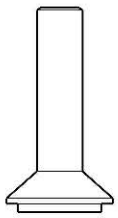
Reference	V905246620
Description	Drift for 40 mm cup plug



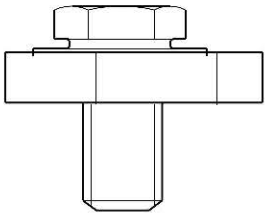
Reference	V905246650
Description	Drift for 16 mm cup plug



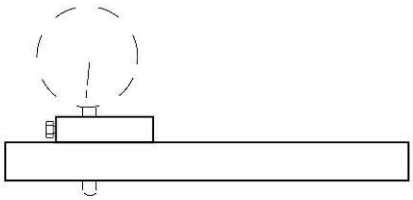
Reference	V902587400
Description	Drift for fitting camshaft cup plug



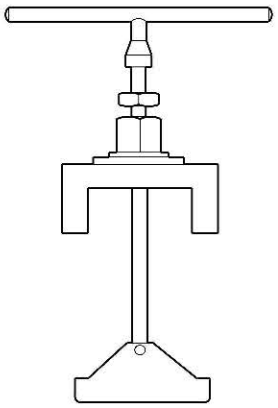
Reference	V910166300
Description	Press tool for cylinder liner



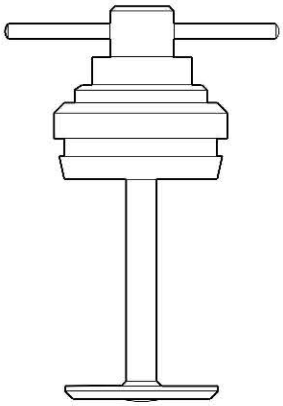
Reference	V902579200
Description	Holder for dial gauge



Reference	V910451500
Description	Puller for cylinder liner



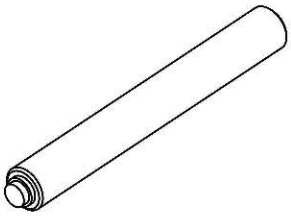
Reference	V910452000
Description	Milling cutter for cylinder liner seat



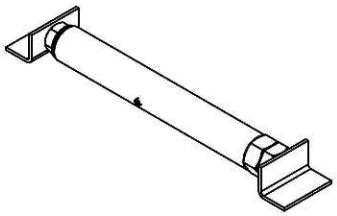
Reference	V904587600
Description	Spare cutting blade for milling cutter



Reference	V920120520
Description	Drift for 12 mm HLA cup plug

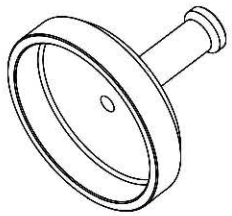


Reference	V920240120
Description	Expander of the cylinder block

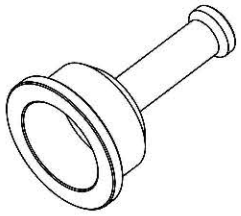


2.15.3 Timing gear and flywheel housing tools

Reference	V920215670
Description	Drift for fitting crankshaft rear oil seal



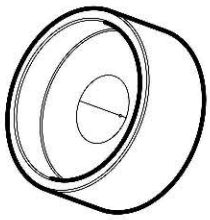
Reference	V920215660
Description	Drift for fitting crankshaft front oil seal



Reference	V902598700
Description	Drift for tension pins in timing gear housing

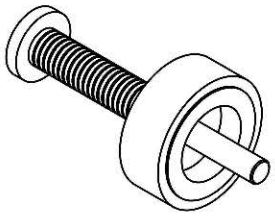


Reference	V920218070
Description	Drift for the installation of the PTO bearing



To hit the PTO bearing in the timing gear housing

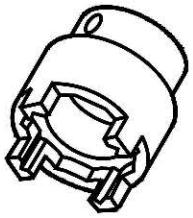
Reference	V920233250
Description	Drift for the installation of the PTO bearing



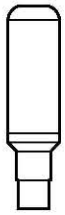
To hit the PTO bearing in the front cover of the timing gear housing

2.15.4 Cylinder head and valve mechanism tools

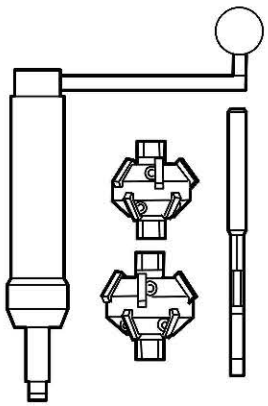
Reference	V920179670
Description	Socket for injector wiring



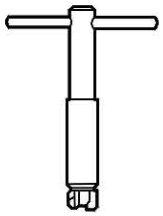
Reference	V920185580
Description	Fitting tool for valve stem gasket



Reference	V837062635
Description	Milling cutter kit for valve seat



Reference	V912085400
Description	Milling tool for injector seat



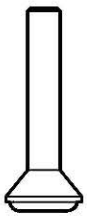
Reference	V921085300
Description	Drift for removing valve guide



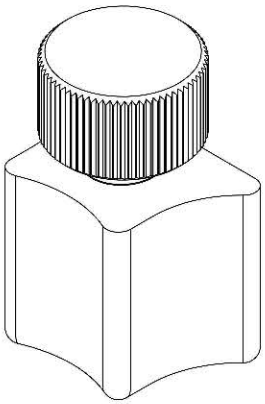
Reference	V912085000
Description	Drift for fitting valve guide



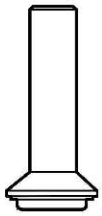
Reference	V905246660
Description	Drift for 36 mm cup plug



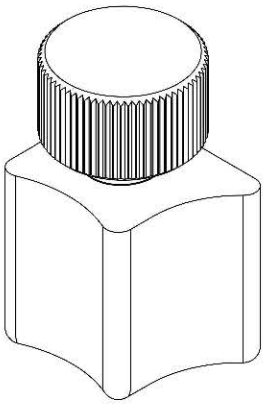
Reference	V920253320
Description	Pre-tensioning tool for the hydraulic lash adjusters



Reference	V910394800
Description	Drift for 45 mm cup plug

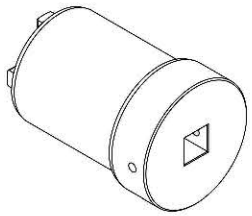


Reference	V920253320
Description	Pre-tensioning tool for the hydraulic lash adjusters

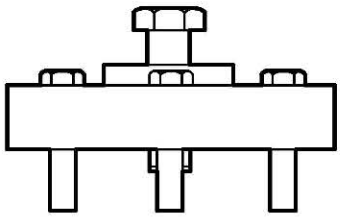


2.15.5 Crank mechanism tools

Reference	V920220290
Description	Opening tool for crankshaft hub nut

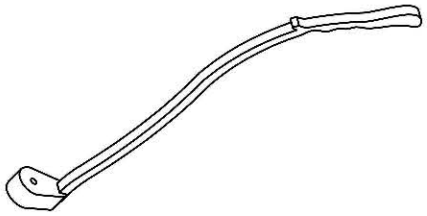


Reference	V920182390
Description	Puller for crankshaft hub



2.15.6 Lubrication system tools

Reference	V920243710
Description	Installation tool of the piston cooling nozzle



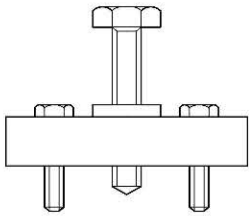
2.15.7 Coolant pump tools

Reference	V920191771
Description	Drift for fitting coolant pump water seal

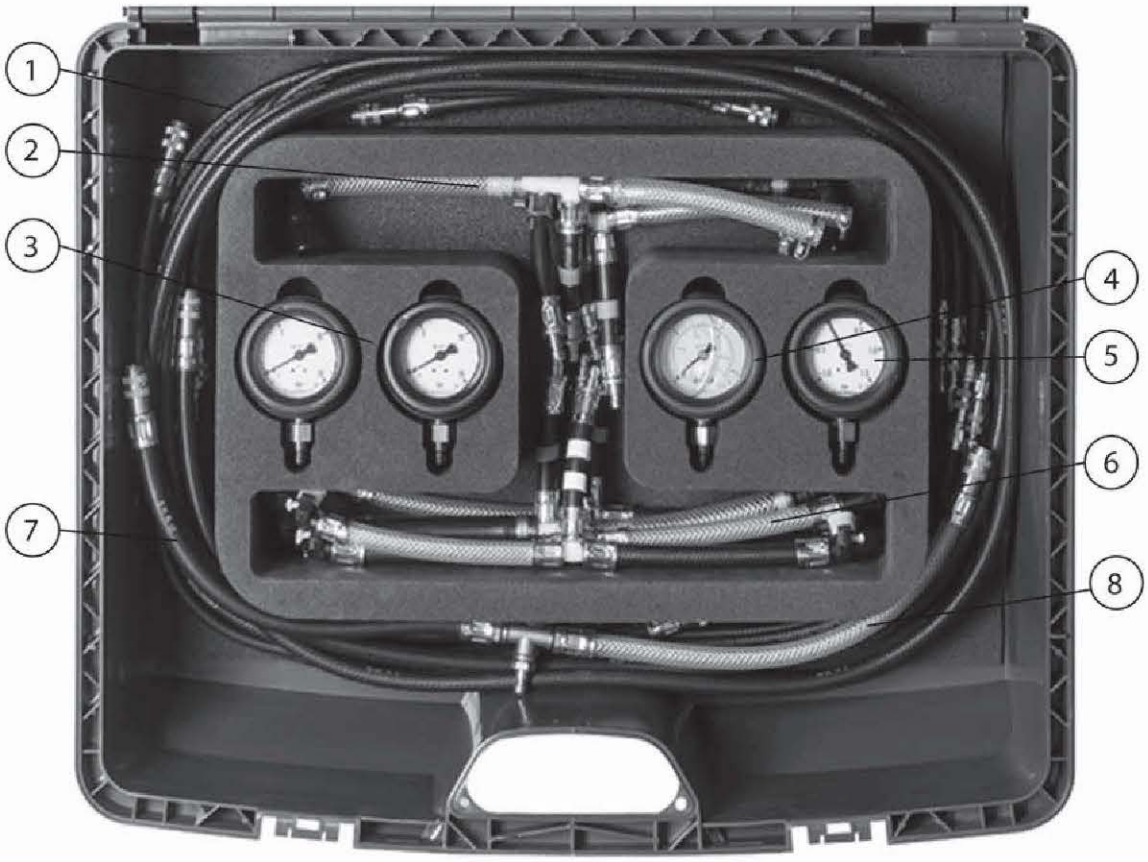


2.15.8 Fuel system tools

Reference	V905248900
Description	Puller for high-pressure pump gear



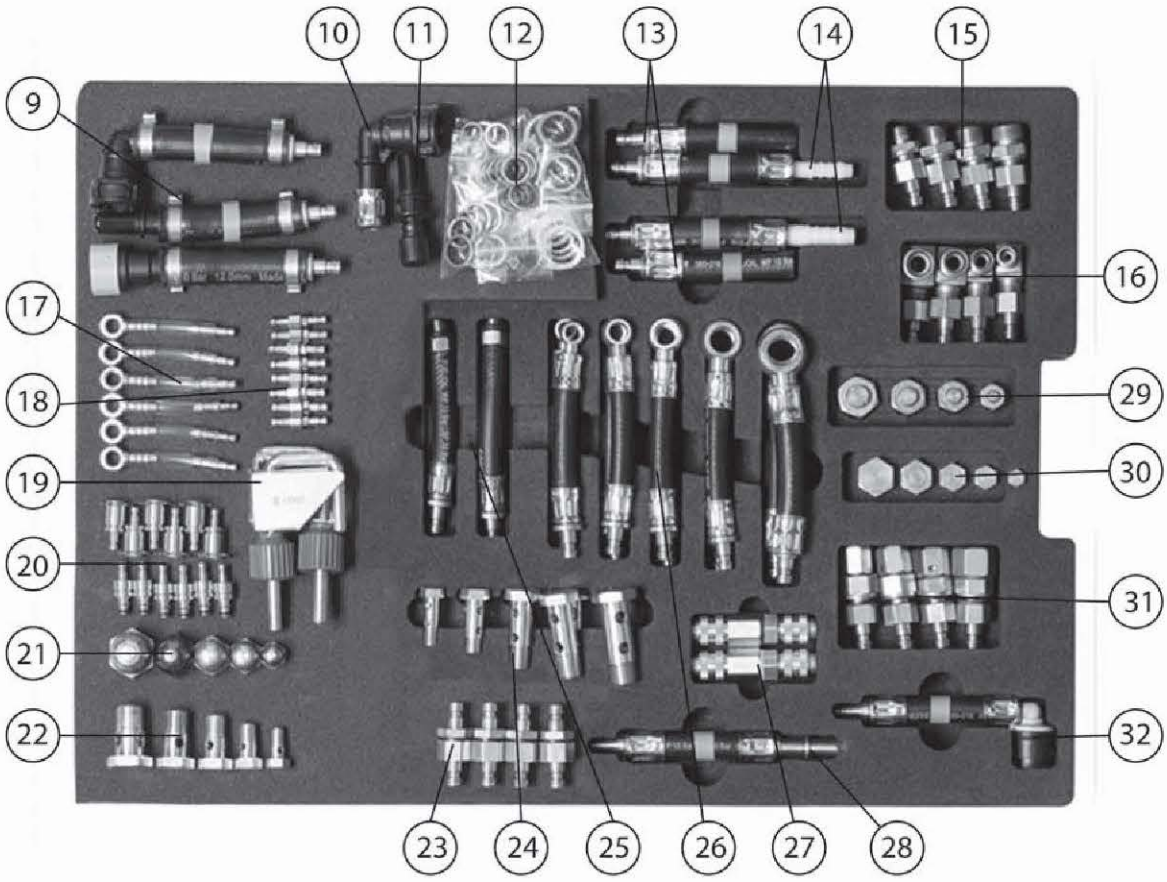
Reference	V837091176
Description	Diesel tool kit



(1)	Adapter hose set, 2-part 70 cm (8 pcs.)
(2)	T-piece (4 pcs.)

(3)	Manometer, quick-fit plug, -1-15 bar (2 pcs.)
(4)	Manometer, quick-fit plug, 0-16 bar glycerin
(5)	Manometer, quick-fit plut, -1-1,5 bar
(6)	T-piece (4 pcs.)
(7)	Adapter hose, 2 m with coupling
(8)	Adapter-T-piece, 2 x 30 cm

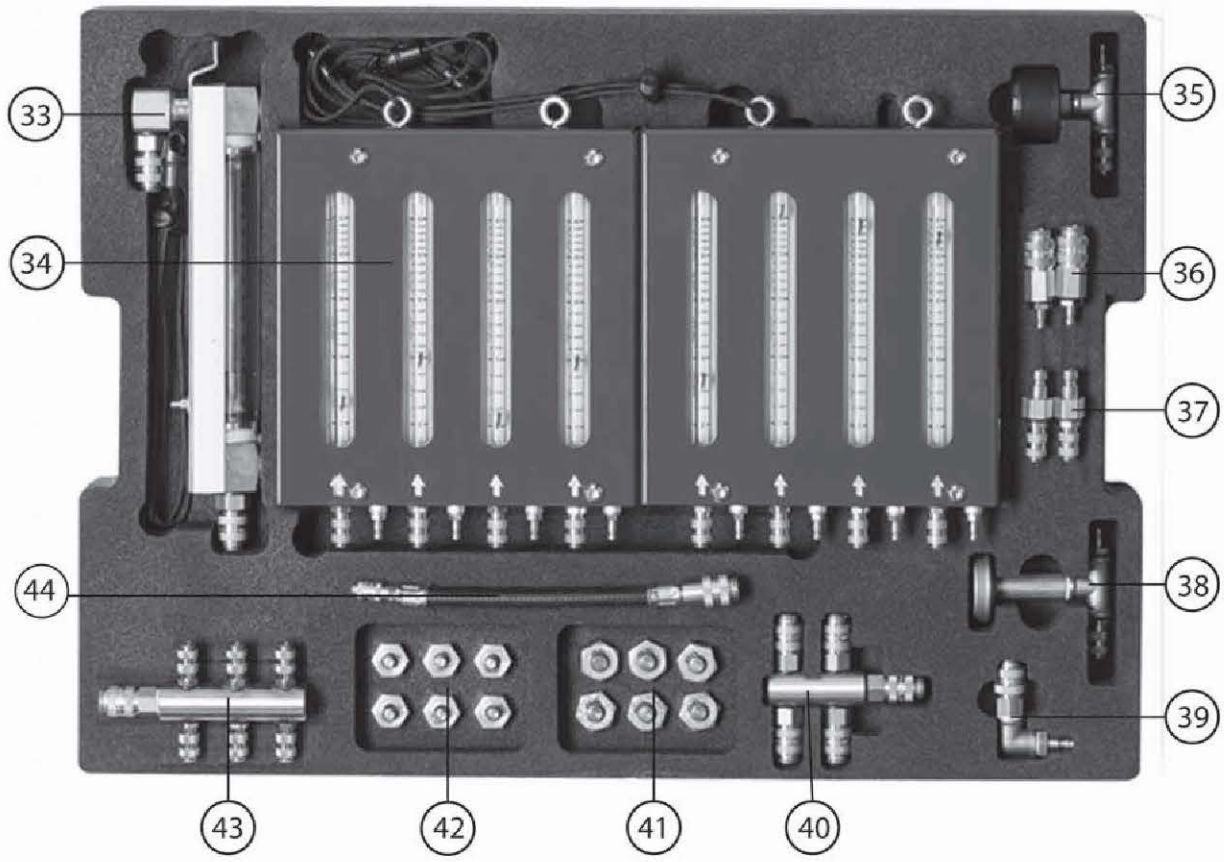
Reference	V837091176
Description	Diesel tool kit



(9)	Adapter, quick-fit plug (3 pcs.)
(10)	Closing coupling
(11)	Clousing spout
(12)	Sealing ring (M8, M10, M12, M14, M16)
(13)	Adapter hose, quick-fit plug (8 mm, 10 mm)

(14)	Adapter hose, hose fitting with quick-fit plug (8 mm, 10 mm)
(15)	Male connector, straight with quick-fit plug (M12, M14, M16, M18)
(16)	Elbow connector, quick-fit plug (M12, M14, M16, M18)
(17)	Adapter, S20, ring eyelet (M8, 6 pcs.)
(18)	Connector grommet - grommet, S20 (8 pcs.)
(19)	Hose clamp (30 mm, 2 pcs.)
(20)	Adapter set, 2-part Bosch magnet valve (6 pcs.)
(21)	Cap nut (M8, M10, M12, M14, M16)
(22)	Banjo bolt (M8, M10, M12, M14, M16)
(23)	Connector grommet - grommet (2 pcs.)
(24)	Double banjo bolt (M8, M10, M12, M14, M16)
(25)	Male connector, quick-fit plug (M10, M12)
(26)	Ring eyelet, guick-fit plug (M8, M10, M12, M14, M16)
(27)	Connector coupling - coupling (2 pcs.)
(28)	Adapter, quick-fit plug
(29)	Screw plug, internal thread (M12, M14, M16, M18)
(30)	Screw plug, external thread (M10, M12, M14, M16, M18)
(31)	Female connector, straight with quick-fit plug (M12, M14, M16, M18)

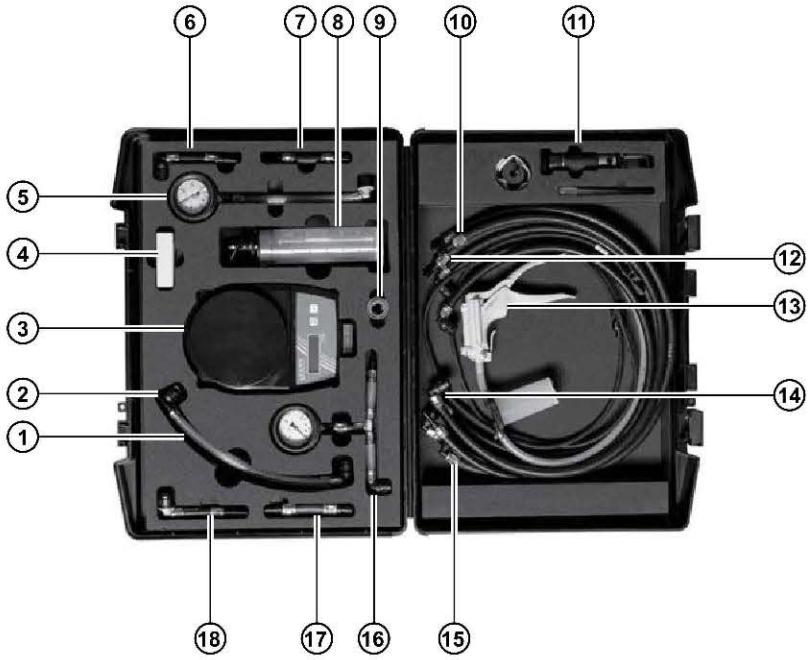
Reference	V837091176
Description	Diesel tool kit



(32)	Adapter, coupling, quick-fit plug
(33)	Collecting return flow meter (10-190 ml)
(34)	Return flow meter for circulation mode, 8 cylinder
(35)	Manometer, 40 mm, 0-1,6 bar
(36)	Connector, K21 to T20 (2 pcs.)
(37)	Connector, K20 to T21 (2 pcs.)
(38)	Temperature sensor, 0-120°C, quick-fit plug
(39)	Adapter hose, K21-K20
(40)	Siamese connector, 5-fold, K21
(41)	Rail sealing plug (M14, 60°, 6 pcs.)
(42)	Rail sealing plug (M12, 6 pcs.)
(43)	Siamese connector, 9-part with coupling
(44)	Adapter hose, K21-K20

2.15.9 SCR system tools

Reference	V837091048
Description	SCR tool kit



SCR tool kit includes:	Reference, if available as a replacement part:
(1) Adapter tube 9.5x20 transparent	Available in the kit V837091202
(2) Adapter tube 8.0x20 transparent	Available in the kit V837091202
(3) Scale with calibration weight	Not available
(4) Oil test paper	V837091208
(5) Pressure test unit -1-1,5 bar	V837091207
(6) Fill head 8.0x20	Available in the kit V837091202
(7) Rinse adapter 8.0x20	Available in the kit V837091203
(8) Measuring jug with adapter for dosing module	V837091209
(9) Garden hose adapter ½"	Available in the kit V837091203
(10) Extension cable dosing module	V837091204
(11) Refractometer	V837091206
(12) Extension tube 9.5x20	Available in the kit V837091202
(13) Vacuumpump	V837091205
(14) Extension tube 8.0x20	Available in the kit V837091202
(15) Rinse hose 9.5x20	Available in the kit V837091203

(16) Pressure test unit 0-16 bar	V837091211
(17) Rinse adapter 9.5x20	Available in the kit V837091203
(18) Fill head 9.5x20	Available in the kit V837091202

Reference	V837091079
Description	SCR tank back-up case
	
SCR tank back-up case includes:	• 2 x 5 liter canisters with adapter units • 2 adapter hoses, 2m 9.5x20mm • 3 adapter hoses 9,5x20mm

2.15.10 Electronic diagnostic tool

NOTE:
See also EDT user manual and instructions of the appliance.

AGCO's Electronic Diagnostic Tool (EDT) program offers a common platform diagnostic tool used to service all AGCO brands. EDT is an in-field diagnostic program to help the dealer technician accurately diagnose and solve a technical problem.

The EDT can be used by dealership technicians to interface with specific machines that have a Controller Area Network CAN BUS as part of the electronic system architecture

EDT is a plug and play diagnostic tool kit that contains a diagnostic terminal, vehicle connection cables, CAN BUS protocol adapter, carry case, and other items.



Fig. 649

A version of the EDT kit less the diagnostic terminal and associated parts is available. This kit will contain the EDT software application, cables, and 2x4 CAN USB Protocol Adapter.

EDT includes troubleshoot documentation with ECU fault codes and their explanations.

2.15.10.1 EDT diagnostic terminal

NOTE:
Make sure hands are clean of grease, water or excessive grime before touching or turning on the unit.

The EDT diagnostic terminal is a tablet computer. The terminal has a network connection port and will function like any other computer.

The EDT diagnostic terminal is semi-ruggedized which means the terminal will withstand moderate shock and vibration during use. The screen is fluid resistant (including oil) with a replaceable protective cover.



Fig. 650

NOTE:
It is advised to treat the EDT diagnostic terminal as a service tool and not an additional computer to include in the dealership LAN network.

The diagnostic terminal needs to be available to the service technician at all times for use in repairing customer applications.

The EDT diagnostic terminal has an electronic keyboard program installed. The keyboard can be activated by the user from within the EDT application.

The on-screen keyboard is touch-screen activated, fully functional, and is presented in the regional format based on language requirements.

2.15.10.2 Diagnostic terminal components

(1) Battery LED
(2) Hard drive activity LED
(3) Speaker



Fig. 651 Front terminal view

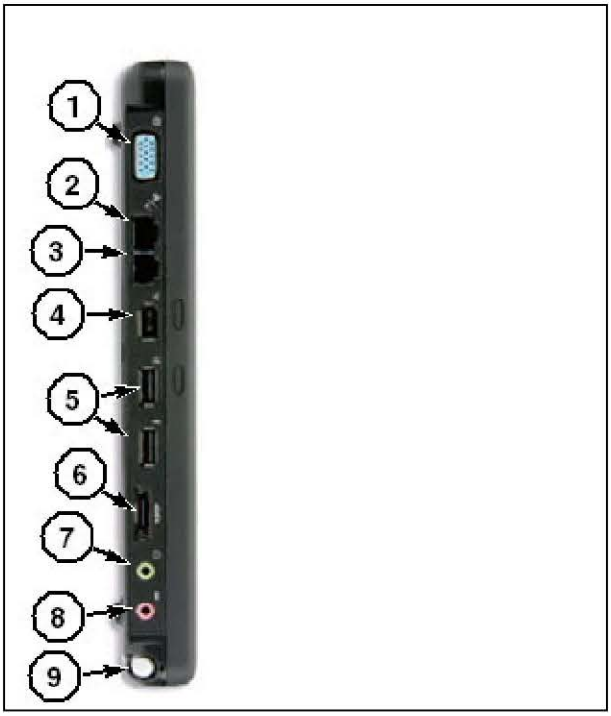


Fig. 652 Left hand side terminal view

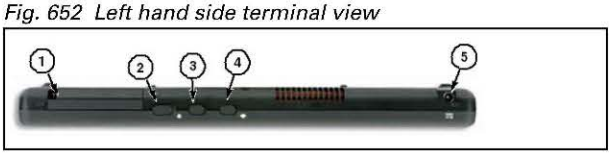


Fig. 653 Top terminal view

2.16 Major maintenance and engine replacement

2.16.1 Prepare a major engine maintenance

Be careful in all work phases. See the instructions of the machine manufacturer on how to remove and install the engine.

Before you start a major engine maintenance:

1. Disconnect the electrical current from the main switch.
2. Clean the machine and the engine.
3. Use the service tool to save all engine logs from the ECU (Electronic Control Unit).
4. Make sure that you have applicable containers for all drained liquids.
5. Make sure that you have necessary lifting devices, support stands and pallets for the engine and the parts of the engine.

During the major engine maintenance:

6. Drain all liquids from the engine.
7. Remove the engine carefully from the machine to prevent damage to the engine or to the machine.

   Remove the necessary parts to remove the engine safely.
8. Do not repair the engine on a lifting device.
9. If possible, remove larger assemblies as an alternative to individual parts.

   There is a risk of leakage, when you open joints.

   NOTE:
   Do a check for the condition of the pipes and hoses during maintenance work. After the installation, make sure that the pipes and hoses do not have a leak. Always replace damaged pipes and hoses.
10. Keep dirt and dust away from the fuel system components.
    a) Put plugs into all open connections.
11. Remove the wiring harnesses carefully.
12. Clean all removed parts and the surfaces of the removed parts before you install them again.

    NOTE: *Replace faulty or worn parts with new ones.*

    NOTE:
    Always replace the engine gaskets, seals and washers when you open joints.
13. Clean the screws, bolts and nuts carefully, if you use them again.

    NOTE: *Replace faulty or worn parts with new ones.*

    NOTE:
    Always replace the engine gaskets, seals and washers when you open joints.

2.16.2 Prepare the long block replacement

Be careful in all work phases. See the instructions of the machine manufacturer, how to remove and install the engine.

Before you start the engine replacement:

1. Disconnect electrical current from the main switch.
2. Clean the machine and the engine.
3. Use the service tool to save all engine logs from the ECU (Electronic Control Unit).
4. Make sure that you have applicable containers for all drained liquids.

5. Make sure that you have necessary lifting devices, support stands and pallets for the engine and the parts of the engine.

During the engine replacement:

6. Remove the engine carefully from the machine to prevent damage to the engine or to the machine.

   Remove the necessary parts to remove the engine safely.

7. Do not repair the engine on a lifting device.

8. If possible, remove larger assemblies as an alternative to individual parts.

   There is a risk of leakage, when you open joints.

   NOTE:
   Do a check for the condition of the pipes and hoses during maintenance work. After the installation, make sure that the pipes and hoses do not have a leak. Always replace damaged pipes and hoses.

9. Keep dirt and dust away from the fuel system components.
   a) Put plugs into all open connections.

10. Remove the wiring harnesses carefully.

11. Clean all removed parts and the surfaces of the removed parts before you install them to the new long block.

    NOTE: *Replace faulty or worn parts with new ones.*

    NOTE:
    Always replace the engine gaskets, seals and washers when you open joints.

12. Clean the screws, bolts and nuts carefully, if you use them again.

    NOTE: *Replace faulty or worn parts with new ones.*

    NOTE:
    Always replace the engine gaskets, seals and washers when you open joints.

2.16.3 How to support the engine in a major maintenance

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

1. Remove all the possible parts before installing the engine to the support stand.

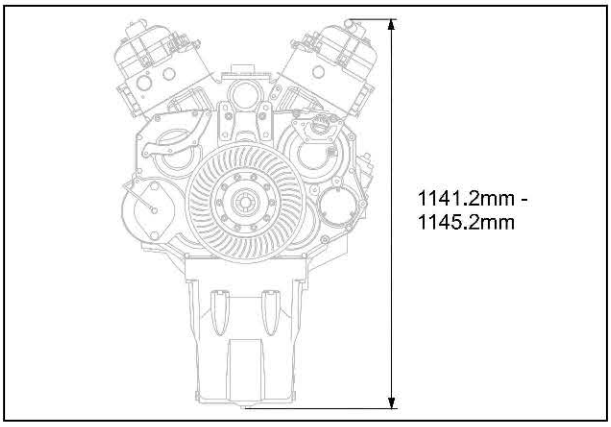


Fig. 654

2. Make sure that the screws of the main bearing caps are available.

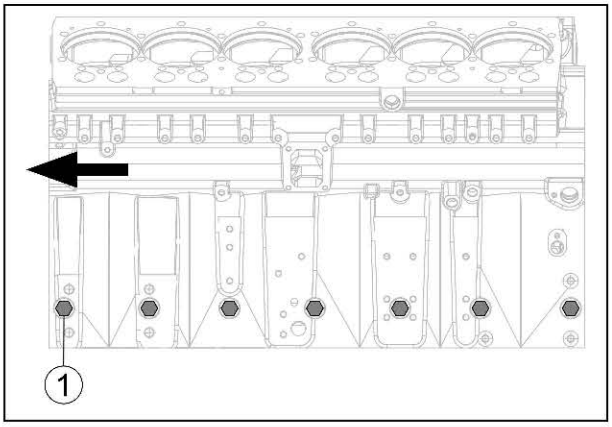


Fig. 655

(1) Screw of the main bearing cap (7 screws on each side)

3. Use a sufficient support stand to do the maintenance work correctly.

NOTE: *Approximate dry weight of the complete engine is* ***1800 kg****.*

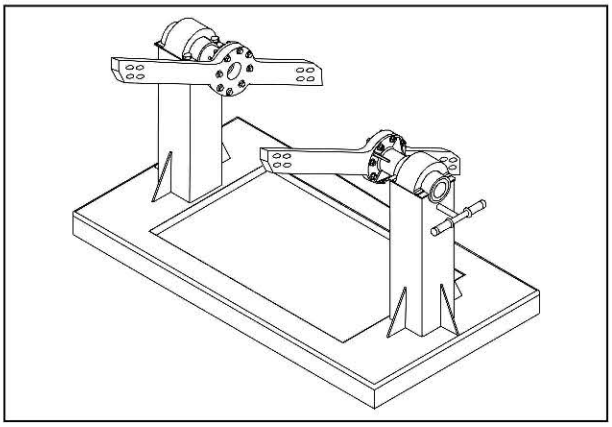


Fig. 656

4. Install the adapter plates of the support stand to the points shown in the figure.

Lengths of the adapter plate bolts

Adapter plate bolt	Minimum length	Maximum length
M16	Thickness of the adapter plate + 20 mm	Thickness of the adapter plate + 25 mm
M12	Thickness of the adapter plate + 15 mm	Thickness of the adapter plate + 20 mm

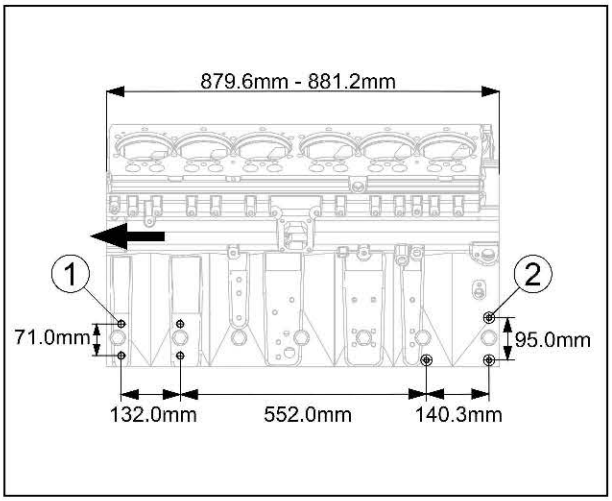


Fig. 657 Left side of the cylinder block

(1) M16 hole x 8 (4 holes on each side)
(2) M12 hole x 6 (3 holes on each side)

5. It is necessary to support the engine from the two sides to prevent the damage for the cylinder block.

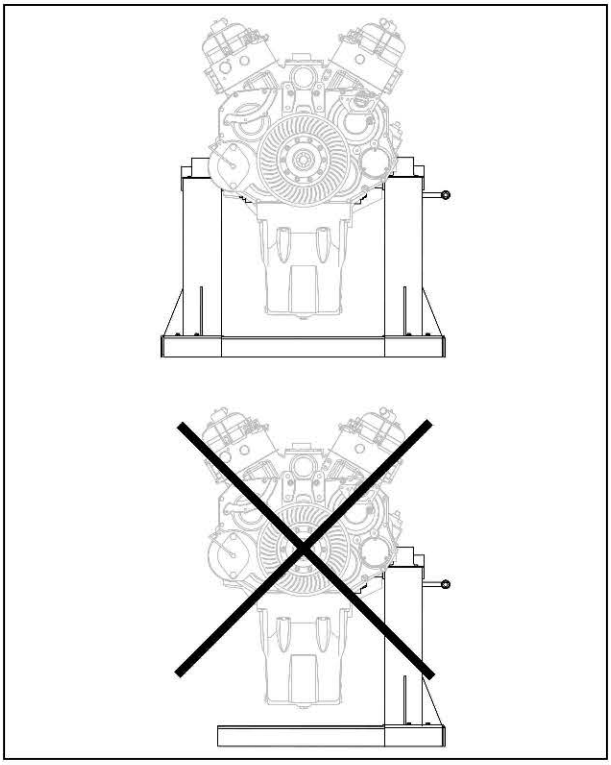


Fig. 658

6. If you do maintenance work for the crank mechanism, you must remove also the parts that follow.

a) Remove the engine mounts from the front end of the engine.

Tightening torque of the engine mounts is 300Nm.

b) Remove the timing gear housing.

c) Remove the flywheel housing with the engine mounts from the rear end of the engine.

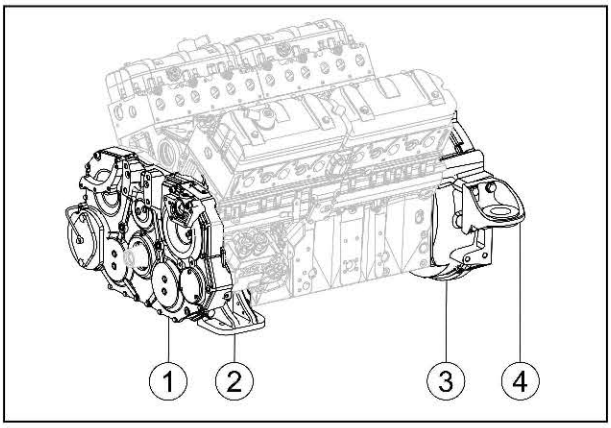


Fig. 659

(1) Timing gear housing
(2) Engine mount of the front end (1 engine mount on each side)
(3) Flywheel housing
(4) Engine mount of the rear end (1 engine mount on each side)

7. Make sure that the support stand is applicable for the dimensions of the engine.

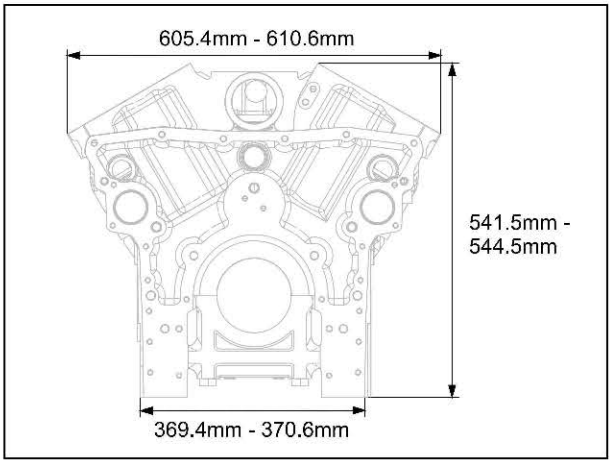


Fig. 660 Front end of the cylinder block

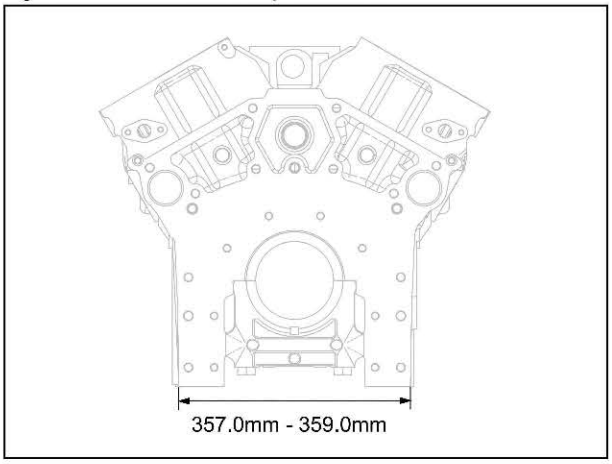


Fig. 661 Rear end of the cylinder block

2.16.4 Remove the parts on top of the long block engine

The 12-cylinder engine has many different parts on top of it. These parts must be removed to replace the long block engine or to do maintenance for the long block. For example, it is necessary to remove these parts before the cylinder head can be touched.

NOTE:
This is a general procedure that gives a sequence of the part removal. If it is necessary, see for more instructions for the steps from the applicable chapter of the workshop manual.

NOTE:
Before the removal of pipes, attach a written label on each of the pipes. Labels make it easier to install the pipes back to the engine.

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

Procedure

1. If possible, remove larger assemblies as an alternative to individual parts.

There is a risk of leakage, when you open joints.

2. Remove the exhaust manifolds.
3. It is not possible to remove all the wiring harnesses at one time. Disconnect part of the wiring harnesses always when it is possible.
4. Remove the air pipe and the throttle valves as one assembly.

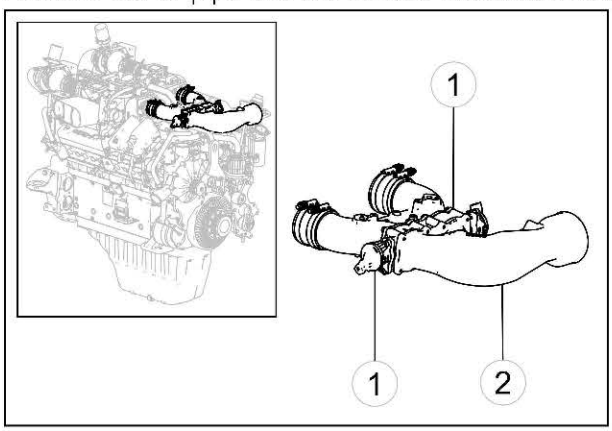


Fig. 662

(1) Throttle valve
(2) Air pipe

5. Remove the cover of the ECU.
6. Remove the machine wiring connector from the cylinder block.

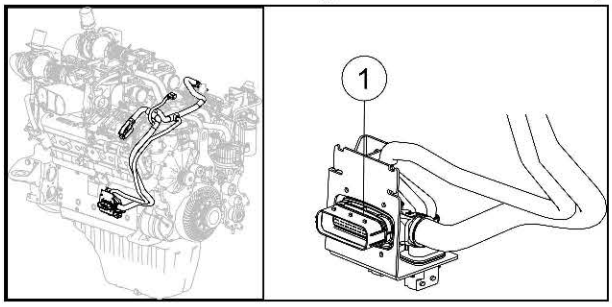


Fig. 663

(1) Machine wiring connector

7. Remove the ECU.
8. Remove the belt tensioner.
9. Remove the fuel filters with the fuel filter bracket.
10. Remove the rear distribution unit.

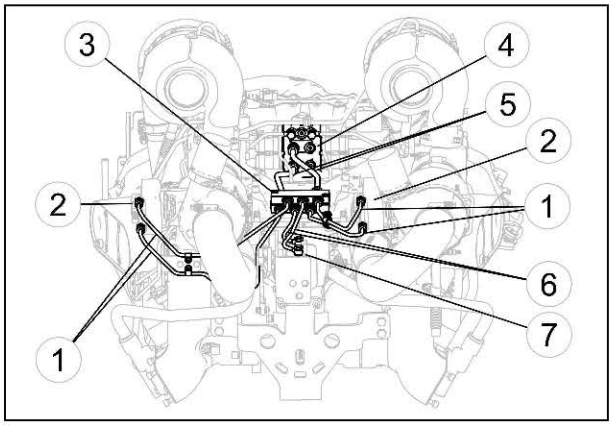


Fig. 664

(1) Coolant pipe for the actuator of the high-pressure turbocharger
(2) Actuator of the high-pressure turbocharger (wastegate actuator)
(3) Rear distribution unit of the coolant
(4) Front distribution unit of the coolant
(5) Coolant pipe between the front distribution unit and the rear distribution unit
(6) Coolant pipe for the EGR actuator
(7) EGR actuator

11. Remove the low-pressure turbochargers with the mounting bracket.

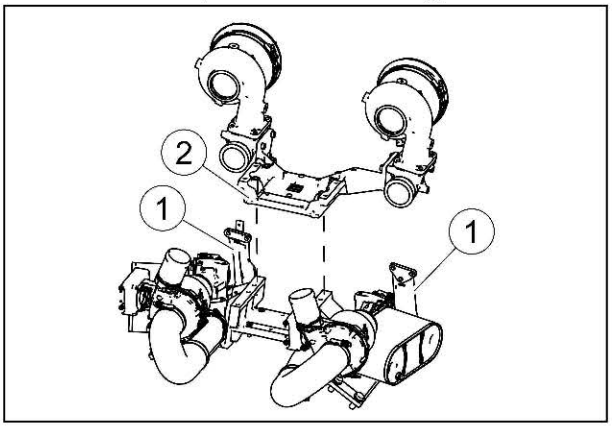


Fig. 665

(1) Vertical support
(2) Mounting bracket

12. Remove the EGR coolers with the air pipes and the high-pressure turbochargers.

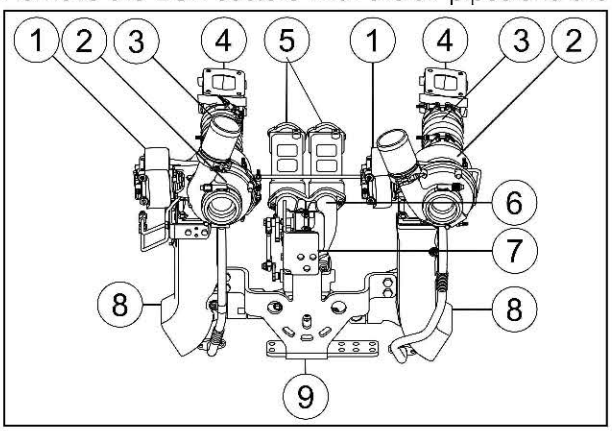


Fig. 666

(1) Actuator of the high-pressure turbocharger
(2) High-pressure turbocharger
(3) Air pipe of the high-pressure turbocharger
(4) Connection flange of the low-pressure turbocharger
(5) EGR coolers
(6) Air pipe of the EGR
(7) EGR actuator
(8) Connection flange of the exhaust manifold
(9) Lifting bracket

13. Remove the ICACs with the mounting bracket.

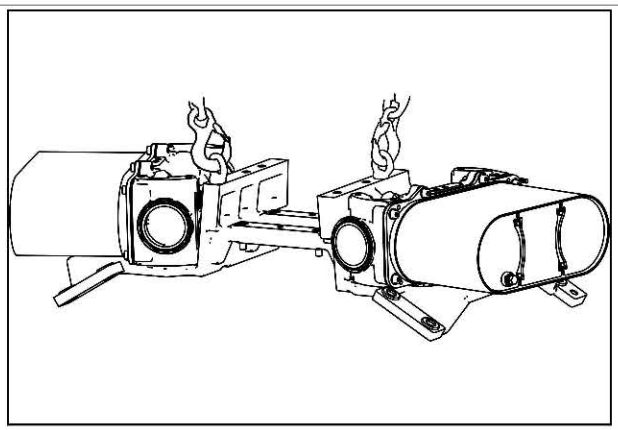


Fig. 667

14. Remove the coolant return pipe.

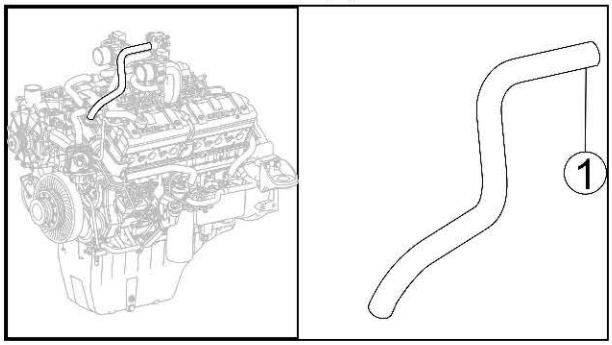


Fig. 668

(1) Coolant return pipe

15. Remove the bracket.

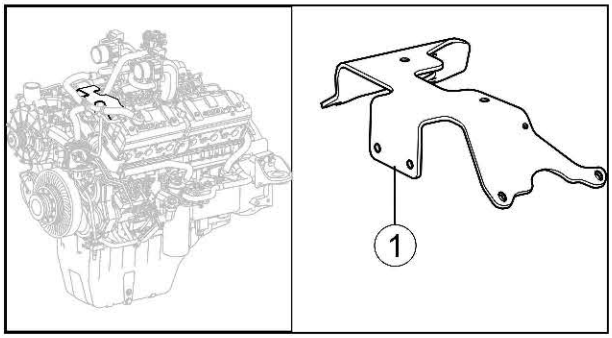


Fig. 669

(1) Bracket

16. Remove the coolant pressure pipe from the front distribution unit.

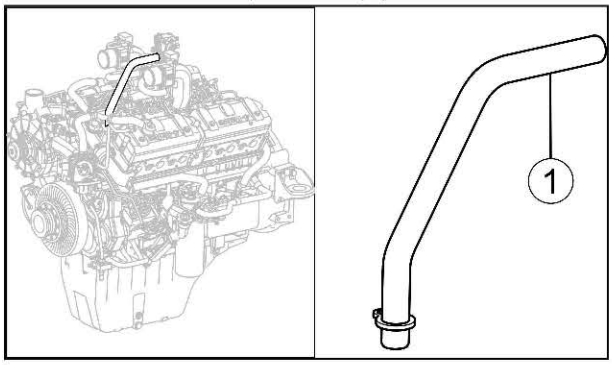


Fig. 670

(1) Coolant pressure pipe

17. Open the fuel pipe connections from the high-pressure pump to the rail.

18. Remove the CCV system (closed crankcase ventilation).

Remove also the CCV hoses from the valve covers.

19. Remove the front distribution unit.

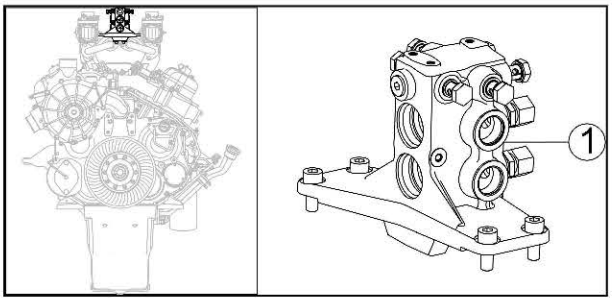


Fig. 671

(1) Front distribution unit of the coolant

20. **WARNING: High pressure fuel during and after engine operation.**

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

Remove the high-pressure pipes from the rail.

21. Remove the return coolant pipe of the oil cooler.

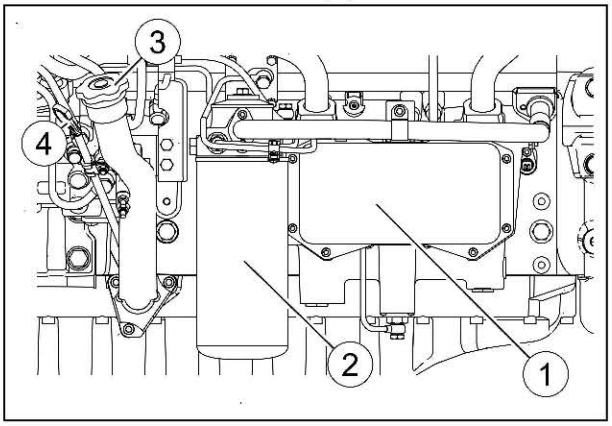


Fig. 672

(1) Oil cooler
(2) Oil filter
(3) Oil filler plug
(4) Oil dipstick

22. Remove the oil filter.

23. Remove the oil cooler.

24. Remove the oil cooler bracket.

25. If you are replacing the long block, remove the oil filler pipe and the dipstick.

26. Remove the coolant pipe between the cylinder block and the coolant pump.

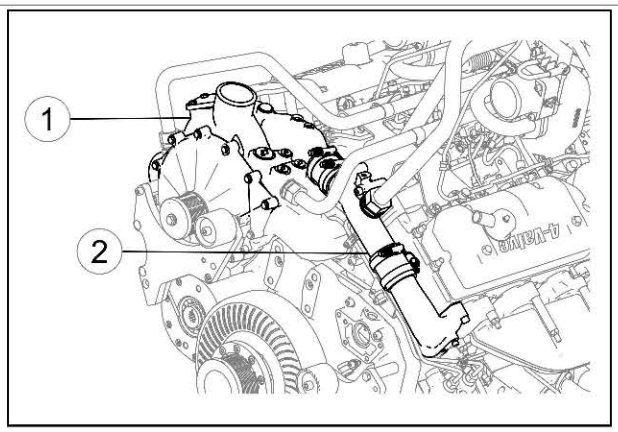


Fig. 673

(1) Coolant pump
(2) Coolant pipe between the cylinder block and the coolant pump

27. Remove the remaining fuel pipes.

28. Remove the coolant pump.

29. Remove the common rails.

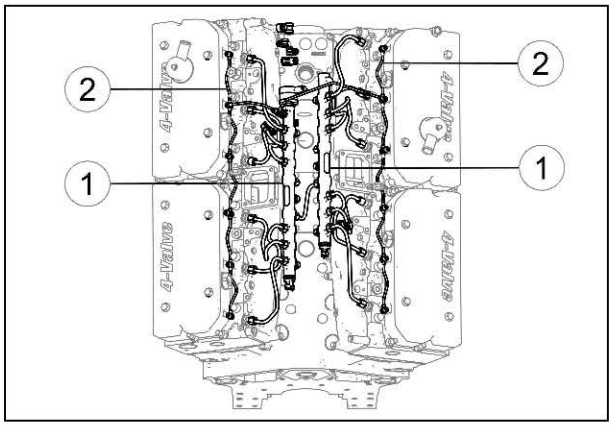


Fig. 674

(1) Common rail
(2) Injector overflow pipe

30. Remove the injector overflow pipes.

31. Remove the bracket.

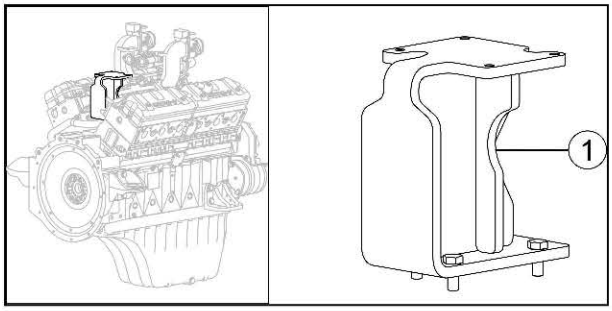


Fig. 675

(1) Bracket

32. Remove the coolant pipes between the distribution unit and the oil cooler.

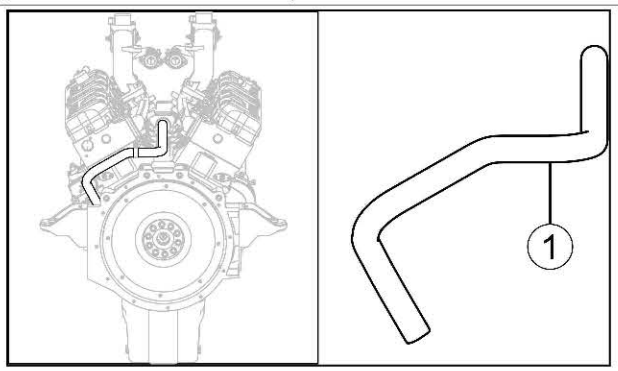


Fig. 676

(1) Coolant pipe

33. Remove the inlet manifolds with the air pipes.

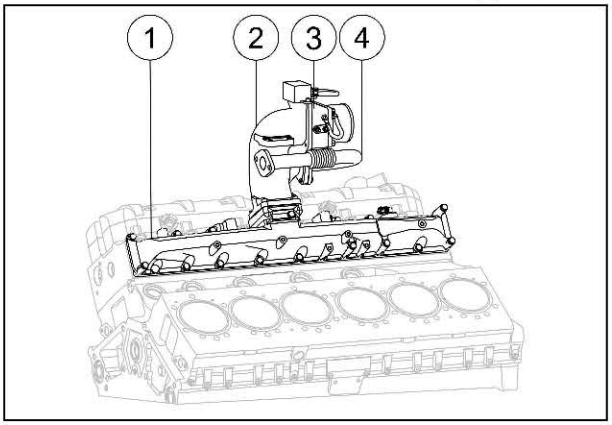


Fig. 677

(1) Inlet manifold
(2) Air pipe
(3) Air-intake heater
(4) EGR pipe

34. If you are replacing the long block, remove the distribution unit cover.

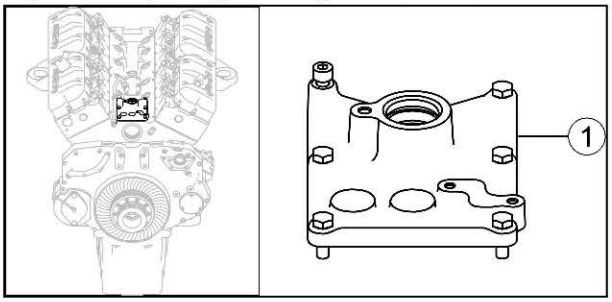


Fig. 678

(1) Distribution unit cover

35. Remove the high-pressure pump.

36. If you are replacing the long block, remove the speed sensor (crankshaft), the speed sensor (camshaft) and the oil pressure sensor from the cylinder block.

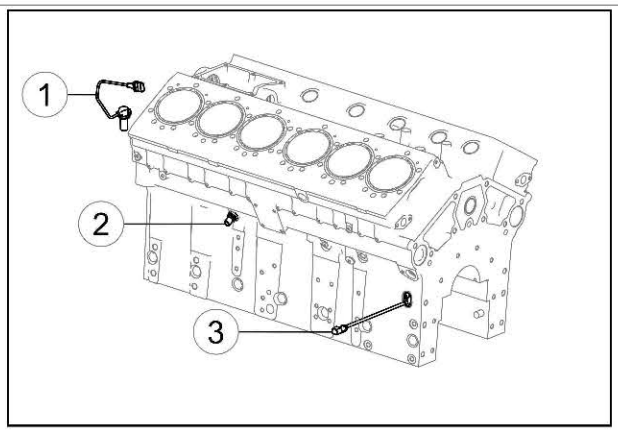


Fig. 679

(1) Speed sensor (camshaft)
(2) Oil pressure sensor
(3) Speed sensor (crankshaft)

37. Remove the starters.

38. Remove the flywheel.

Related Links

Prepare a major engine maintenance page 2-262
How to support the engine in a major maintenance page 2-263
Remove the exhaust manifold page 2-339
Remove the fuel filters with the fuel filter bracket page 2-354
Remove the rear distribution unit of the coolant page 2-336
Remove the low-pressure turbochargers with the mounting bracket page 2-342
Remove the EGR coolers with the air pipes and the high-pressure turbochargers page 2-350
Removing the ICACs with the mounting bracket page 2-348
Removing the oil cooler page 2-329
Remove the inlet manifold page 2-340
Removing the high-pressure pump page 2-361
Remove the flywheel page 2-317

2.16.5 Install the parts on top of the long block engine

The 12-cylinder engine has many different parts on top of it. These parts must be removed to replace the long block engine or to do maintenance for the long block. For example, it is necessary to remove these parts before the cylinder head can be touched.

This is a general procedure that gives a sequence of the part installation. If it is necessary, see for more instructions for the steps from the applicable chapter of the workshop manual.

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Procedure

1. It is not possible to install all the wiring harnesses at one time. Connect part of the wiring harnesses always when it is possible.
2. Install the flywheel.
3. Install the starters.
4. Install the speed sensor (crankshaft), the speed sensor (camshaft) and the oil pressure sensor to the cylinder block, if you have removed them.

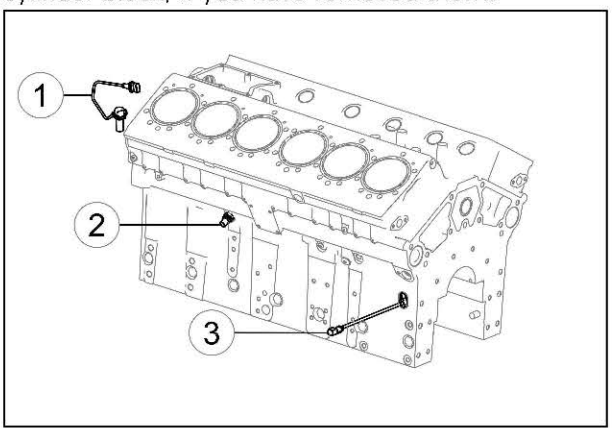


Fig. 680

(1) Speed sensor (camshaft)
(2) Oil pressure sensor
(3) Speed sensor (crankshaft)

5. Install the belt pulley.
6. Install the high-pressure pump.
7. Install the distribution unit cover, if you have removed it.

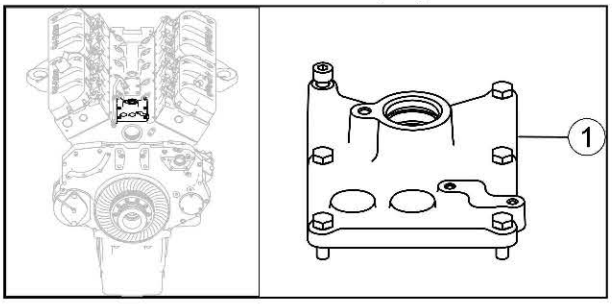


Fig. 681

(1) Distribution unit cover

8. Install the inlet manifolds with the air pipes.

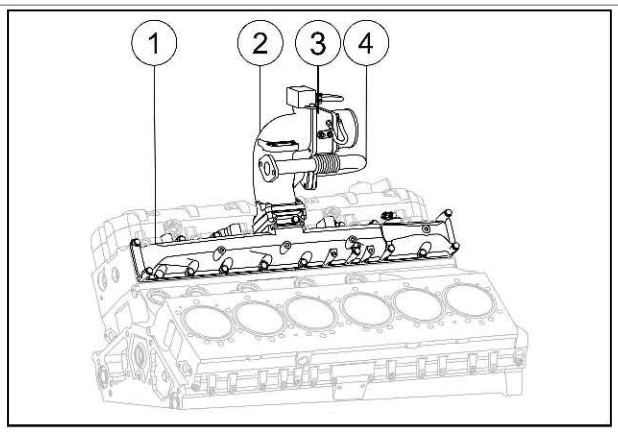


Fig. 682

(1) Inlet manifold
(2) Air pipe
(3) Air-intake heater
(4) EGR pipe

9. Install the coolant pipes between the distribution unit and the oil cooler.

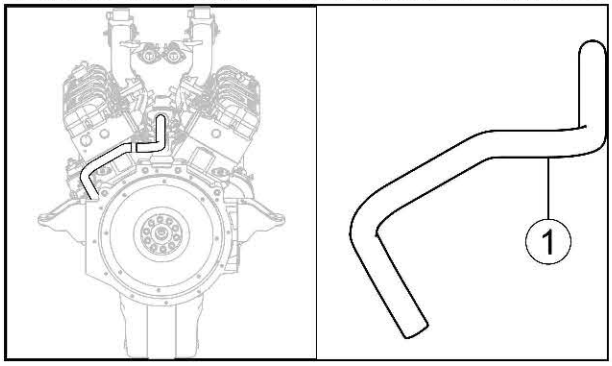


Fig. 683

(1) Coolant pipe

10. Install the bracket.

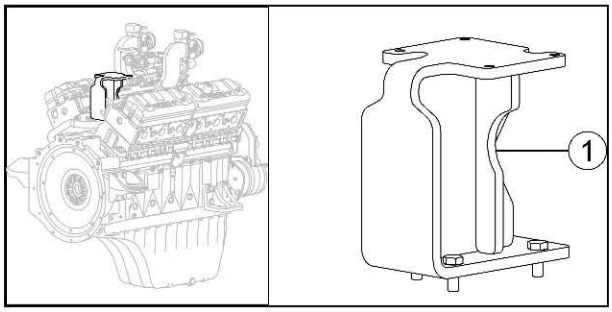


Fig. 684

(1) Bracket

11. Install the injector overflow pipes.

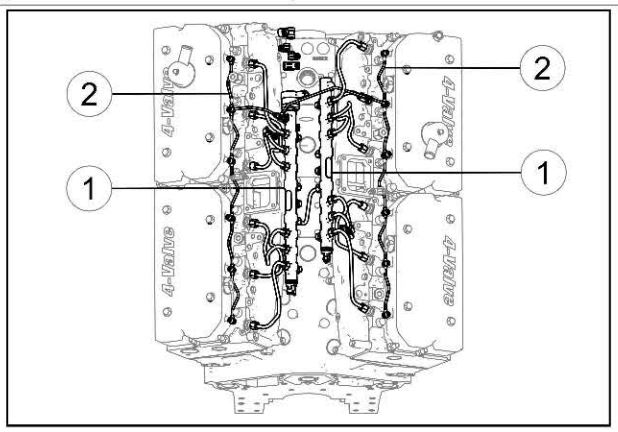


Fig. 685

(1) Common rail
(2) Injector overflow pipe

12. Install the common rails.

13. Install the coolant pump.

14. Install the fuel pipes between the rail and the high-pressure pump.

15. Install the coolant pipe between the cylinder block and the coolant pump.

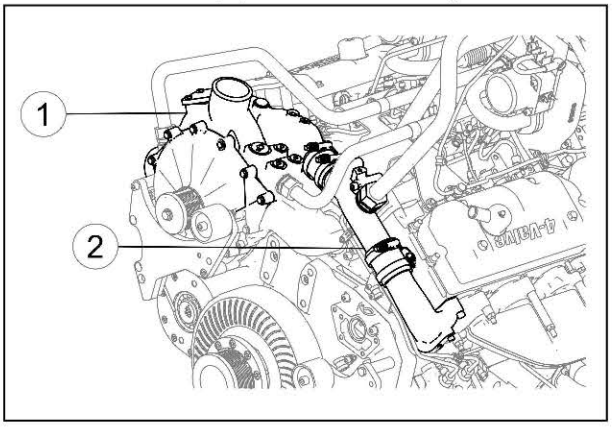


Fig. 686

(1) Coolant pump
(2) Coolant pipe between the cylinder block and the coolant pump

16. Install the oil filler pipe and the dipstick, if you have removed them.

17. Install the oil cooler bracket.

18. Install the oil cooler.

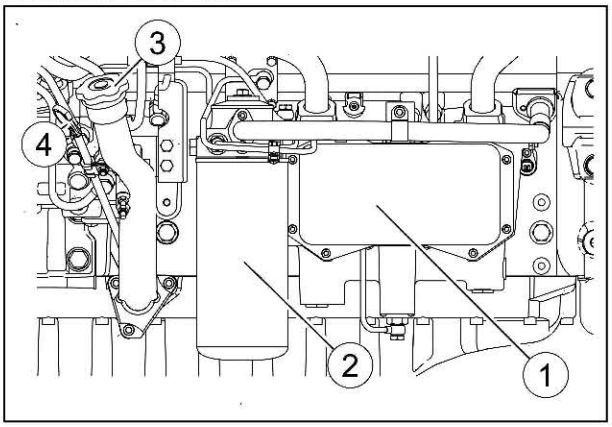


Fig. 687

(1) Oil cooler
(2) Oil filter
(3) Oil filler plug
(4) Oil dipstick

19. Install the oil filter.

20. Install the return coolant pipe of the oil cooler.

21. Install the high-pressure pipes to the rail.

22. Install the front distribution unit.

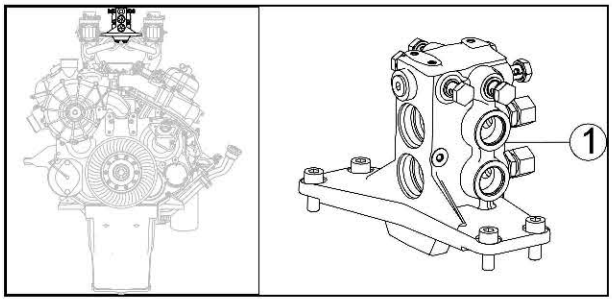


Fig. 688

(1) Front distribution unit of the coolant

23. Install the CCV system (closed crankcase ventilation).

Install also the CCV hoses to the valve covers.

24. Install and tighten the fuel pipe connections from the high-pressure pump to the rail.

25. Install the coolant pressure pipe to the front distribution unit.

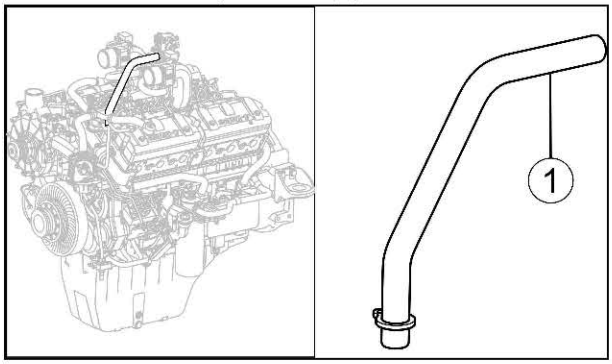


Fig. 689

(1) Coolant pressure pipe

26. Install the bracket.

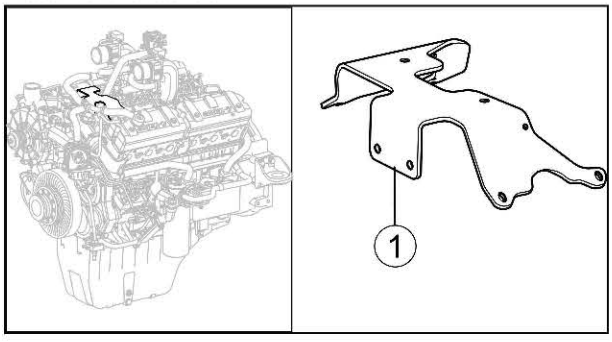


Fig. 690

(1) Bracket

27. Install the coolant return pipe.

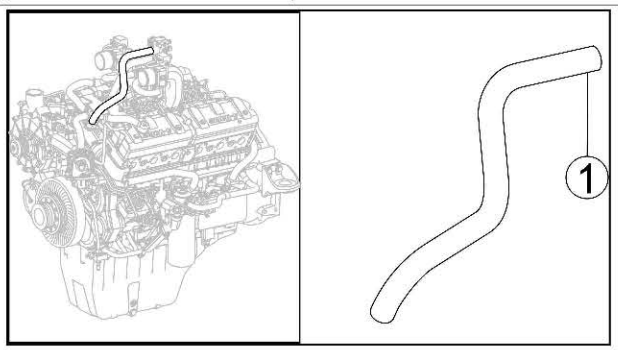


Fig. 691

(1) Coolant return pipe

28. Install the ICACs with the mounting bracket.

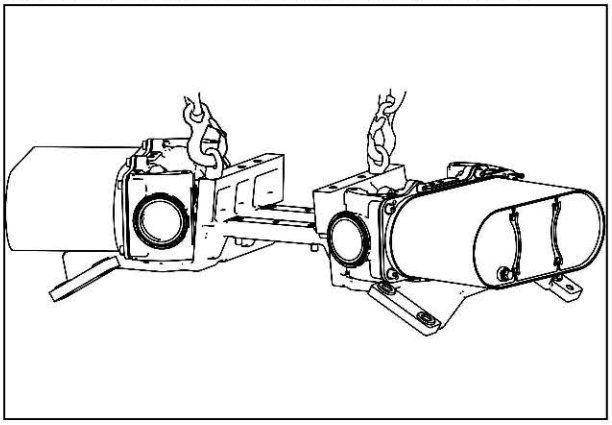


Fig. 692

29. Install the EGR coolers with the air pipes and the high-pressure turbochargers.

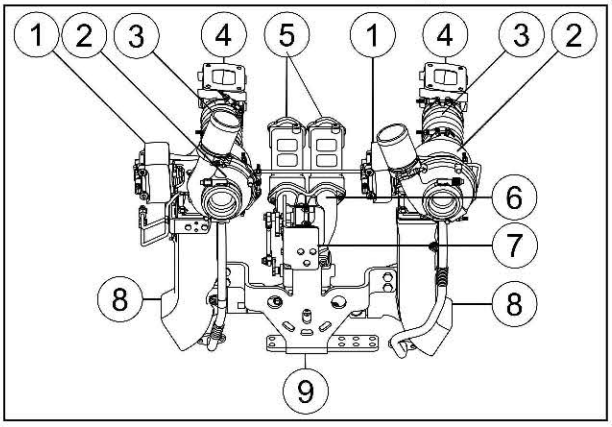


Fig. 693

(1) Actuator of the high-pressure turbocharger
(2) High-pressure turbocharger
(3) Air pipe of the high-pressure turbocharger
(4) Connection flange of the low-pressure turbocharger
(5) EGR coolers
(6) Air pipe of the EGR
(7) EGR actuator
(8) Connection flange of the exhaust manifold
(9) Lifting bracket

30. Install the low-pressure turbochargers with the mounting bracket.

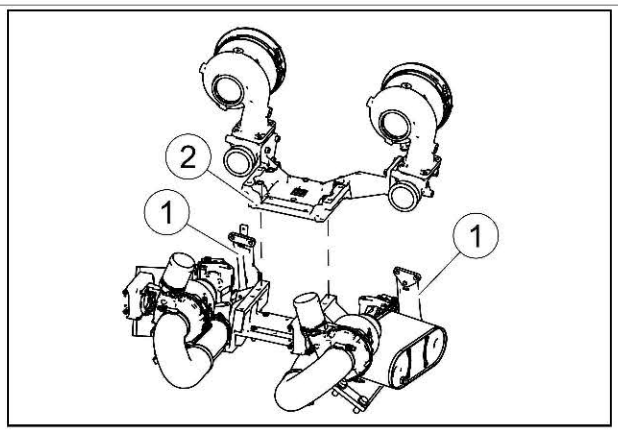


Fig. 694

(1) Vertical support
(2) Mounting bracket

31. Install the rear distribution unit.

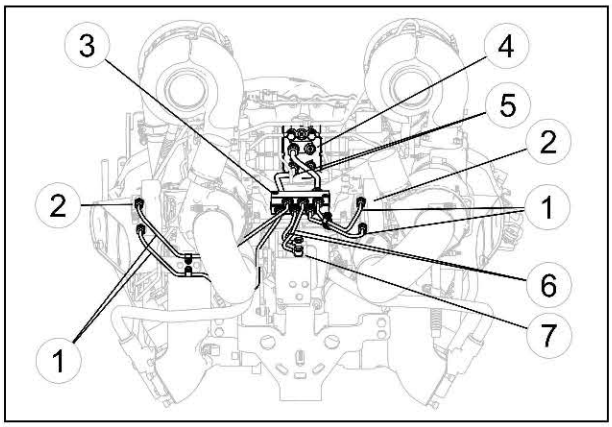


Fig. 695

(1) Coolant pipe for the actuator of the high-pressure turbocharger
(2) Actuator of the high-pressure turbocharger (wastegate actuator)
(3) Rear distribution unit of the coolant
(4) Front distribution unit of the coolant
(5) Coolant pipe between the front distribution unit and the rear distribution unit
(6) Coolant pipe for the EGR actuator
(7) EGR actuator

32. Install the fuel filters with the fuel filter bracket.

33. Install the belt tensioner.

34. Install the ECU.

35. Install the machine wiring connector to the cylinder block.

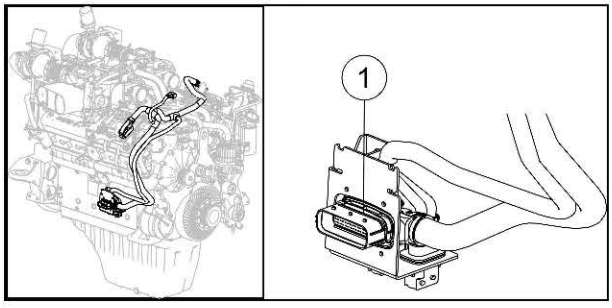


Fig. 696

(1) Machine wiring connector

36. Install the cover of the ECU.

37. Install the air pipe and the throttle valves.

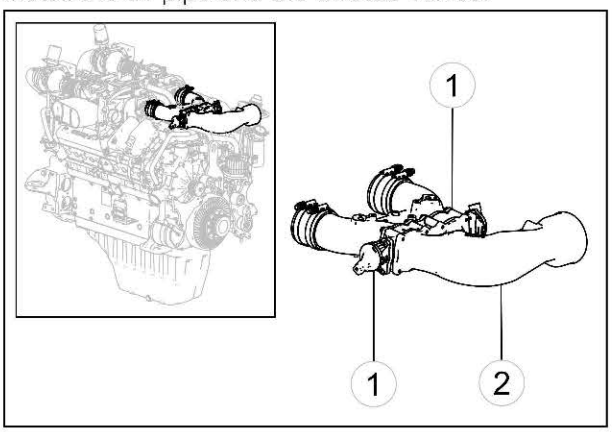


Fig. 697

(1) Throttle valve

(2) Air pipe

38. Install the exhaust manifolds.

39. Install the remaining parts of the wiring harnesses.

Related Links

Fitting flywheel page 2-317
Install the high-pressure pump page 2-362
Install the inlet manifold page 2-340
Fitting the oil cooler page 2-329
Change oil filter page 2-331
Fitting the ICACs with the mounting bracket page 2-349
Install the EGR coolers with the air pipes and the high-pressure turbochargers page 2-351
Install the low-pressure turbochargers with the mounting bracket page 2-343
Install the rear distribution unit of the coolant page 2-337
Install the fuel filters with the fuel filter bracket page 2-355
Install the exhaust manifold page 2-339
Starting the engine after major maintenance page 2-280
Update the engine software page 2-281
Break in the engine page 2-281

2.16.6 Starting the engine after major maintenance

Some parts in the exhaust system can be damaged easily by increased amount of oil and impurities.

Excessive oil can occur after a major engine overhaul, for example when the pistons are lubricated during the assembly.

Procedure

1. Do not connect the exhaust system to the engine, if there can be extra oil or impurities in the engine after any maintenance work or engine overhaul.

2. Run the engine 1-2 minutes on high idle.

Running the engine burns possible extra oil and impurities from the engine.

NOTE: *Excessive amount of oil can damage the catalysts.*

3. Connect the exhaust system to the engine according to the instructions of the machine manufacturer.

2.16.7 Update the engine software

Engine software updates bring new features to the engine controller that improve the performance of the engine, update diagnostic features and help to protect the engine and its emission components over the engine lifetime.

Procedure

1. Use the EDT and examine, if new software is available for the machine.
2. Update the engine software, if possible.

2.16.8 Break in the engine

A dealer or an other service technician does the break in procedure of the 1st phase:

- for a machine that has a new engine.
- for a machine that has a new long block engine.
- for a machine that has a new short block engine.
- for a machine that had an engine overhaul.

A customer does the break in procedure of the 2nd phase:

- for a machine that has a new engine.
- for a machine that has a new long block engine.
- for a machine that has a new short block engine.
- for a machine that had an engine overhaul.

The 1st phase

1. Do not idle (low or high idle) the engine for more than 5 minutes.

   IMPORTANT: *Do not idle the engine, if it is not necessary!*

   Before the break in of the engine, the oil sealing capacity of the piston rings is not perfect. Running the engine at idle speed can cause an oil leakage.

2. Run the engine to a running temperature (more than 75°C).
   a) Change the rpm and the load frequently, but keep the load below the maximum rated power.
3. When the engine is warm, make sure that there are no leaks.
4. If there is a leak:
   a) Stop the break in procedure.
   b) Repair the leak.
   c) Start the break in procedure of the engine from the start.

The 2nd phase

5. For the next 100 operating hours:
   a) Do not idle (low or high idle) the engine for more than 5 minutes.

      IMPORTANT: *Do not idle the engine, if it is not necessary!*

      Before the break in of the engine, the oil sealing capacity of the piston rings is not perfect. Running the engine at idle speed can cause an oil leakage.
   b) You can use the engine as usually. If it is possible, change the rpm and the load frequently.

Daily operation of the machine

6. Do not idle the engine for more than 15 minutes in general.

   IMPORTANT: *Do not idle the engine, if it is not necessary!*

   In general, running the engine at idle speed is not recommended. At idle speed the piston rings do not operate optimally, because of the low cylinder pressure.

2.17 Cylinder block

2.17.1 Measure the cylinder liner wear

Procedure

1. Using a micrometer, set the dial gauge to zero using a new cylinder liner to indicate the initial dimension of the bore.
2. Clean the inner surface of the cylinder liner fully before measurement.
3. Do the measurement crosswise at the top end, lower end and middle of the cylinder liner.
4. Read the gauge for maximum wear and ovalness (compare with rated).

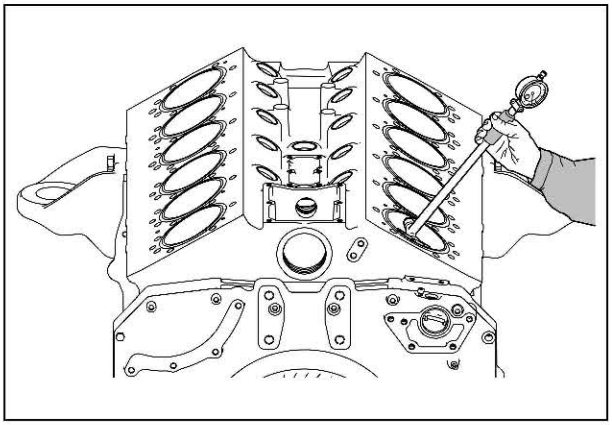


Fig. 698

Related Links

Cylinder liners page 2-231

2.17.2 Remove the cylinder liner

Procedure

1. Mark the cylinder liners, if you use the cylinder liners again.

   The cylinder liners must be fitted in the same position.
2. Remove the cylinder liners with the cylinder liner puller.

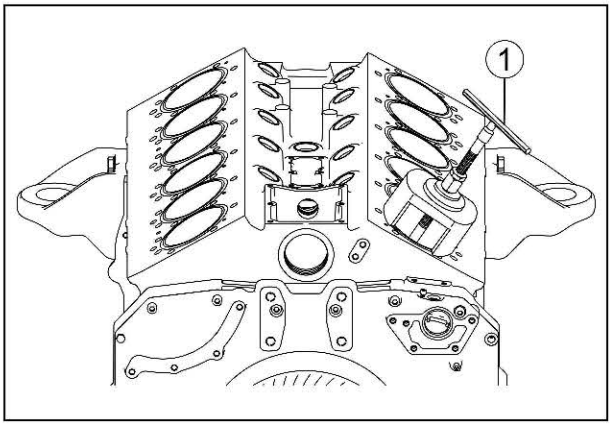


Fig. 699
(1) Cylinder liner puller V910451500

2.17.3 Do a check for the cylinder block

Procedure

1. Clean the cylinder block and all oil galleries.
2. Do a check for the coolant channels.
   a) Remove the scale and sediment to make sure the coolant flow.
3. Make sure that the cup plugs and the thread plugs in the cylinder block are tight.
4. Do a check for the condition of the cylinder block and all the sealing surfaces.
5. Measure the wear of the camshaft bearing points (compare with rated).
6. If it is necessary, machine the top face of the cylinder block.

a) Shorten the pistons by the same dimension.
b) Make sure that the height of the cylinder block is in tolerance.
c) Monitor the valve disc spaces on the piston top face.

2.17.4 Replace the camshaft bushing

All camshaft bearing points are supplied with a separate bearing bushing.

Procedure

1. Remove the camshaft rear end plug.
2. Tap the bushings out with a long drift.

   Look for the different outer diameters when removing.

Hole	Hole diameter (right side)	Hole diameter (left side)
1	55.62 - 55.65 mm	55.62 - 55.65 mm
2	55.42 - 55.45 mm	55.42 - 55.45 mm
3	55.20 - 55.23 mm	55.20 - 55.23 mm
4	55.42 - 55.45 mm	55.20 - 55.23 mm
5	55.64 - 55.67 mm	55.64 - 55.67 mm

Hole diameters for the bushings. Numbers starts from the front end of the engine.

3. Clean the bushing locations carefully.

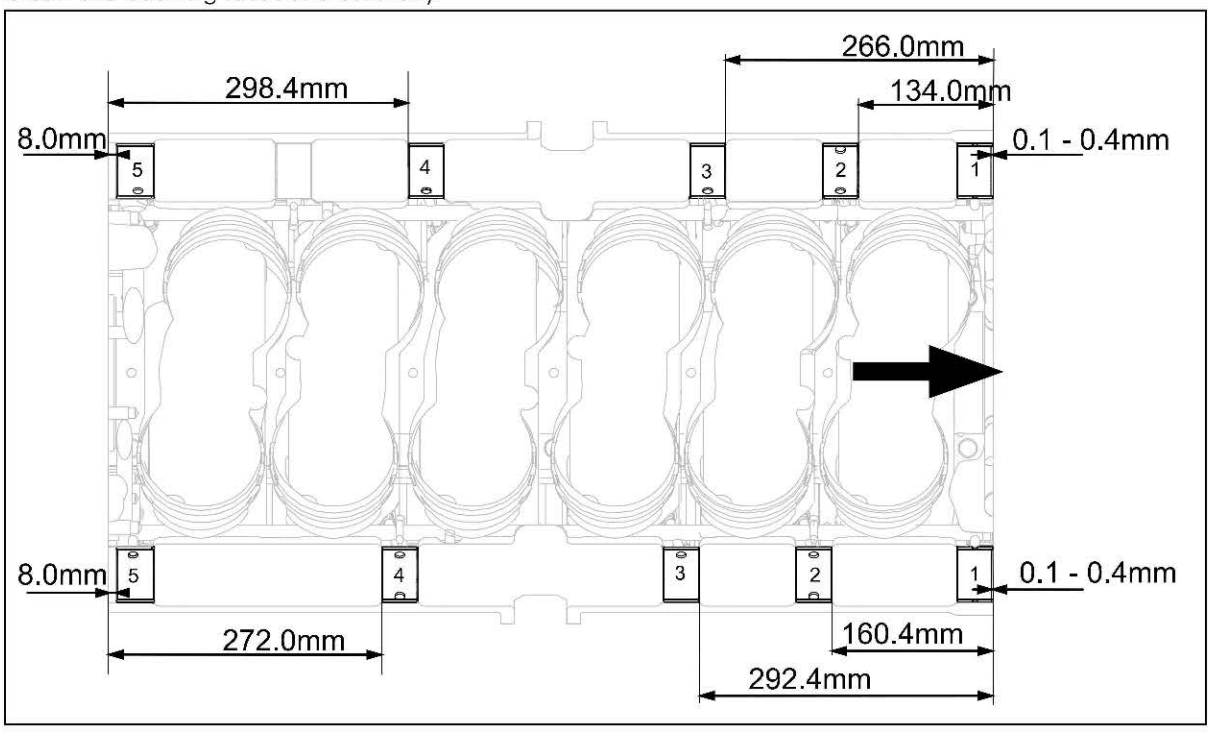


Fig. 700

4. Press in new bushings (2 - 5).
   a) Look for the different outer diameters.

      NOTE: *The position of the oil hole.*
   b) Make sure that the oil hole of the bushings is at a 68° angle from the horizontal orientation of the cylinder bank.

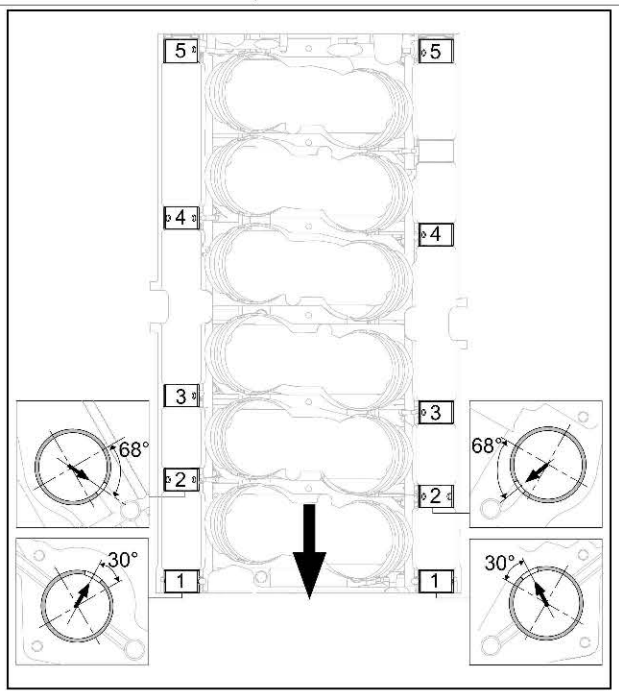


Fig. 701

c) It is not necessary to ream the bushing, because the bushing has a correct inner diameter when you install the bushing in its position.

5. Install the camshaft front end bushing (1).

NOTE: *The camshaft front end bushing (1) has the oil groove on the outer side.*

a) Make sure that the oil hole of the bushing is at a 30° angle from the horizontal orientation of the cylinder bank.

b) It is not necessary to ream the bushing, because the bushing has a correct inner diameter when you install the bushing in its position.

2.17.5 Fitting plug at camshaft rear end

Procedure

1. Clean the seat for the plug.

2. Apply sealing compound (Loctite 638 or similar) to the contact surface of the plug.

3. Drive in the plug with fitting drift V902587400.

NOTE: *Do not drive in the plug too far because it will affect the camshaft end float.*

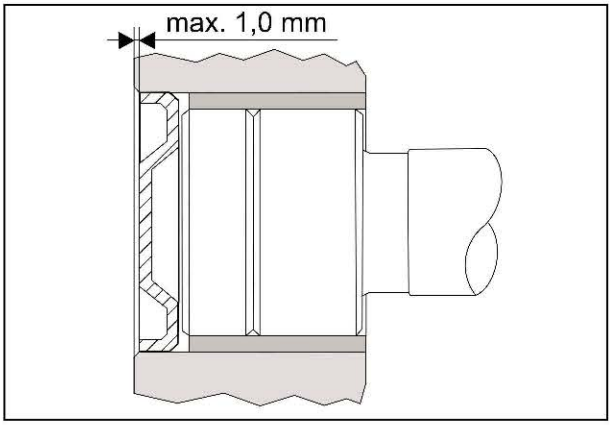


Fig. 702

2.17.6 Install the cylinder liner

Procedure

1. Clean the cylinder liner and the recess of the cylinder liner in the cylinder block.

Without O-rings, the cylinder liner rotates easily in the recess of the cylinder liner.

2. Do a check for the condition of the recess of the cylinder liner and the cylinder liner height.
a) Apply a thin layer of marking paint on the underside of the cylinder liner flange.
b) Install the cylinder liner without O-rings and turn the cylinder liner forward and backward.
c) Lift out the cylinder liner.
d) Make sure that the paint has spread evenly on the whole contact surface.

3. Use a milling cutter, if the recess of the cylinder liner is damaged or the cylinder liner height needs to be adjusted.

NOTE: *If you mill the bottom surface of the cylinder liner recess too much, the cylinder block is useless.*

a) Install the milling cutter to the cylinder liner location.
b) Make sure that the milling cutter stays in its position.
c) Adjust the blade of the milling cutter until it barely touches the bottom surface of the cylinder liner recess.
d) Rotate the lever of the milling cutter carefully one round.
e) Remove the milling cutter.
f) Make sure that the blade mills the surface of the cylinder liner recess fully and the surface is smooth.
g) Use the cylinder liner to make sure that the height is sufficient.
h) If it is necessary, do the same procedure again.
i) Mill the other cylinder liner locations with the same adjustments.

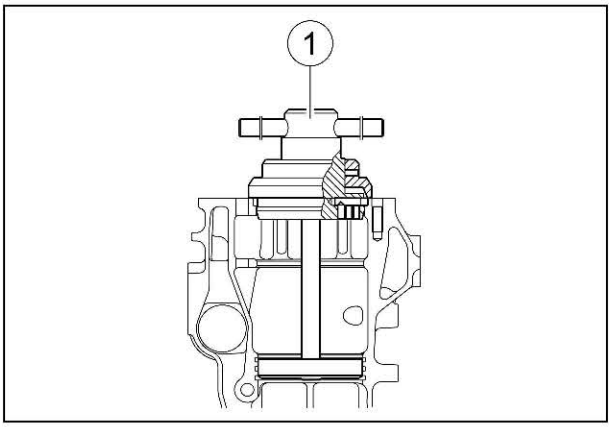


Fig. 703
(1) Milling cutter V910452000

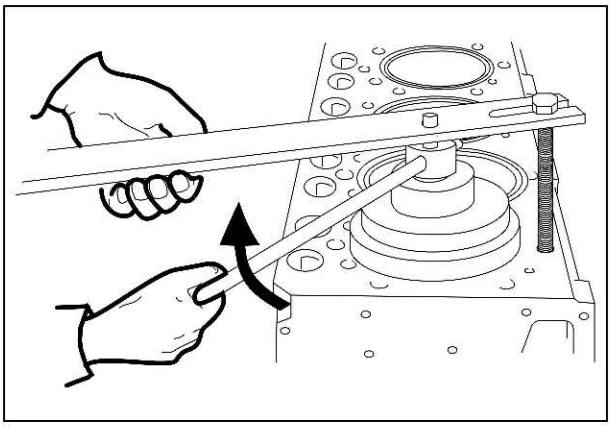


Fig. 704

4. If it is necessary, do light lapping after milling with the help of the cylinder liner.
a) Apply lapping paste to the under side of the cylinder liner flange.
b) Twist the cylinder liner with twisting tool.

Lapping is not correct procedure for adjusting the cylinder liner height.

5. Clean the contact surfaces.

6. Install the cylinder liners for measuring.
a) Press the cylinder liners into the cylinder block.
b) Install each cylinder liner with two press tools.

7. Measure the cylinder liner height with a dial gauge and holder.

a) Zero the dial gauge against a flat surface, for example, the cylinder block face.

b) Measure each cylinder liner in four locations.

- The height of the cylinder liner above the cylinder block face can be 0.03 - 0.08 mm.
- The height difference between cylinder liners under the same cylinder head must not be more than 0.02 mm.
- An intermediate cylinder liner must not be lower than an outer one.

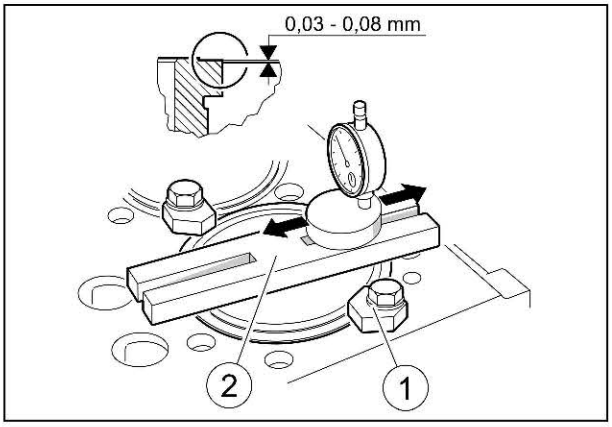


Fig. 705

(1) Press tools V910166300
(2) Dial gauge and holder V902579200

8. Install a cylinder liner with a higher flange, if the cylinder liner height is too low.

168 engines

H	Marking grooves pcs	Order number
9.03+0.02	- (std.)	V836867048
9.08+0.02	1	V836867050
9.13+0.02	2	V836867051
9.23+0.02	3	V836867052

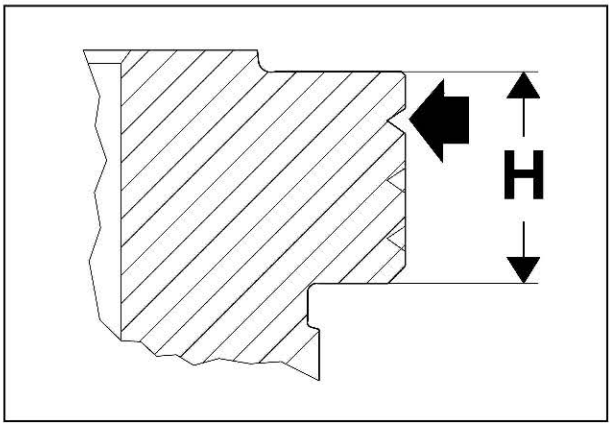


Fig. 706

Cylinder liners with oversize flanges (higher flanges) have grooves as a mark on the outer circumference as follows:

- 1st oversize, 0.05 mm = 1 groove
- 2nd oversize, 0.10 mm = 2 grooves
- 3rd oversize, 0.20 mm = 3 grooves

9. Use milling cutter V910452000 to adjust recess depth.

10. Do a check for the cylinder liner flange and the recess depth of the cylinder block, if the cylinder liner height is not the same all the way round.

11. Replace the cylinder liner, if the cylinder liner flange has a fault.

12. Install the O-rings.

a) Install the O-rings into the grooves in the cylinder block.

b) Install the green O-ring (A) into the bottom groove.

c) Lubricate the O-rings with a liquid soap (not with engine oil).

NOTE: *Do not strech the O-rings too much while installing. Maximum permitted stretch is 6%.*

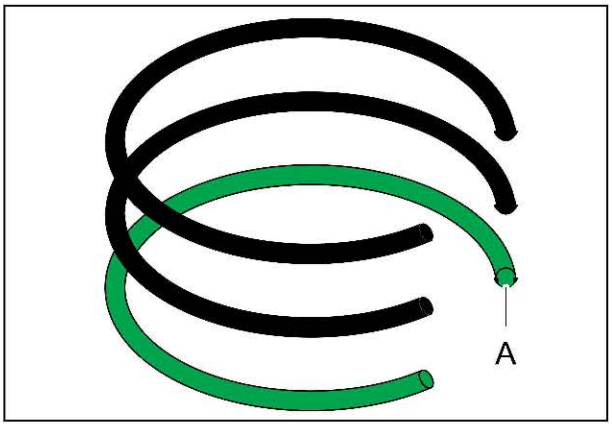


Fig. 707

13. Press the cylinder liners into the cylinder block.

You can press the cylinder liners to the position by hands. If not:

- do a check for the O-rings,
- make sure that the lubrication of the O-rings is sufficient,
- do a check for the contact surface in the cylinder block.

14. Make sure that the cylinder liners do not rise up after the installation.

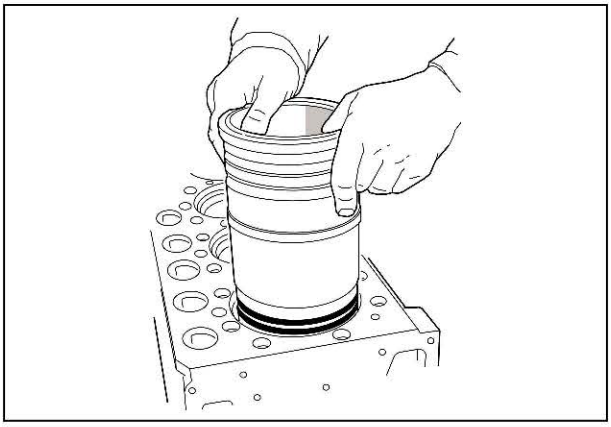


Fig. 708

2.18 Flywheel housing

2.18.1 Remove the flywheel housing

Procedure

1. Attach the flywheel housing to a lifting device.
2. Remove the fixing bolts of the flywheel housing.
3. Remove the flywheel housing.
4. Remove the 2 tension pins from the cylinder block.

   NOTE: *Always remove the 2 tension pins when you remove the flywheel housing.*
5. Remove the old crankshaft rear oil seal.

2.18.2 Install the flywheel housing

The flywheel housing is centered on the cylinder block by two tension pins. Also replacement part flywheel housings have ready-made holes for the pins.

Procedure

1. Clean the sealing surfaces between the cylinder block and the flywheel housing.
2. Apply silicone sealant Loctite 5970 as shown in the figure.
3. Lift the flywheel housing into position and put all the bolts in position.
4. Center the housing with centering tool.

   NOTE: *This is important for engines with a turbine clutch.*
5. Install the tension pins with drift V902598700.
6. Apply thread sealant Loctite 572 to the fixing bolts reaching oil or water spaces.
7. Tighten the fixing bolts to the correct torque value.

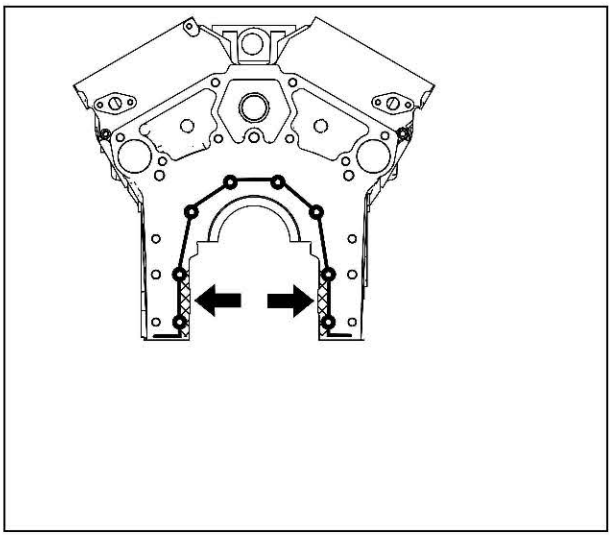


Fig. 709

Flywheel housing screw	Tightening torque
M12	150 Nm
M14	200 Nm

2.18.3 Changing crankshaft rear oil seal

Procedure

1. Lift out the engine.
2. Remove the clutch assembly (and if applicable the turbine clutch).
3. Remove the flywheel.
4. Remove the oil seal.

   Do not damage the crankshaft.

5. Clean the seal location and grind off any burrs.

6. Fit the seal.
a) Fit the seal dry, not oiled.
b) Put the seal carefully on the shaft.
Make sure that the sealing lip is not damaged.
c) Hit the seal into position with the fitting tool.

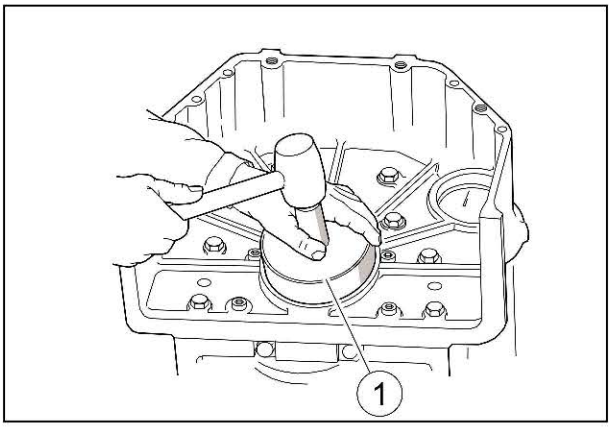


Fig. 710
(1) Fitting tool V920215670

2.19 Cylinder head

2.19.1 Remove the cylinder heads

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

Procedure

1. Remove the valve covers.
2. Disconnect the wires of the injectors.
3. **WARNING: High pressure fuel during and after engine operation.**

   If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

   Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

   Remove the injectors and install protection caps on all open connections.
4. Remove the rocker arm mechanism and the push rods.
5. Loosen all the cylinder head bolts first by a 1/4 turn, then loosen them fully and remove.
6. Remove the cylinder heads.

Related Links

Prepare a major engine maintenance page 2-262
Remove the parts on top of the long block engine page 2-266
Remove the injectors (CRIN3) page 2-357

2.19.2 Removing valves

Procedure

1. Ensure that the valves to be re-used are marked, so that they can be re-fitted in their original locations.
2. Compress the valve springs with standard valve spring press.
3. Remove the valve cotters, spring guide and spring.
4. Remove the valve stem seals and remove the valves.

2.19.3 Do a check for the cylinder head

Procedure

1. Remove the soot from the exhaust ports.
2. Clean the sealing surfaces.
3. Clean the cylinder head.

4. Do a check for cracks and other damage.

5. Do a check that the cylinder head is flat against a straight edge.

- An uneven or warped surface need to be surface ground.
- The height of the cylinder head, after grinding, can not be less than 109.50 mm.
- The valve disc depth from the cylinder head surface must be 0.60 mm for the exhaust valves and 0.80 mm for the inlet valves.

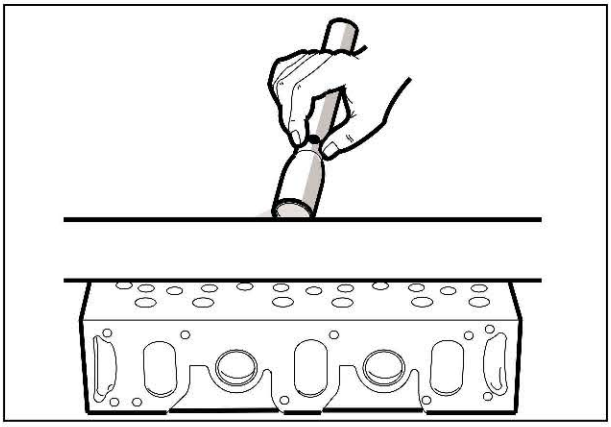


Fig. 711

6. Straighten and clean the injector location seat in the cylinder head with cutter V912085400.

7. Do a check that the location for the side feed pipe is clean, especially the grooves for the guide balls.

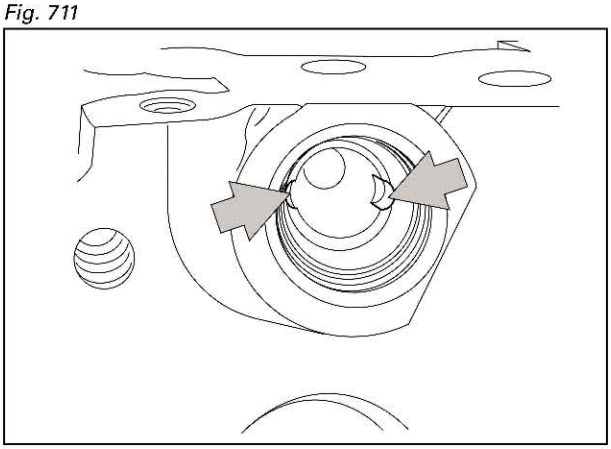


Fig. 712

8. Measure the clearance between the valve stem and the valve guide with a dial gauge.

a) Lift the valve so that the valve head is 15 mm from the face of the cylinder head, and measure the clearance.

The clearance must not be greater than 0.30 mm for the inlet valves and 0.35 mm for the exhaust valves.

b) Use a new valve when measuring, in order to find out the valve guide wear.

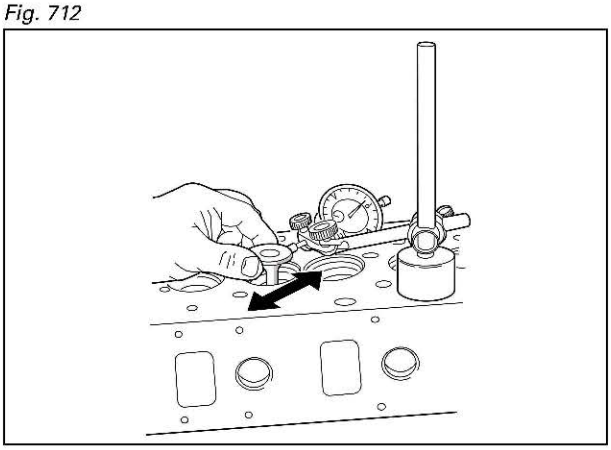


Fig. 713

2.19.4 Replace the valve guides

Procedure

1. Press or knock out the old valve guides using drift V912085300.
2. Clean the valve guide locations.

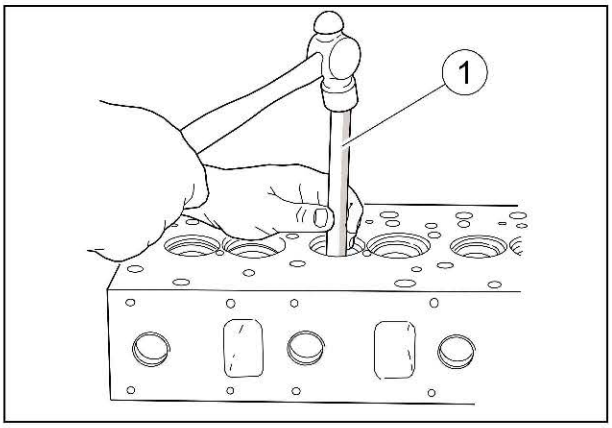


Fig. 714
(1) Drift V912085300

3. Lubricate the outside of the new valve guides.
4. Fit the valve guides using drift V912085000.

   The drift makes sure the correct fitting height (13 mm over the spring face).

   The valve guides are the same for the inlet and exhaust valves.
5. Make sure that the sharp chamfer on the guide faces the valve head.
6. Check that the valves are moving freely in the guides.

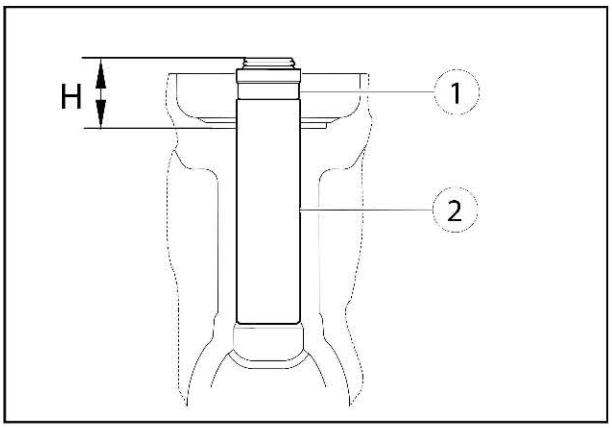


Fig. 715
(1) Valve stem gasket
(2) Valve guide
(H) 13 mm

2.19.5 Machine the valve seat

Procedure

1. Machine the damaged valve seat with milling cutter kit V8370 62635.
2. If the width of the seat exceeds 2.0 mm in the exhaust and 2.2 mm in the intake, it should be reduced primarily at the outer edge. The valve seat angle is 45°+20' for the exhaust valve and 35° +20' for the inlet valve.

2.19.6 Replace the valve seat rings

All valves are fitted with separate valve seat rings. If the sealing surface is damaged so badly that it cannot be repaired with machining, the seat ring must be changed.

Procedure

1. Grind the valve head on a discarded valve so that it sits down in the valve seat ring.
2. Fit the valve and weld the valve in position in the valve seat ring.

3. Cool with water.
4. Turn the cylinder head over and knock out the valve and valve seat ring.
5. Clean the valve seat ring location.
6. Cool the new valve seat ring in liquid nitrogen until it stops bubbling, or alternatively put it in dry ice.
7. Fit the valve seat ring with a drift. Machine the seat surface.

   NOTE: *Where necessary, standard size seats can be replaced by inserts with a larger outer diameter.*

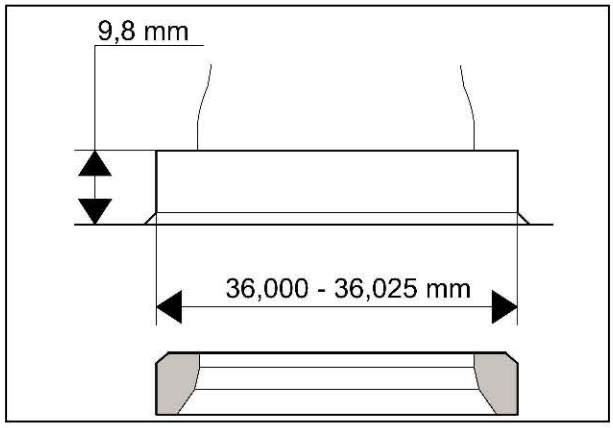


Fig. 716 Exhaust

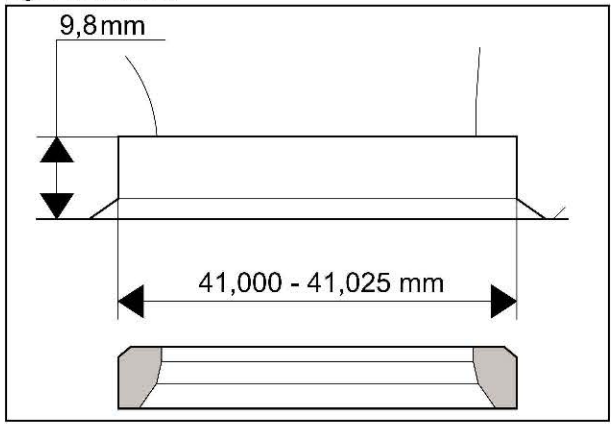


Fig. 717 Inlet

2.19.7 Grinding valves

In order to make sure that there is a proper seal around the valves, there is a difference in the sealing surface angles. There is there fore a very narrow sealing surface which seals good even after extended running.

	A	B	C (mm)
Inlet	35°-20'	35°+20'	0.8±0.05 (max. 2.20)
Exhaust	45°-20'	45°+20'	0.6±0.05 (max. 2.20)

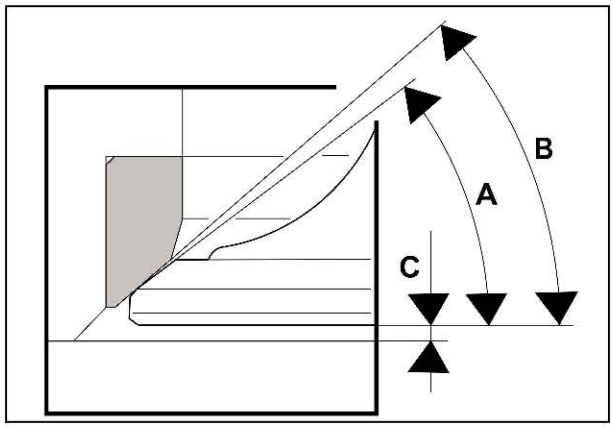


Fig. 718

Procedure

1. Grind the damaged valve disc with a valve refacer.

   Adjust angles to 45°±20' for exhaust valves and 35°±20' for inlet valves.
2. The valve must be discarded, if the edge of the valve head is less than 1.5 mm after it has been ground, or if the valve stem is bent.
3. Grind the end of the valve stem, if necessary.
4. Lap the valves with lapping paste.

5. Check the contact surface with marking paint.
6. Clean the cylinder head and valves of any remaining lapping paste.

2.19.8 Fitting valves

Procedure

1. Check the valve springs for straightness, length and tension using a spring tester.
2. Lubricate the valve stems.
3. Fit the valves in the correct order in the cylinder head.
4. Fit the valve stem seals.
5. Fit the springs, spring guides and valve cotters with the aid of a valve spring press.
6. Tap the end of the valve stems lightly after fitting the valve in order to make sure that the valve stems are secure.

2.19.9 Install the cylinder head

Procedure

1. Measure the length of the cylinder head bolts.
   a) Compare with the correct dimensions.
   b) Change any bolts that are too long.
2. Install the valve tappets if removed.
3. Make sure that the sealing surfaces are clean.
4. Install the cylinder head gaskets and the cylinder heads.
5. Make sure that cylinder heads are parallel.

   The exhaust manifolds can become damaged if the heads are not parallel.
6. Clean and lubricate the cylinder head bolts.
7. Fit the cylinder head bolts.

   See the correct tightening order of the cylinder head bolts.

   The tightening order is not marked on the cylinder heads.

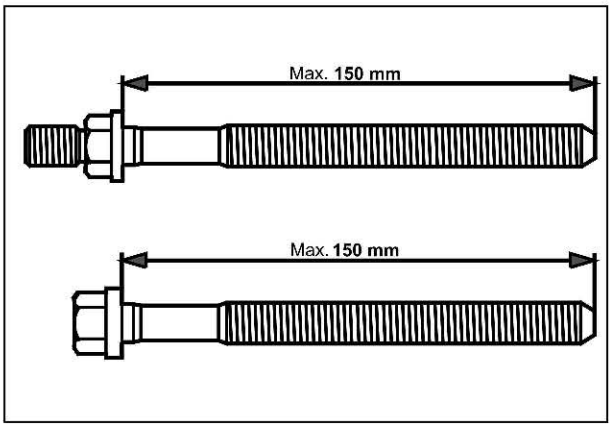


Fig. 719

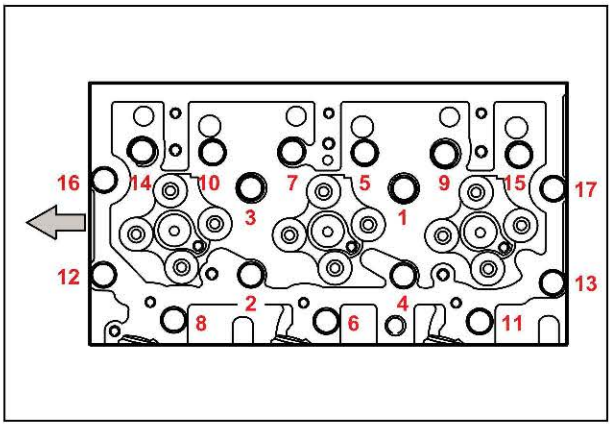


Fig. 720

8. Tighten the cylinder head bolts increasing:
   a) First tighten to 80 Nm.
   b) Tighten by 90°.
   c) Tighten again by 90°.

9. **NOTE:** *After this the cylinder head does not need retightening.*

   Adjust the valve clearances.

Related Links

Cylinder head page 2-232
Install the injectors (CRIN3) page 2-359
Install the parts on top of the long block engine page 2-273

2.20 Valve mechanism

2.20.1 Recondition the valve mechanism

Procedure

1. Examine the hydraulic lash adjusters, specially the contact surface against the camshaft.

   NOTE: *The quantity of oil in a hydraulic lash adjuster changes the stiffness of the hydraulic lash adjuster. Some of the unassembled hydraulic lash adjusters can feel stiffer than the other.*

2. Replace a worn or damaged hydraulic lash adjuster.

3. Roll the push rods on a surface table to examine the straightness of the push rods.

4. Examine the spherical surfaces at the ends of the push rods.

5. Measure the length of the push rods.

The length of the push rod	Engine type
241 - 242 mm	168

6. Disassemble and clean the rocker shaft assembly.
   a) Examine the shaft for wear.
   b) Examine that the oil ways are clean.

7. Measure the diameter of the rocker arm bore, 25.000 - 25.021 mm.

8. Replace a worn or damaged rocker arm.

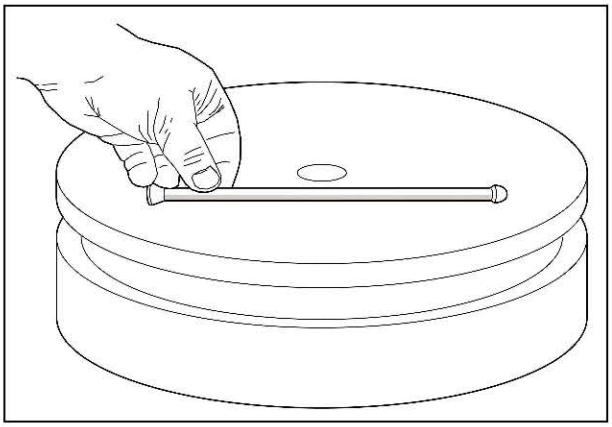


Fig. 721

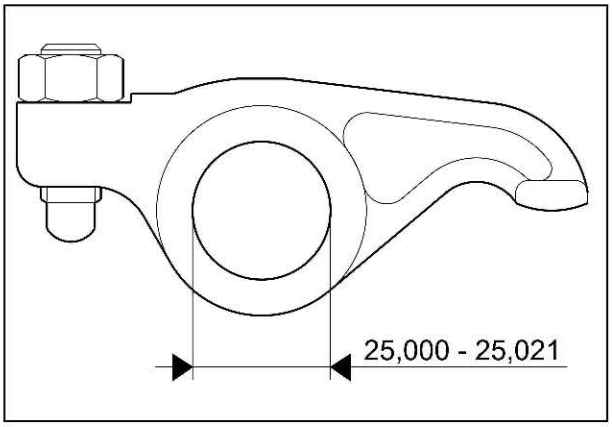


Fig. 722

2.20.2 Compressing the oil out from the hydraulic lash adjusters

Before starting the procedure

Compress the oil out from a hydraulic lash adjuster (HLA) before pre-adjusting it, if the hydraulic lash adjuster was used in a running engine.

Procedure

1. Remove the hydraulic lash adjuster from the engine.
2. Compress the hydraulic lash adjuster to get the oil out from it.
3. Do the steps 1-2 for all hydraulic lash adjusters, which were used in a running engine.

2.20.3 Assembling the valve mechanism with the hydraulic lash adjusters

Procedure

1. Put a plug to the other end of the rocker arm shaft.
2. Lubricate the rocker arm shaft.

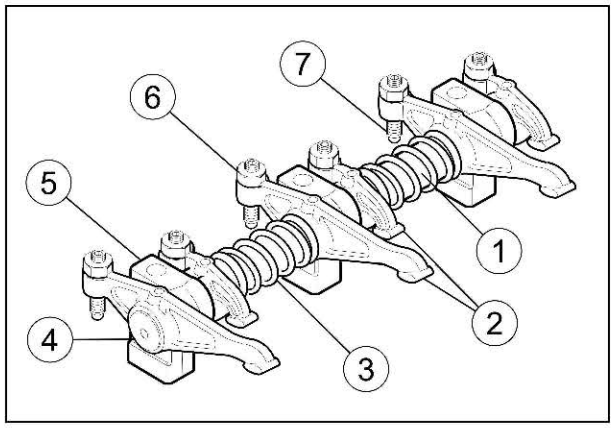


Fig. 723

(1) Rocker arm shaft
(2) Rocker arm
(3) Spring
(4) Plug
(5) Bearing bracket
(6) Nut
(7) Screw

3. To make the rocker shaft assembly, put the rocker arms, springs and the bearing brackets on the rocker arm shaft.
   a) Make sure that the parts of the rocker shaft assembly are in the correct sequence.
   b) Make sure that the oil ways of the rocker arm shaft and the oil ways of the bearing brackets are parallel.
4. Put an other plug to the other end of the rocker arm shaft.
5. Tighten the plugs to 25 Nm.

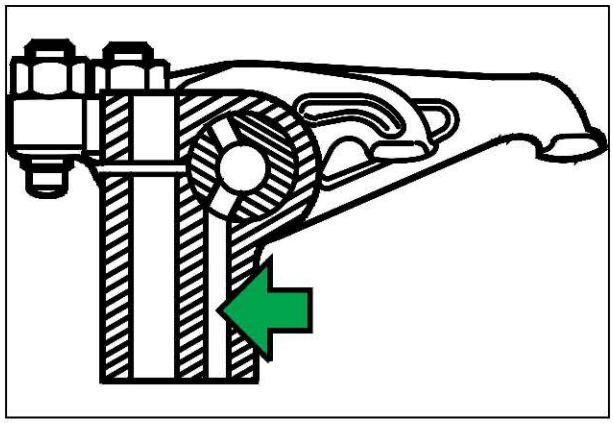


Fig. 724

6. Put the connecting parts onto the valves in correct position.

   The straight side of the connecting parts is to direction of the rocker arm shaft.

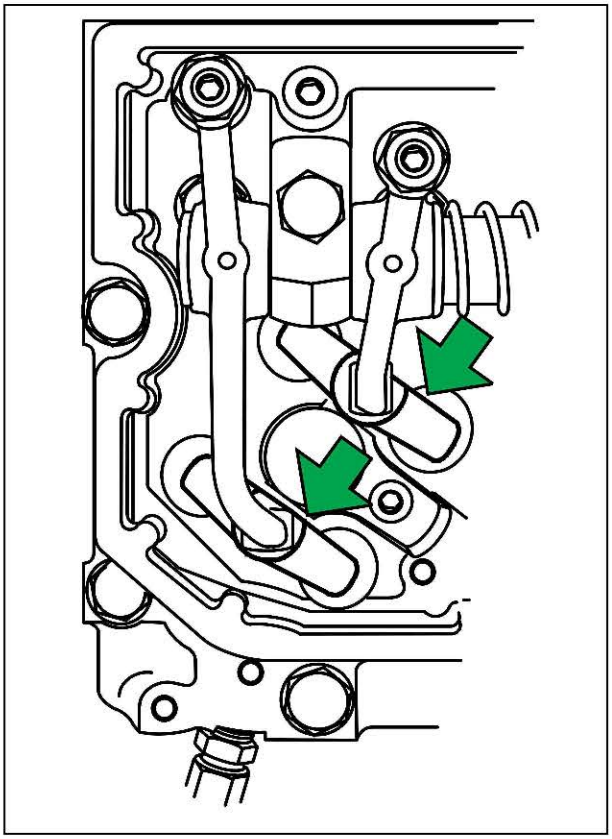


Fig. 725

7. Assemble the rocker shaft assembly.

   NOTE: *In slant mounted engines (for example terminal tractors) the additional oil bore on the rocker arm shaft must point as much down as possible.*

8. Measure the end clearance of the rocker arms at the end of the rocker arm shaft.

   The correct clearance is 0.05 - 0.20 mm.

9. Tighten the screws of the bearing brackets and the nuts of the bearing brackets to a torque of 45 Nm.

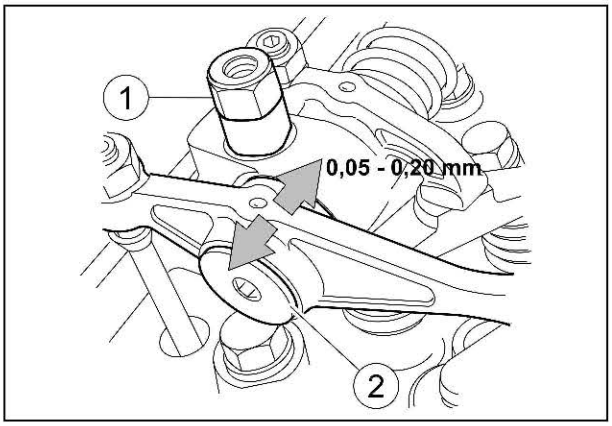


Fig. 726
(1) 45 Nm
(2) 25 Nm

2.20.4 Pre-adjusting the hydraulic lash adjusters

Procedure

1. Open the adjusting screw.
2. Loosen the adjusting screw about 4 rounds.

3. Make sure that all the parts of the valve mechanism are assembled.

4. Turn the crankshaft in the running direction of the engine until the valves in the 6th cylinder are rocking (exhaust closes, inlet opens).

5. Tighten the adjusting screw of the 1st cylinder until the push rod has no vertical clearance.

   To make sure when the vertical clearance is 0, you can lightly move the push rod up and down.

   The hydraulic lash adjuster must be on the top position.

   The push rod can have a small horizontal clearance.

6. Make sure that there is no clearance between the valve lever and the connecting part.

7. Use the pre-tensioning tool to pre-adjust the hydraulic lash adjusters.

   NOTE: *If you do not use the pre-tensioning tool, a collision between a piston and a valve is possible and that can cause a major engine damage.*

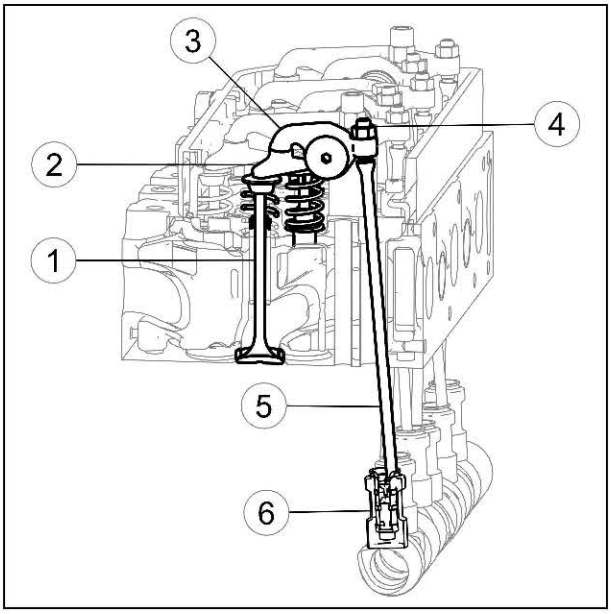


Fig. 727

(1) Valve
(2) Connecting part
(3) Rocker arm
(4) Adjusting screw
(5) Push rod
(6) Hydraulic lash adjuster

8. Install the pre-tensioning tool of the hydraulic lash adjusters under the connecting part and against the valve springs.

9. Turn the adjusting screw of the pre-tensioning tool counter clockwise until the pre-tensioning tool is tightly between the connecting part and the cylinder head.

   NOTE: *Do not over tighten!*

10. Make sure that the hydraulic lash adjuster is on the top position.

11. Tighten the adjusting screw of the rocker arm carefully max. 90° at a time and wait until the oil is stable in the hydraulic lash adjuster.

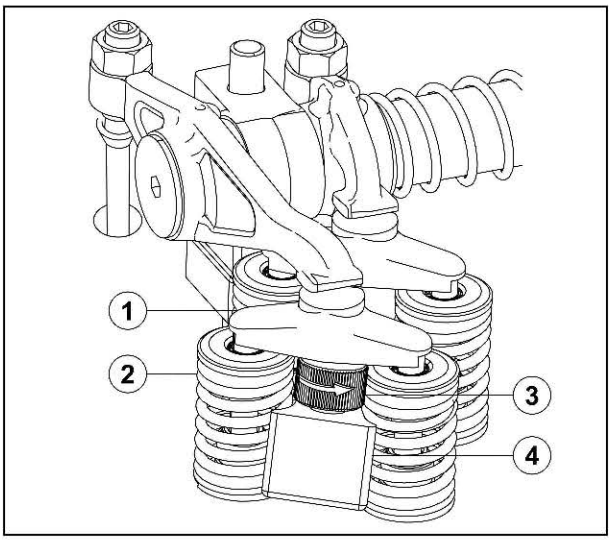


Fig. 728

(1) Connecting part
(2) Valve spring
(3) Adjusting screw of the pre-tensioning tool
(4) Pre-tensioning tool V920253320

12. Tighten the adjusting screw of the rocker arm in total 3 1/4 rounds clockwise.

Hydraulic lash adjuster element will move 3,25 mm down.

NOTE: *The quantity of oil in a hydraulic lash adjuster changes the stiffness of the hydraulic lash adjuster. Some of the unassembled hydraulic lash adjusters can feel stiffer than the other.*

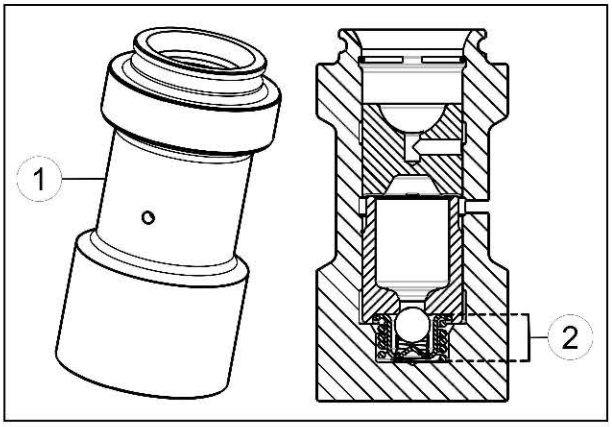


Fig. 729

(1) Hydraulic lash adjuster
(2) Hydraulic lash adjuster element

13. Tighten the nut of the adjusting screw.

14. Do not tighten the adjusting screw below the top level of the nut.

15. Refer to the injection sequence and do the steps 3-7 for all cylinders.

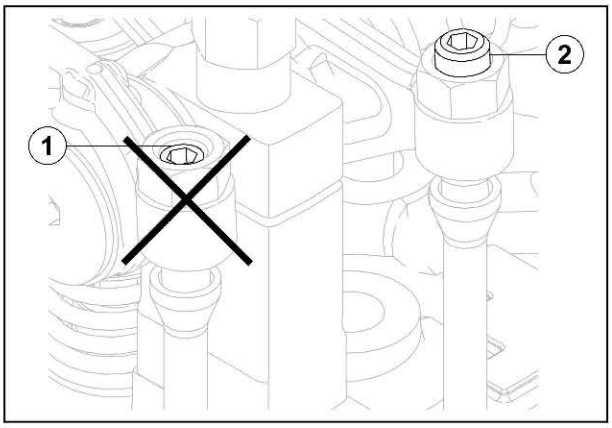


Fig. 730

(1) Incorrect tightening of the adjusting screw
(2) Correct tightening of the adjusting screw

168 engines	
Injection sequence	1 - 12 - 2 - 11 - 4 - 9 - 6 - 7 - 5 - 8 - 3 - 10
Valves rock in cylinder number	6 - 7 - 5 - 8 - 3 - 10 - 1 - 12 - 2 - 11 - 4 - 9

16. After tightening compare the adjusting screws with each other and make sure that the adjusting screws are at the same height.

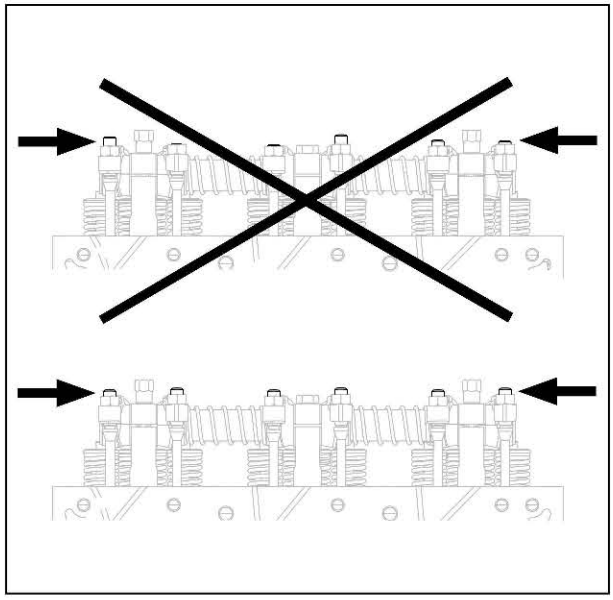


Fig. 731

After finishing the procedure

The engine oil replaces the air in the hydraulic lash adjusters in approximately 45 minutes after the valve mechanism maintenance. Before the oil replaces the air, there can be unusual noises in the valve mechanism.

IMPORTANT: *The engine speed must be less than 1500 rpm during the 45 minutes after the valve mechanism maintenance.*

Related Links

Cylinders of the 12 cylinder engine page 2-231

2.20.5 Replace the camshaft or the camshaft gear

Procedure

1. Remove the valve covers.
2. Remove the rocker arm mechanisms.
3. Remove the alternators and the belts.
4. Remove the belt pulleys and the vibration damper.
5. Loosen the screw of the crankshaft hub with the crankshaft screw tool V920220290.

   Do not remove it!
6. Remove the crankshaft hub using puller V920182390.
7. Take off the puller, open the screw of the crankshaft hub and remove the hub.
8. Remove the brackets from the engine front end.
9. Remove the coolant pump.
10. Remove the fuel pipe attached to the front cover.
11. Remove the oil pipe of the PTO gear.
12. Remove the cover of the timing gear housing (engine front cover).
13. Lock the tappets up.

    Locking removes the risk of the tappets falling down when removing the camshaft, preventing the installation of the camshaft.

14. Prevent the push rods from falling through.

15. Crank the engine until the aligning marks on the idler gear and camshaft gears are facing each other. Pull out the camshafts.

16. Separate the camshaft from the gear wheel.

17. Clean all removed parts if you install them again.

18. Make sure that you install the correct gear to the correct camshaft.

    NOTE: *The 2 camshafts and the 2 camshaft gears are different.*

19. Install the key in its groove and install the gear on the camshaft. Tighten the nut to 200 Nm.

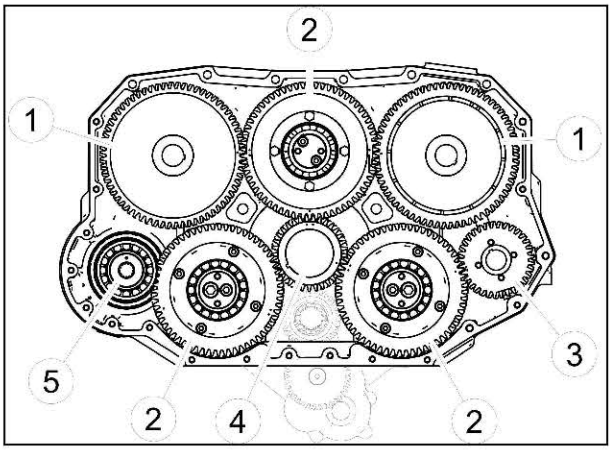


Fig. 732

(1) Camshaft gear
(2) Idler gear
(3) High-pressure pump gear
(4) Crankshaft gear
(5) PTO gear

20. Lubricate bearing surfaces and lobes.

21. Install the camshafts in the cylinder block.

    Make sure that the aligning marks on the gears match.

22. Install the cover of the timing gear housing, the crankshaft hub, the vibration damper, crankshaft belt pulleys and the coolant pump.

23. Install the oil pipe of the PTO gear.

24. Attach the fuel pipe to the front cover.

25. Free the push rods and install the rocker arm mechanism.

26. Adjust the valves.

27. Install the valve covers.

28. Install the other removed parts.

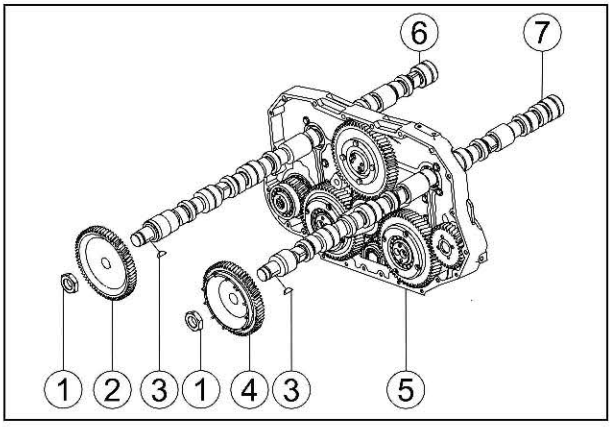


Fig. 733

(1) Nut
(2) Camshaft gear (right side)
(3) Key
(4) Camshaft gear (left side)
(5) Timing gear housing
(6) Camshaft (cylinders 1-6)
(7) Camshaft (cylinders 7-12)

Related Links

Remove the parts on top of the long block engine page 2-266
Recondition the valve mechanism page 2-296
Compressing the oil out from the hydraulic lash adjusters page 2-296
Assembling the valve mechanism with the hydraulic lash adjusters page 2-297
Pre-adjusting the hydraulic lash adjusters page 2-298
Install the parts on top of the long block engine page 2-273

2.21 Crankshaft

2.21.1 Remove the crankshaft

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

1. Remove the oil sump.
2. Remove the oil pump and the suction oil pipe and the pressure oil pipe.
3. Remove the flywheel and the flywheel housing.
4. Remove the belt pulley and the hub from the crankshaft front end.
5. Remove the timing gear housing.
6. Remove the bearing caps of the connecting rod and push the connecting rods out of the way of the crankshaft.

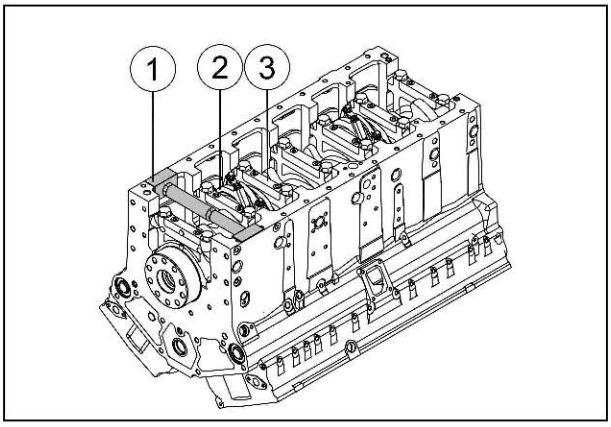


Fig. 734

(1) Expander of the cylinder block
(2) Bearing cap of the connecting rod
(3) Main bearing cap

7. Remove the screws of the main bearing caps from the side and on the top.
8. Use the special tool V920240120 to expand the cylinder block.
   a) Put the expander between the main bearing caps you want to remove.
   b) Move the position of the expander always between the main bearing caps you will remove.
   c) Tighten the expander until the main bearing caps become loose (max. tightening torque is 100 Nm).

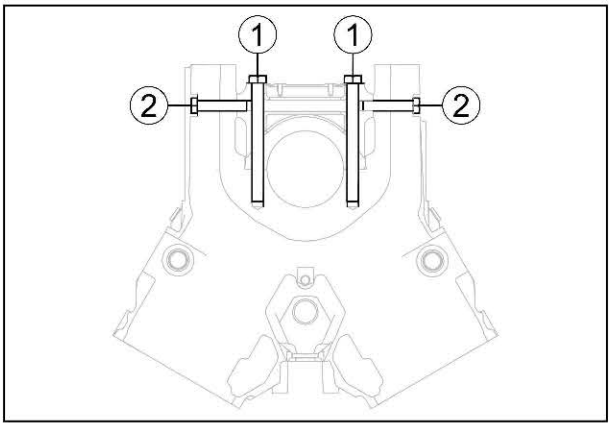


Fig. 735

(1) Vertical screws of the main bearing cap
(2) Horizontal screws of the main bearing cap (both sides of the cylinder block)

9. Remove the main bearing caps.

a) Lift the main bearing caps out with the aid of two M8 screws.
b) The main bearing cap at the rear end is tight to remove because of the guide pins.
c) Lift the main bearing cap at the rear end **vertically straight up to prevent damage for the guide pins or the cylinder block.**

10. Attach the lifting tool to the crankshaft.

11. Make sure that the lift is balanced and the crankshaft or the cylinder block cannot have defects.

12. Lift out the crankshaft.

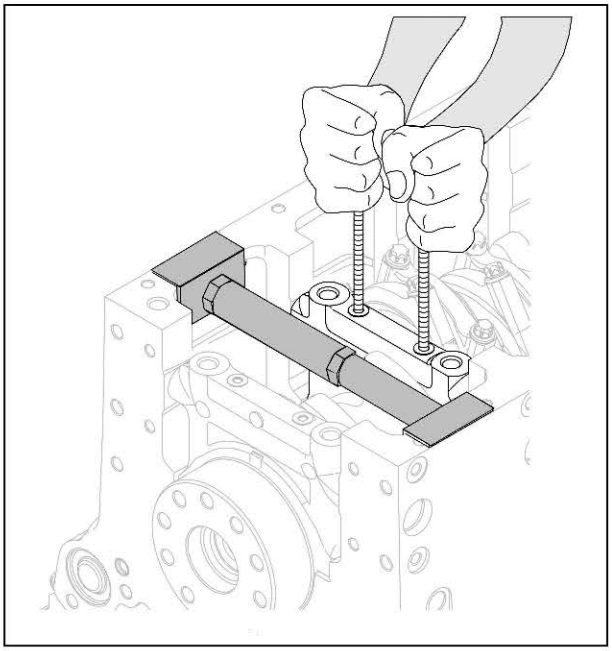


Fig. 736

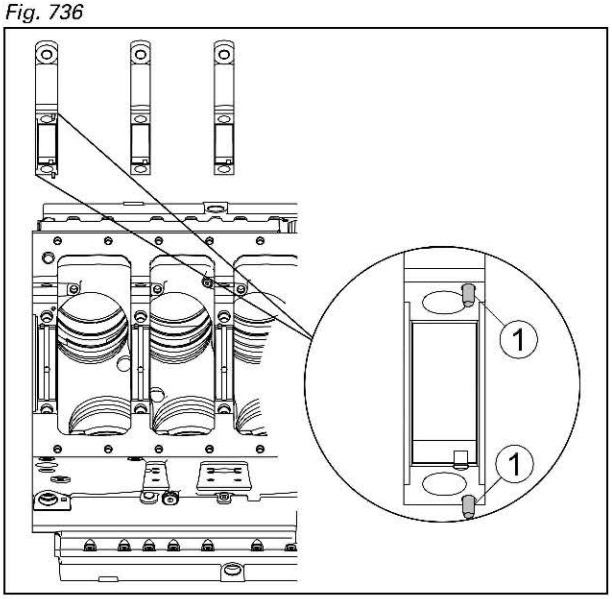


Fig. 737

(1) Guide pins in the rear main bearing cap

Related Links

Remove the parts on top of the long block engine page 2-266
Removing the oil pump page 2-326
Remove the flywheel housing page 2-288
Remove the flywheel page 2-317
Remove the timing gear housing page 2-318

2.21.2 Do a check for the crankshaft

NOTE: *Rework of the crank pin fillet area or the main journal fillet area is not allowed.*

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

1. Clean the crankshaft and the oilways carefully.
2. Measure the journal wear in several points.

   Out-of-round, taper or other wear must not be over 0.025 mm for crank pins and 0.030 for main journals.
3. Refit the bearing caps with new bearing shells and tighten them to the correct torque.

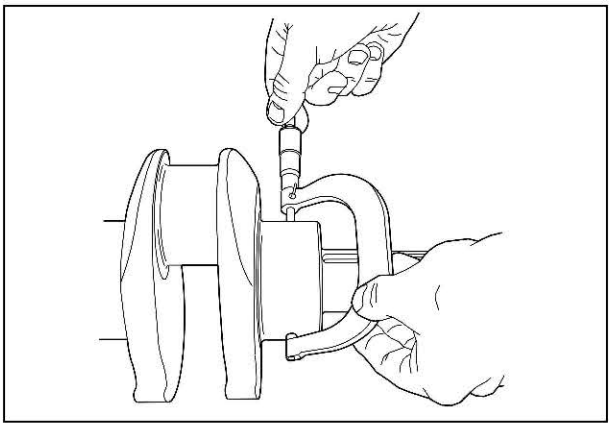


Fig. 738

4. Measure the I.D. with a dial gauge which has been zeroed to the dimensions given in point 2.

   With this method the indicator shows the actual bearing clearance.

   Measure at several points in case the worn bearing housing is not round.
5. If it is necessary, grind the bearing journals on the crankshaft.

   The maximum bearing clearance for the main bearings is 0.16 mm and for the connecting rod big- end bearings 0.15 mm.

   Refer to the specifications for the corresponding bearings.

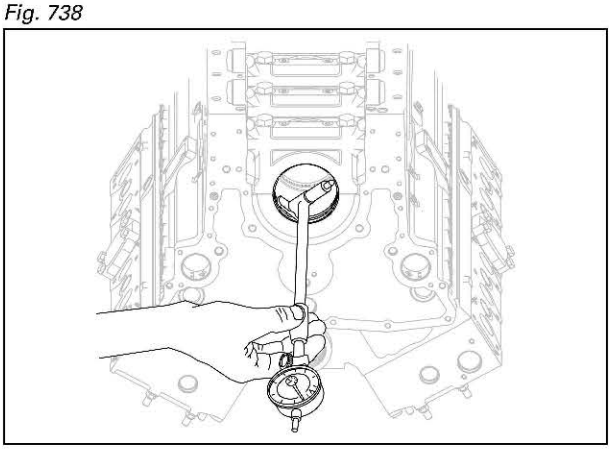


Fig. 739

2.21.2.1 Rework instructions for the crankshaft

NOTE: *Rework of the crank pin fillet area or the main journal fillet area is not allowed.*

NOTE: *Heat treatment of the crankshaft is not allowed.*

Crank pins

- Do not go below the surface of the crank pin with grinding tools or polishing tools on the area marked grey in the figure.
- Do not touch the fillet area of the crank pin with machining tools or polishing tools.
- Do not leave extruding edges in the surface of the crank pin.

(1) Fillet area of the crank pin
(2) Surface of the crank pin

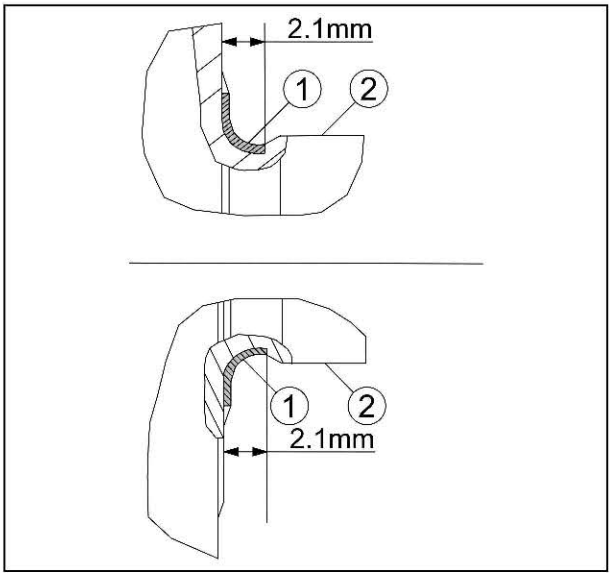


Fig. 740

Main journals

- Do not go below the surface of the main journal with grinding tools or polishing tools on the area marked grey in the figure.
- Do not touch the fillet area of the main journal with machining tools or polishing tools.
- Do not leave extruding edges in the surface of the main journal.

(1) Fillet area of the main journal
(2) Surface of the main journal

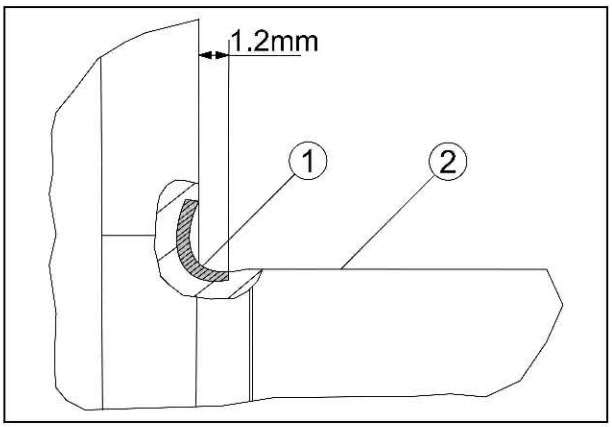


Fig. 741

2.21.3 Replace the crankshaft gears

Procedure

1. Break the crankshaft gears using for example a grinder.
   a) Grind the gears sufficiently for breaking.
   b) Hit the gears apart with a chisel.
   c) Be careful to prevent the damage for the crankshaft!

2. Clean the seat on the crankshaft for example with a wire brush.

3. Heat the new gears to 220 - 250°C.

4. Assemble the gears onto the shaft.
   a) Make sure that the crankshaft key is in correct position.
   b) Make sure that the aligning marks on the front gear are visible.
   c) Set the crankshaft key into the angular key slot.

5. Let the gears cool.

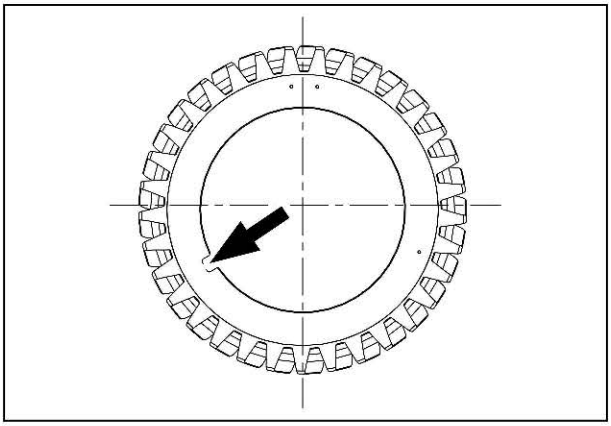


Fig. 742

2.21.4 Install the crankshaft

NOTE: *Do not ream or machine the bearing shells. Also do not file the sides of the bearing caps.*

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

Procedure

1. Clean the oilways, bearing shells and bearing locations.

2. Make sure that the crankshaft is clean.
   a) Clean the bearing surfaces carefully.
   b) Clean the oil holes of the crankshaft carefully.

3. Assemble the bearing shell with the oil holes and the oil grooves to the cylinder block.
   a) Make sure that the locating tabs of the bearing shell are in their notches.
   b) Make sure that the oil holes of the bearing shell are parallel with the oil ports of the cylinder block.
   c) Make sure that the middle main bearing (4th main bearing) is 2 mm wider than the other main bearings.

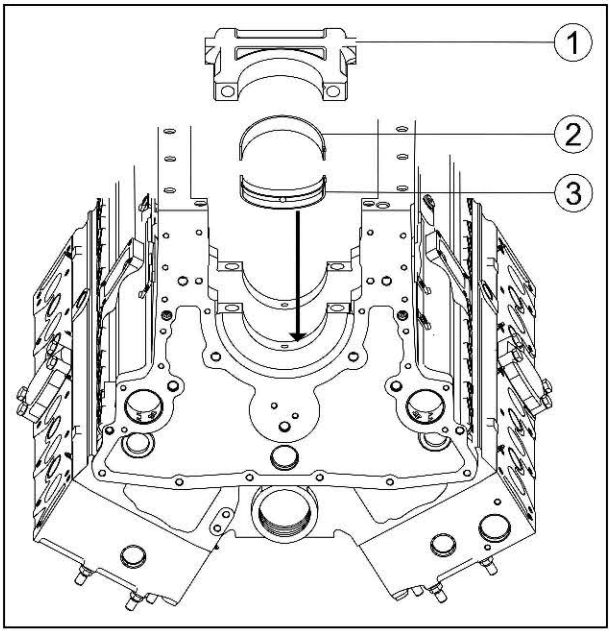


Fig. 743

(1) Main bearing cap
(2) Bearing shell (no oil holes)
(3) Bearing shell (with oil holes)

4. Assemble the bearing shell with no oil holes to the bearing cap.
   a) Make sure that the locating tabs of the bearing shell are in their notches.
   b) Make sure that the middle main bearing (4th main bearing) is 2 mm wider than the other main bearings.
5. Lubricate the bearing surfaces and assemble the crankshaft.
   a) Attach the lifting tool to the crankshaft.
   b) Make sure that the lift is balanced and the crankshaft or the cylinder block cannot have defects.
   c) Lift the crankshaft in the cylinder block.
6. Assemble the rear thrust bearings of the crankshaft and make sure that the lubricating grooves are in the direction of the crankshaft.

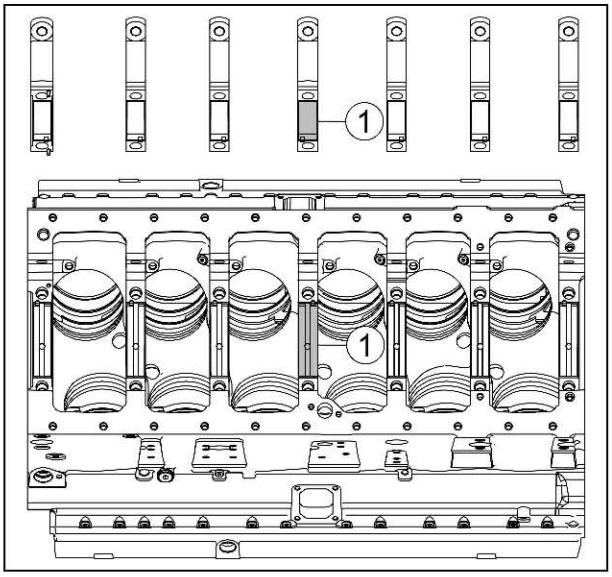


Fig. 744

(1) 4th main bearing, 2 mm wider than the others

7. Use the special tool V920240120 to expand the cylinder block.
8. Lubricate the bolts of the main bearing caps.

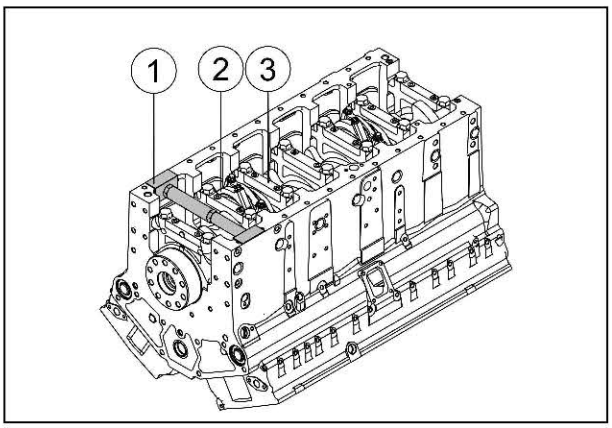


Fig. 745

(1) Expander of the cylinder block
(2) Bearing cap of the connecting rod
(3) Main bearing cap

9. Refer to the numbering of the main bearing caps and assemble them in correct sequence.

   NOTE: *Do not hit the main bearing caps into their locations. The bearing shells can fall off.*

   a) Put the expander between the main bearing caps you will install.
   b) Move the position of the expander always between the main bearing caps you will install.
   c) Tighten the expander until the main bearing caps are easy to install (max. tightening torque is 100 Nm).

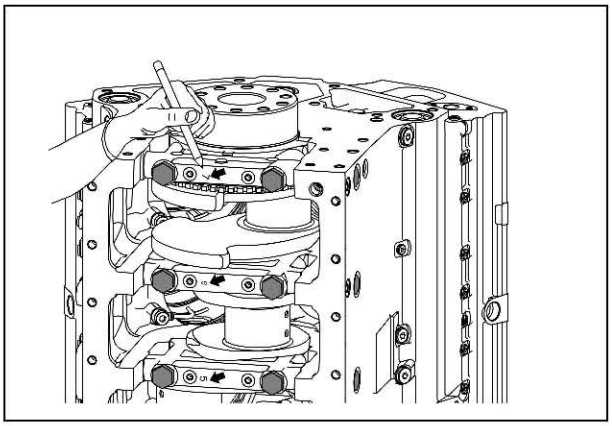


Fig. 746

The bearing lock in the cylinder block and in the main bearing cap are on the same side as the locating tabs of the bearing shell.

The rear thrust bearings are supplied with locating slats.

10. Make sure that there is guide pins in the rear main bearing cap.

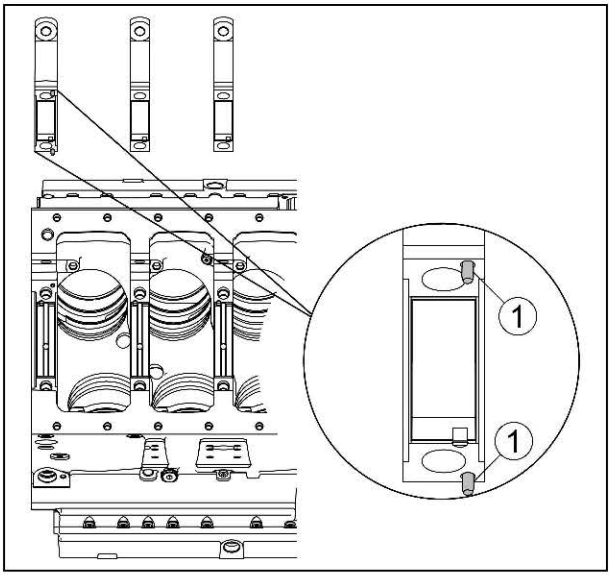


Fig. 747

(1) Guide pins in the rear main bearing cap

11. Tighten the screws of the main bearing caps.

a) Make sure that the support stand does not bend the cylinder block to any direction.
b) If it is necessary, loosen the bolts of the support stand a little.
c) Tighten the vertical screws to 80 Nm.
d) Put Loctite® 574 (or equivalent) to the horizontal screws.
e) Tighten the horizontal screws to 80 Nm (from the two sides of the cylinder block).
f) Tighten the vertical screws to 325 Nm.
g) Tighten the horizontal screws to 200 Nm at the same time from the 2 sides of the cylinder block.

You can also tighten the horizontal screws in steps of 50 Nm from side to side.

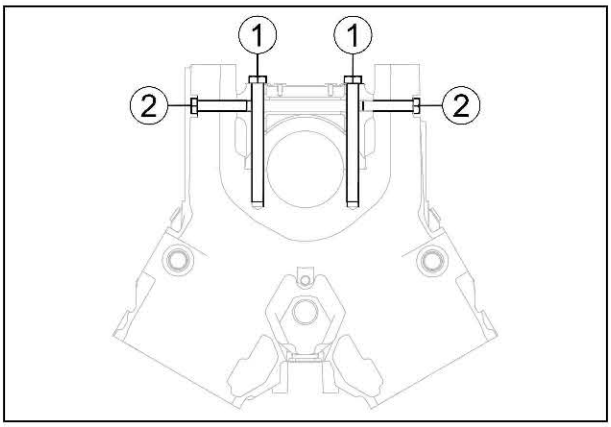


Fig. 748

(1) Vertical screws of the main bearing cap
(2) Horizontal screws of the main bearing cap (on the two sides of the cylinder block)

12. Make sure that the crankshaft turns freely.

13. Use a dial gauge to measure the end float.

The correct end float is 0.10 - 0.26 mm.

NOTE: *Measure the end float also after the engine is installed into the machine or connected to the transmission.*

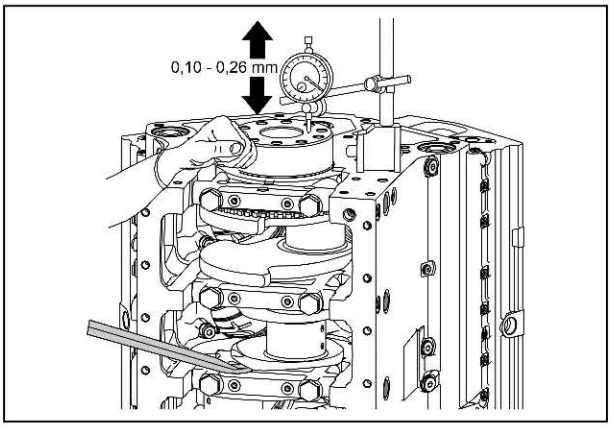


Fig. 749

Related Links

Install the flywheel housing page 2-288
Fitting flywheel page 2-317

Fitting the oil pump page 2-326
Install the timing gear housing page 2-319
Install the parts on top of the long block engine page 2-273

2.21.5 Viscose type vibration damper

(1) Housing
(2) Damper mass
(3) Liquid cavity
(4) Bushing

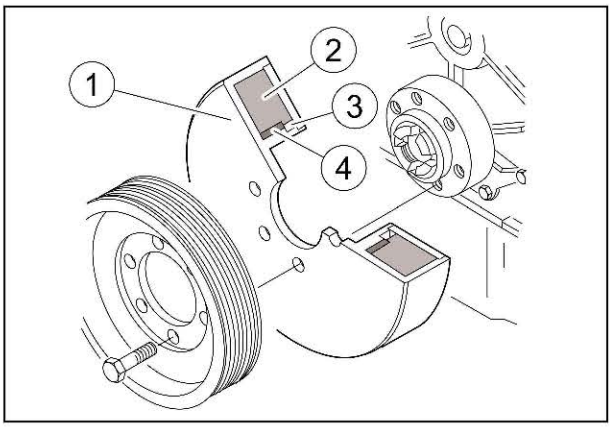


Fig. 750

Engine has a vibration damper of "viscose type". Inside the damper there is a housing filled with stiff silicone oil, in which the damping substance has very small tolerances.

NOTE: *Even a small dent makes the vibration damper inoperative. Do not remove it by turning forcibly and be careful not to damage it when it is loose. If you detect a dent on the outer surface, do not re-install the damper in the engine.*

NOTE: *If you are making the installation mark on the vibration damper, use an electric pen, do not tap it.*

2.22 Connecting rods and pistons

2.22.1 Removing pistons together with connecting rods

Procedure

1. Remove the oil sump and the oil inlet and pressure pipes.
2. Remove the cylinder head.
3. Scrape off any soot in the cylinder liner. If the turning edge is clearly marked, smooth it down carefully with a scraper.
4. Remove the big-end bearing caps and bearing shells. Place the shells in order if they are to be re-used.
5. Push up the piston and connecting rod with the shaft of a hammer or similar wooden tool.
6. Remove the piston pin snap rings. Push out the pin.

   NOTE: *If the piston pin does not move under thumb pressure, the piston should be heated to 100°C.*

Related Links

Remove the cylinder heads page 2-290

2.22.2 Replace the piston rings

NOTE: *Be careful with the pistons to prevent any scratches.*

Procedure

1. Remove the piston rings with piston ring pliers V905246900.

   NOTE: *Be careful with the piston rings to prevent any damage to the sliding surface of the piston ring.*

   - Do not open the piston rings more than is necessary to prevent any permanent changes in the shape of the piston rings.
   - Install the piston rings in the same grooves, if you use the piston rings again.

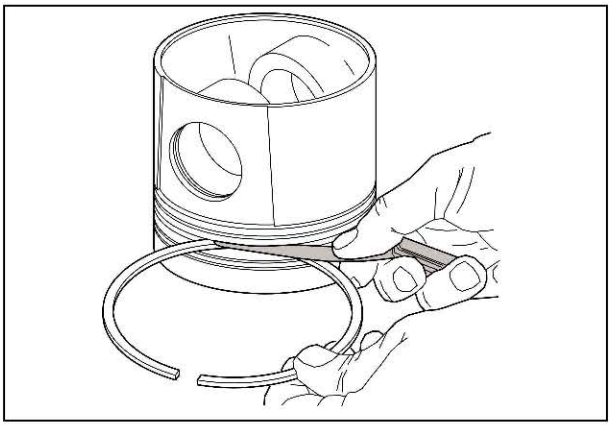


Fig. 751

2. Clean the piston ring grooves.

   Prevent making scratches to the piston ring grooves.

3. Measure the piston ring clearance.

   NOTE: *The piston ring clearance must be smaller than 0.15 mm.*

   If the clearance is too large, determine whether the piston rings or the piston ring grooves are worn.

4. Replace worn parts.

5. Measure the piston ring gap by pushing one piston ring at a time into the cylinder bore.

   The piston ring gap must not be larger than 1 mm on the 1st and 3rd piston rings and 1.3 mm on the 2nd piston ring.

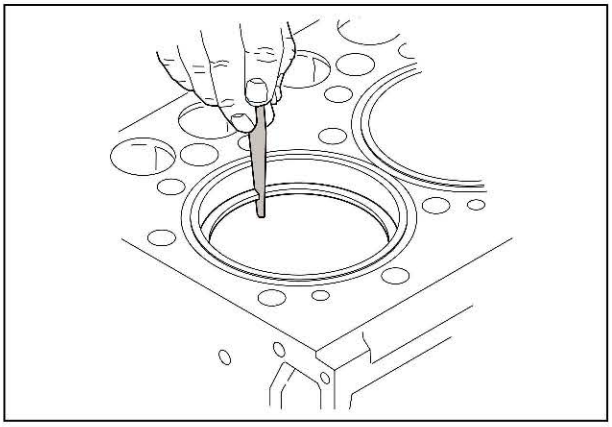


Fig. 752

6. Install the piston rings on the piston, use the piston ring pliers.
   a) Install the piston rings in the correct piston ring grooves.
   b) Make sure that the text "TOP", or the manufacturer indication, faces up.

   NOTE: *Be careful with the pistons to prevent any scratches.*

7. Make sure that the piston ring sliding surface is not damaged.

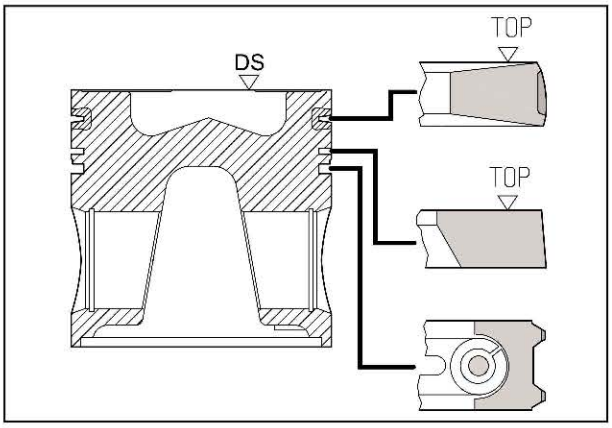


Fig. 753

2.22.3 Replace the connecting rod bearings

2.22.3.1 Piston pin bushing

Procedure

1. Clean the connecting rod and bearing shells.
2. Measure the I.D. of the piston pin bushing, use a cylinder gauge.
3. Drive the piston pin bushing out using a drift, if the piston pin bushing is worn.
4. Press the new piston pin bushing in position.

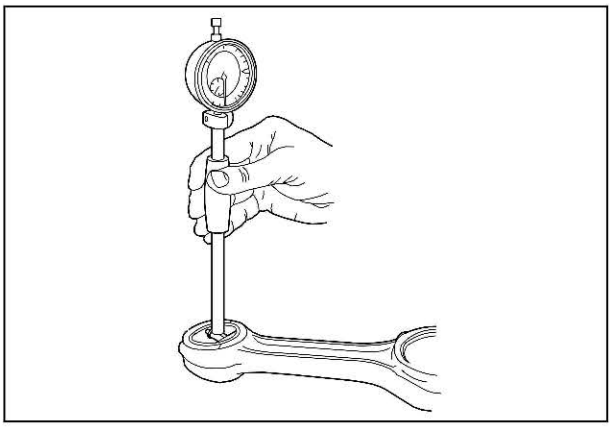


Fig. 754

5. Make sure that the oil hole in the piston pin bushing aligns with the respective hole in the connecting rod by size and location.

   a) Ream the piston pin bushing to get correct diameter.

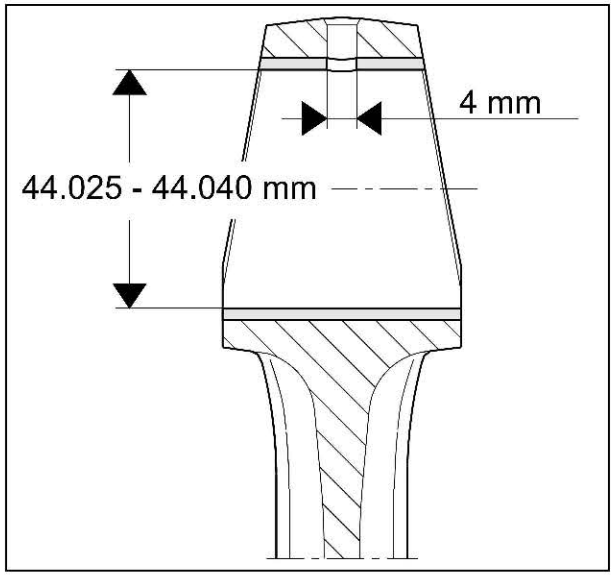


Fig. 755

2.22.3.2 Big-end bearing

Procedure

1. Make sure that the bearing surfaces are clean.

   NOTE: *The upper half bearing is sputter coated.*

2. Install the upper half of the bearing to the connecting rod.

   Observer the guide lug of the bearing.

3. Install the lower half of the bearing to the bearing cap.

   Observer the guide lug of the bearing.

4. Tighten the connecting rod screws.

5. Measure the I.D. using a cylinder gauge which has been zeroed to the diameter of the correct bearing journal.

   If the clearance is more than 0.15 mm with new bearing shells, it is necessary to grind the big-end journals.

   Refer to the specifications for the related bearing.

   NOTE: *Rework of the fillet area of the main bearing journal is not allowed.*

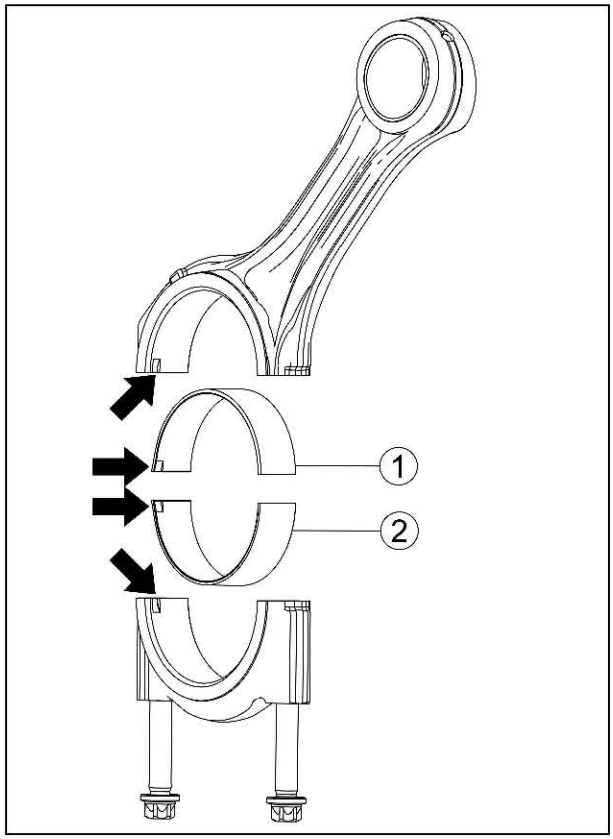


Fig. 756

(1) An upper half bearing
(2) A lower half bearing

2.22.4 Do a check for the connecting rod

NOTE: *Always replace the screws of the connecting rod, when opened.*

- The connecting rods have different weight classes with intervals of 20 g.
- The stamp of the weight class letter is on the side face of the connecting rod.

(1) Weight class letter

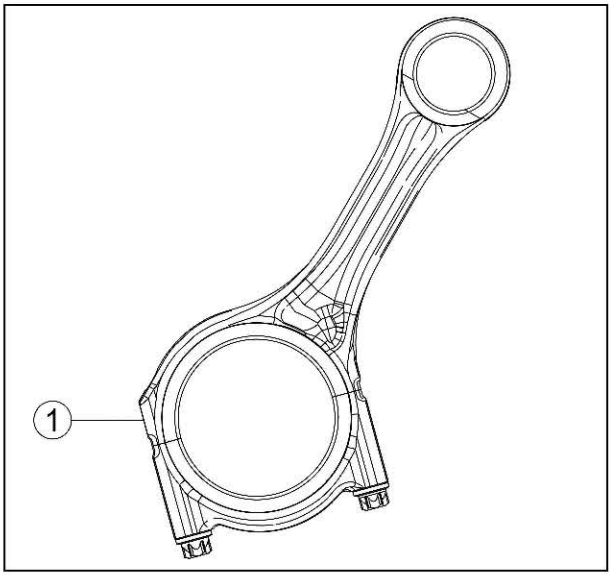


Fig. 757

- All the connecting rods in one cylinder bank must be of the same weight class (cylinders 1-6 same weight class and cylinders 7-12 same weight class), maximum permitted weight difference is 20g.

(1) Right cylinder bank (cylinders 1-6)
(2) Left cylinder bank (cylinders 7-12)

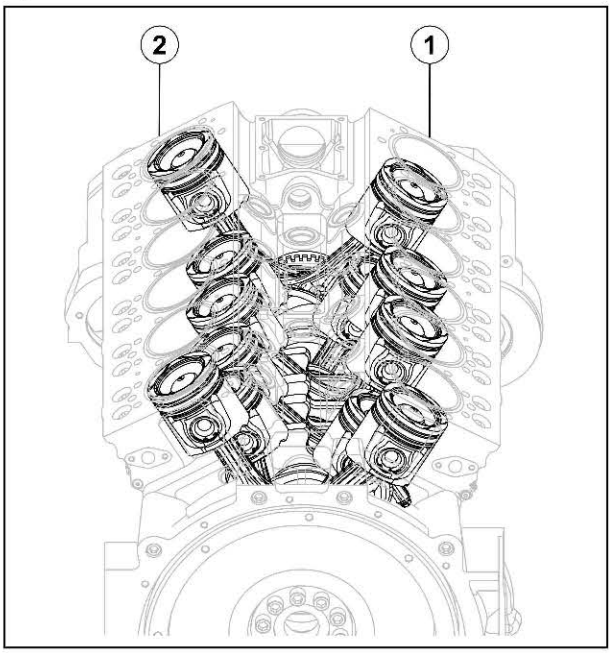


Fig. 758

Weight class	
Mark on the connecting rod	**Weight**
H	2620 - 2639 g
I	2640 - 2659 g
J	2660 - 2679 g
K	2680 - 2699 g
L	2700 - 2719 g

Spare part connecting rod kits

Spare part connecting rods are only available as kits.

Engine type	Number of cylinders	Order number
168	12	V837091171

Related Links

Cylinders of the 12 cylinder engine page 2-231

2.22.5 Checking pistons

Procedure

1. Check the condition of the pistons and piston pins.

   See if there are any cracks on the edge of the combustion chamber or on the upper edge of the piston pin hole.

2. Replace a damaged piston.

3. Measure the diameter of the piston.

   See the height (H) of the measurement point in the table.

4. Replace the piston if needed.

   The diameter of the piston must be within the reference value (D) range.

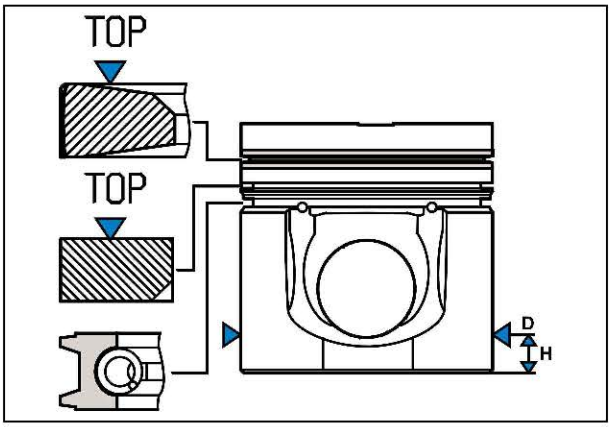


Fig. 759

Engine	D (mm)	H (mm)
168	110.863 - 110.877	15.0

2.22.6 Install the piston pin

Procedure

1. Install the connecting rod inside the piston and push the piston pin into position.

   - Cylinders 1 - 6 the weight class letter of the connecting rod must be on the side of the high-pressure pump (left side of the cylinder block).
   - Cylinders 7 - 12 the weight class letter of the connecting rod must be on the side of the starter motor. (right side of the cylinder block).

   The arrow on the piston points toward the front end of the engine.

2. Install the piston pin circlips.
   a) Make sure that the circlips are pressed correctly into the grooves.
   b) The circlip ends must point up.

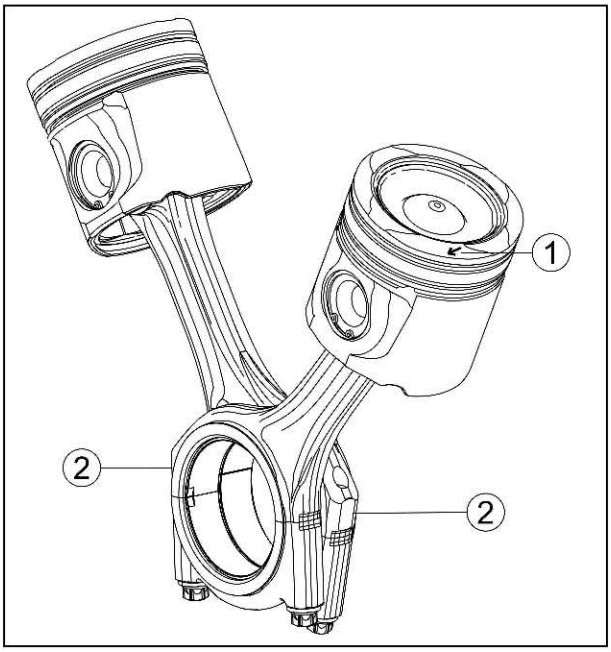


Fig. 760

(1) Arrow on the piston
(2) Weight class letter

2.22.7 Install the piston together with the connecting rod

Procedure

1. Do a check that the bearing locations are clean.
2. Put the bearing shells in the connecting rod and bearing cap.
3. Make sure that the position of the bearing shells is correct.
4. Lubricate the piston, the piston rings and the cylinder bore.
5. Make sure that the piston ring gaps are spread around the piston.
   a) Turn the gap of the 1st piston ring forward (toward coolant pump).
   b) Turn the gap of the 2nd piston ring back (toward flywheel).
   c) Turn the gap of the oil ring on the side of the starter motor.
6. Lubricate the big-end bearing journal and bearing shells.
7. Push the piston down.
8. Install the bearing cap of the connecting rod.

   NOTE: *The shape of the bearing cap is not symmetrical.*

   a) Make sure that the wider shoulder of the bearing cap is pointing against the crankshaft wall.

   Make sure that the notches for the guide lugs are in the same side.
9. Tighten the connecting rod screws.

Connecting rod screws	Tightening torque
M12	40 Nm > 80 Nm + 90°

10. Make sure that the connecting rod has sufficient end float on the big-end bearing journal.

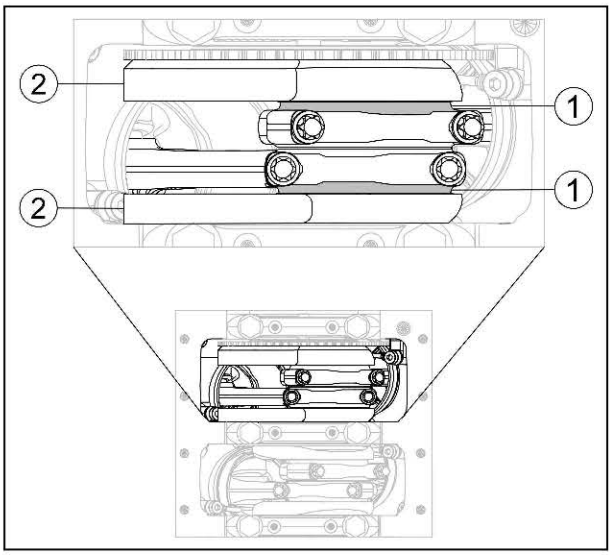


Fig. 761

(1) Wider shoulder of the bearing cap
(2) Crankshaft wall

2.23 Flywheel

2.23.1 Changing starter ring gear on flywheel

If the ring gear is worn, replace it with a new one. The ring gear cannot be turned around because its teeth are chamfered and hardened on the starter motor side.

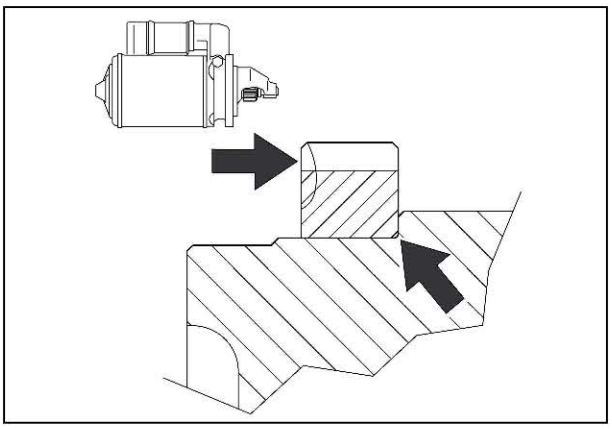


Fig. 762

Procedure

1. Remove the old starter ring by tapping it at various points with a drift. Clean the flywheel contact face with a steel-wire brush.
2. Warm the ring gear to a temperature of 150 - 200°C. Fit the ring gear with the inner diameter chamfering turned against the flywheel and the teeth chamfering against the starter motor.
3. Allow the ring gear to cool freely without using any coolant.

2.23.2 Remove the flywheel

NOTE: ***Lift the engine to an applicable support stand to remove the flywheel.***

1. Remove the flywheel fixing screws.

   NOTE: *Be careful that the flywheel does not fall down.*
2. Remove the flywheel with the starter ring.

2.23.3 Fitting flywheel

Procedure

1. Clean the contact surfaces on the crankshaft rear flange and on the flywheel.
2. Fasten the flywheel to the crankshaft rear end.

   Suitable studs (2 pcs) can be used as guide pins and screwed into the flywheel fixing bolt holes.
3. Tighten the flywheel retaining screws evenly to the correct torque value.

Engine type	Tightening torque
168	350

2.24 Timing gear assembly

2.24.1 Remove the timing gear housing

The bottom face of the timing gear housing is a part of the mating face of the oil sump gasket. It is necessary to remove the oil sump (or the engine), before the removal of the timing gear housing.

Procedure

1. Drain the engine oil and remove the oil sump.
2. Remove all the necessary parts to do maintenance for the long block.
3. Remove the crankshaft belt pulleys and the vibration damper.
4. Loosen the crankshaft screw approximately 2 turns with the opening tool.

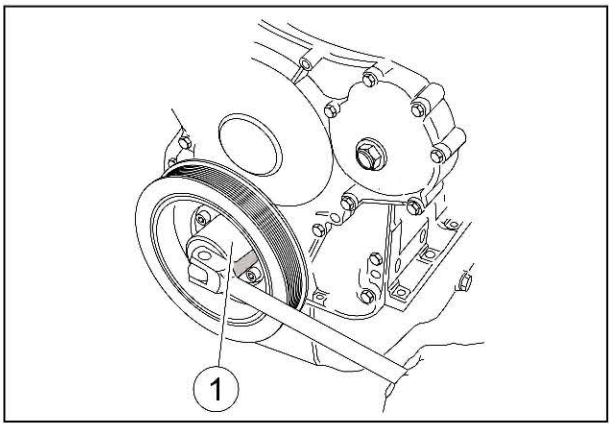


Fig. 763

(1) Opening tool for crankshaft screw V920220290

5. **WARNING: The engine has parts that move.**

   Injury to persons because the crankshaft hub can move when you loosen the nut.

   Carefully loosen the nut, do not remove the nut fully at first.

   Remove the hub from the crankshaft with puller. Remove the puller, open the crankshaft screw and remove the hub.

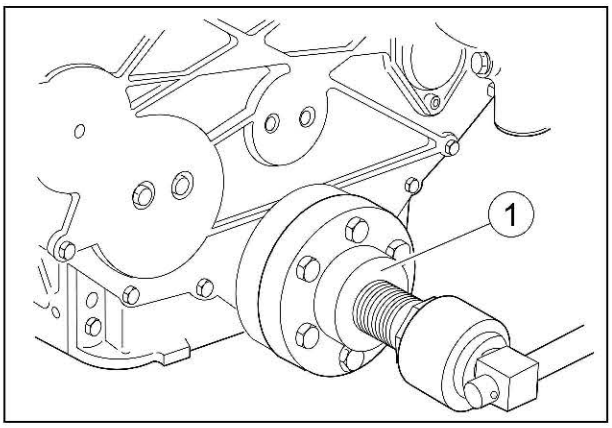


Fig. 764

(1) Crankshaft hub puller V920182390

6. Remove the camshaft speed sensor and the oil pipe of the PTO gear.
7. Remove the front cover of the timing gear housing.

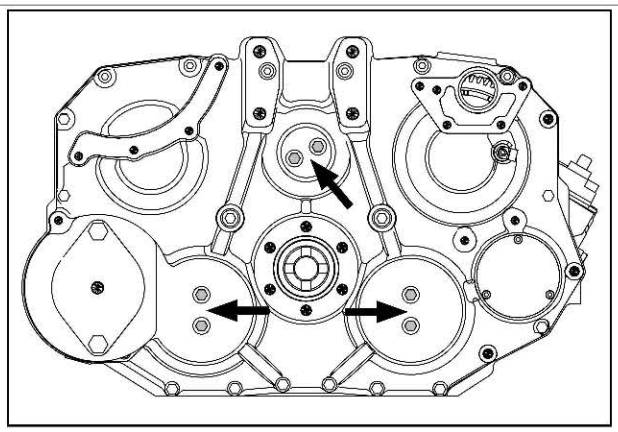


Fig. 765

a) Remove the screws attached to the idler gear shafts (see the picture).
b) Remove the attaching screws of the front cover.
c) Use lifting tool to remove the front cover.

8. Remove the protective plate of the crankshaft front oil seal.

9. Remove the oil deflector ring.

10. Remove the high-pressure pump.
- If you do not replace the timing gear housing, the high-pressure pump can stay in its position.
- If the high-pressure pump stays in its position, disconnect all the wires and the pipes from the high-pressure pump.

11. Open the idler gear screws and remove the idler gears.

12. Remove the camshaft gears.

13. Remove the PTO gear.

14. Remove the high-pressure pump gear.

15. Open the screws of the timing gear housing and remove the timing gear housing.

If it is necessary, put the chocks between the timing gear housing and the cylinder block to remove them from each other. Prevent damage to the sealing surfaces.

16. Remove the front oil seal of the crankshaft from the front cover of the timing gear housing.

17. Clean the sealing surfaces and all the removed parts.

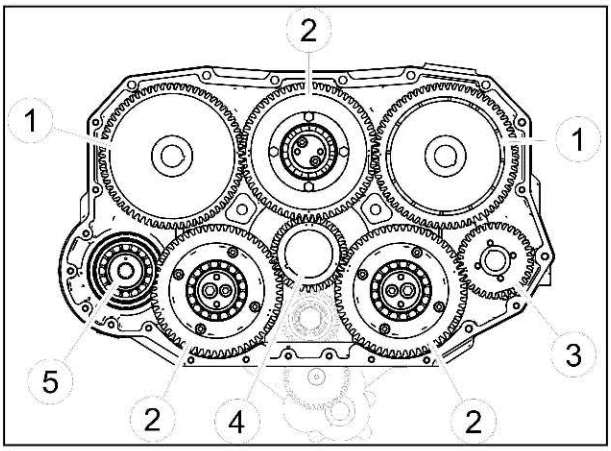


Fig. 766

(1) Camshaft gear
(2) Idler gear
(3) High-pressure pump gear
(4) Crankshaft gear
(5) PTO gear

Related Links

Remove the parts on top of the long block engine page 2-266
Removing the high-pressure pump page 2-361

2.24.2 Install the timing gear housing

2 tension pins help to find the correct position of the timing gear housing.

Timing gear housings sold as replacement part have the holes for the tension pins already machined.

1. Clean the sealing surfaces between the cylinder block and the timing gear housing.

2. Install the timing gear housing.

a) Apply sealant (eg. Loctite® 574) to the sealing surface.
b) Make sure that the sealant aligns the sealing surface of the timing gear housing, specially at the top of the cylinder block.
c) Use guide pins to help the installation of the timing gear housing.
d) Install the timing gear housing against the cylinder block.
e) Install the tension pins with the drift V902598700.
f) Tighten the attaching screws of the timing gear housing to 28 Nm.

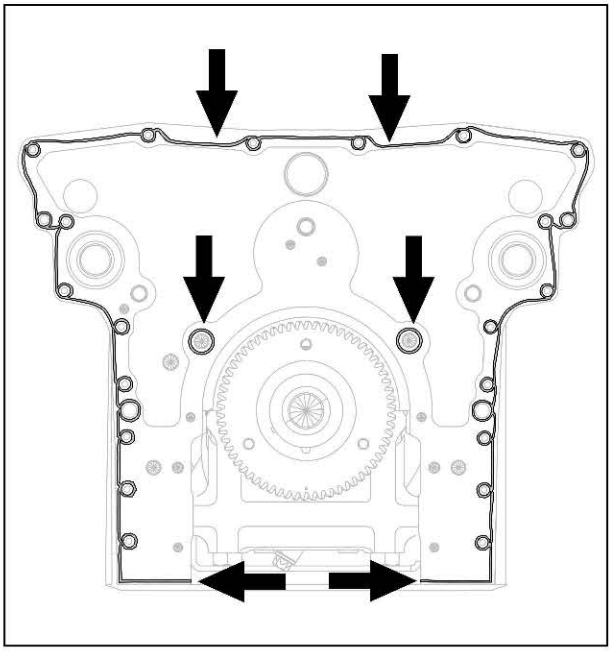


Fig. 767

3. Install the bearing of the PTO gear to the timing gear housing with the drift V920218070.

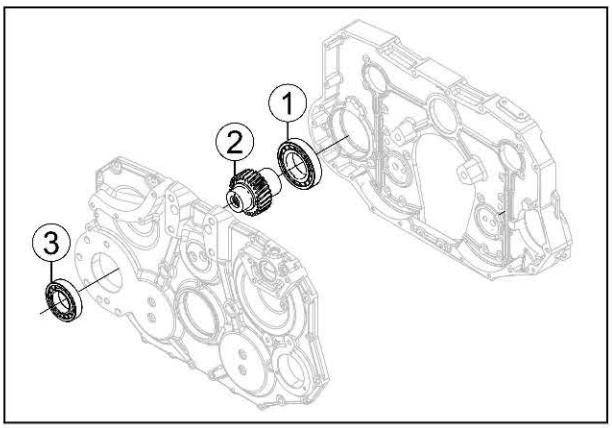


Fig. 768

(1) Bearing 1, installation with the drift V920218070
(2) PTO gear
(3) Bearing 2, installation with the drift V920233250

4. Install the right idler gear.

Use guide pins to help the installation.

5. Install the top idler gear.

6. Install the high-pressure pump.

7. Install the high-pressure pump gear.

8. Install the left idler gear.

a) Make sure that the timing is correct with the high-pressure pump gear and the crankshaft gear.

9. Lubricate the camshaft bearings.

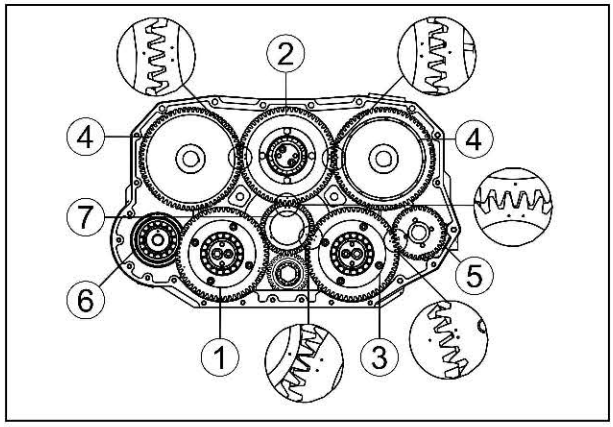


Fig. 769

(1) Right idler gear
(2) Top idler gear
(3) Left idler gear
(4) Camshaft gears
(5) High-pressure pump gear
(6) PTO gear
(7) Crankshaft gear

10. Install the camshafts with the camshaft gears to the cylinder block.

NOTE: *The 2 camshafts and the 2 camshaft gears are different.*

a) Make sure that you install the correct camshaft assembly to the correct side.
b) Make sure that the timing is correct with the camshaft gears and the top idler gear.

11. Install the PTO gear.

12. Tighten the idler gears to the correct torque.

a) M14x70 screws to 200 Nm.
b) M10x70 screws to 80 Nm.
c) M8x70 screws to 40 Nm.

13. Tighten the camshaft gears to 200 Nm.

14. Tighten the high-pressure pump gear to 280 Nm.

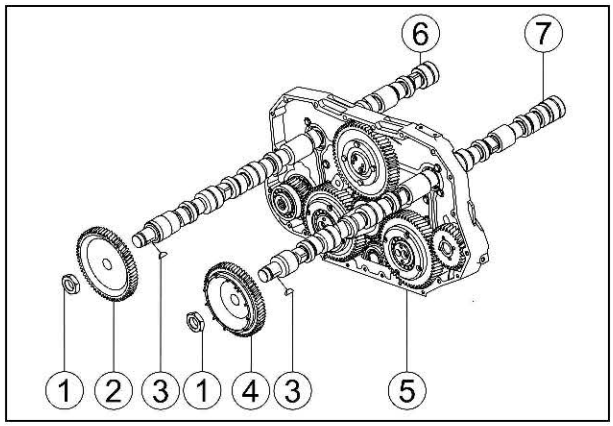


Fig. 770

(1) Nut
(2) Camshaft gear (right side)
(3) Key
(4) Camshaft gear (left side)
(5) Timing gear housing
(6) Camshaft (cylinders 1-6)
(7) Camshaft (cylinders 7-12)

15. Do a check for the tooth backlash.

16. Install the deflector ring on top of the crankshaft gear.

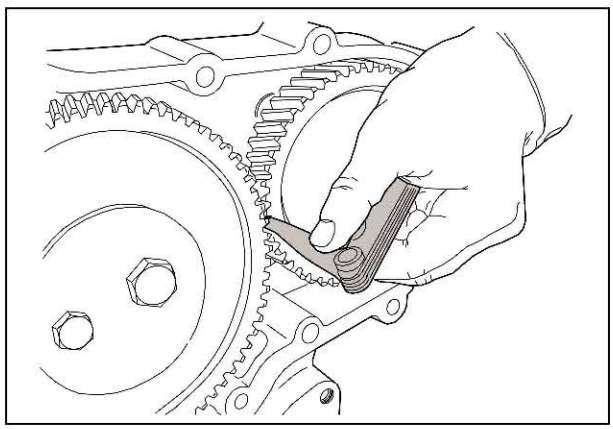


Fig. 771

17. Install the front cover of the timing gear housing.

a) Make sure that the sealing surface between the timing gear housing and the front cover is clean.
b) Apply sealant (eg. Loctite® 574) to the sealing surface.
c) Apply sealant also to the 2 screw threads at the lower end of the timing gear housing.
d) Use guide pins to help the installation of the front cover.
e) Install the front cover of the timing gear housing.

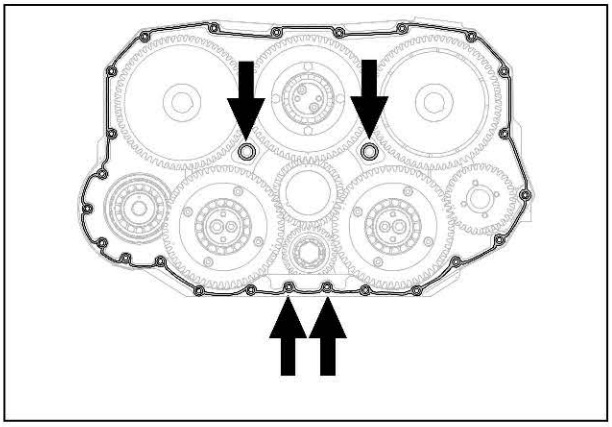


Fig. 772

18. Tighten the attaching screws of the front cover.

a) M14x90 screws to 200 Nm.
b) M8 screws to 28 Nm.

NOTE: *Use Usit washers with M8x20 hex cap screws.*

c) M10 screws to 80 Nm.

19. Install the protective plate into the front cover seal location.

20. Install the gasket and the cover of the high-pressure pump gear.

21. Assemble the PTO.

a) Install the bearing of the PTO gear to the front cover of the timing gear housing with the drift V920233250.
b) Install the O-ring and the flange of the PTO gear.
c) Lubricate the PTO bearings.
d) Install the gasket and the cover of the PTO assembly.
e) Tighten the M14x40 screws to 80 Nm.

22. Install the crankshaft front oil seal with the drift V920215660.

23. Install the crankshaft hub.

a) Do a check for the conical surfaces on the crankshaft and the crankshaft hub.
b) Clean the conical surfaces on the crankshaft and the crankshaft hub carefully.
c) Install the hub into its position to the crankshaft gear.
d) Lubricate the hub screw thread, rear surface and outer surface with (the surfaces affecting nut friction) vaseline.

NOTE: *Do not use oil, it can run into the conical surfaces.*

e) Install the hub screw onto the crankshaft thread.
f) Tighten the hub screw to the torque of 1050 - 1150 Nm.

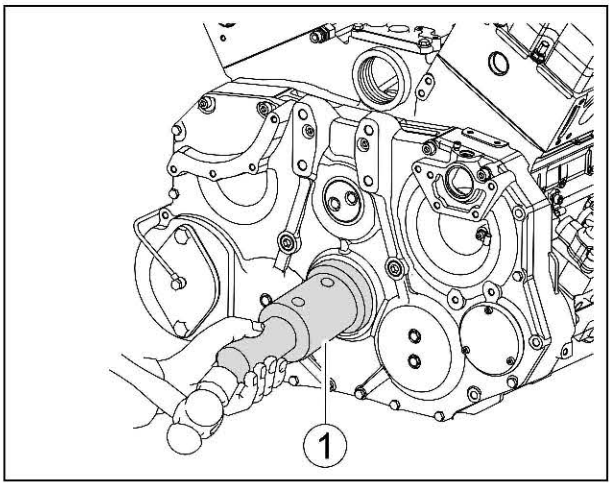


Fig. 773

(1) Drift V920215660.

24. Install the other removed parts.

Related Links

Install the high-pressure pump page 2-362

Fitting the crankshaft hub page 2-323
Install the parts on top of the long block engine page 2-273

2.24.3 Crankshaft hub piece

Procedure

1. Do a check for the condition of the hub piece, specially for the sealing surface.
2. Install a 3 mm spacer ring under the crankshaft front oil seal, if the sealing surface is worn out.

   The crankshaft pulley does not have any timing or installation marks.

   There is no specific position for the crankshaft hub piece.

2.24.4 Fitting the crankshaft hub

When installing the hub must the conical surfaces be absolutely clean.

The crankshaft hub assembly is a very sensitive design. A mistake in the assembly or damaged parts can cause an engine failure.

Procedure

1. Do a check and clean carefully the conical surfaces on the crankshaft and the hub.

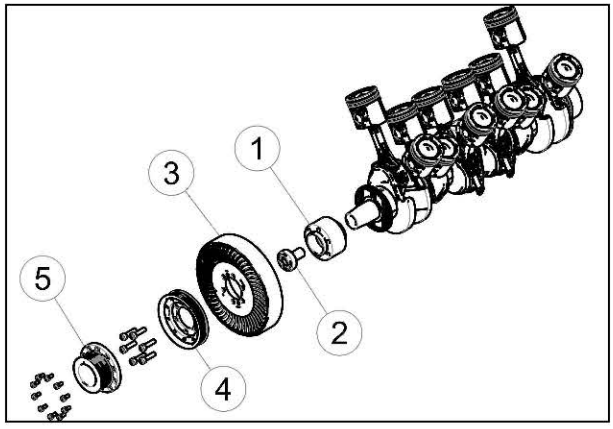


Fig. 774
(1) Crankshaft hub
(2) Crankshaft hub screw
(3) Vibration damper
(4) Belt pulley
(5) Belt pulley

2. Install the hub in its place towards the crankshaft gear.
3. Lubricate the hub screw thread, rear surface and outer surface (the surfaces affecting nut friction) with vaseline.

   NOTE: *Do not use oil, it may run into the conical surfaces.*
4. Install the hub screw onto the crankshaft thread and tighten it to 1100Nm$^{\pm 50Nm}$.
   a) Do not use thread locking compound!

      Thread locking compound can prevent an easy uninstallation of the assembly. Thread locking compound can also run into an incorrect area, which can cause a failure in the installation of the crankshaft hub.

2.25 Belts

2.25.1 Remove the belt tensioner

Procedure

1. Remove the screw of the belt tensioner.
2. Remove the belt tensioner.

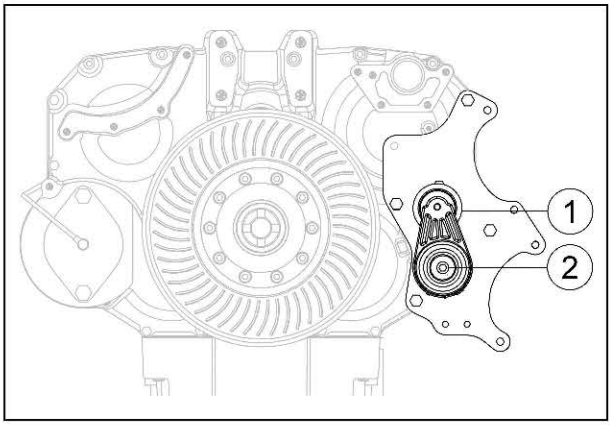


Fig. 775

(1) Belt tensioner
(2) Screw of the belt tensioner

2.25.2 Install the belt tensioner

Procedure

1. Install the belt tensioner.
2. Install the screw of the belt tensioner into its position.
3. Tighten the screw to 50 Nm.

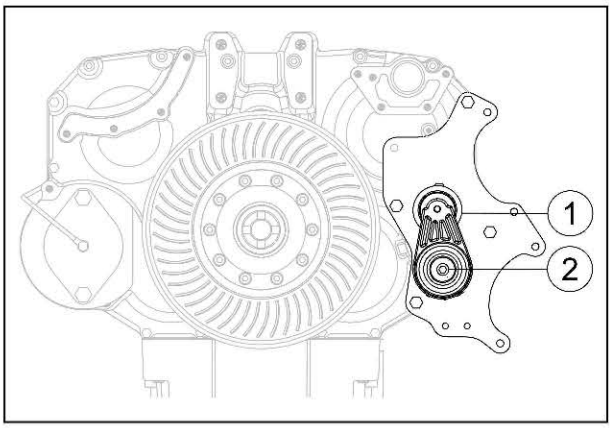


Fig. 776

(1) Belt tensioner
(2) Screw of the belt tensioner

2.25.3 Remove the belt pulley

Procedure

1. Remove the screws of the top belt pulley.
2. Remove the top belt pulley.
3. Remove the screws of the bottom belt pulley.
4. Remove the bottom belt pulley.

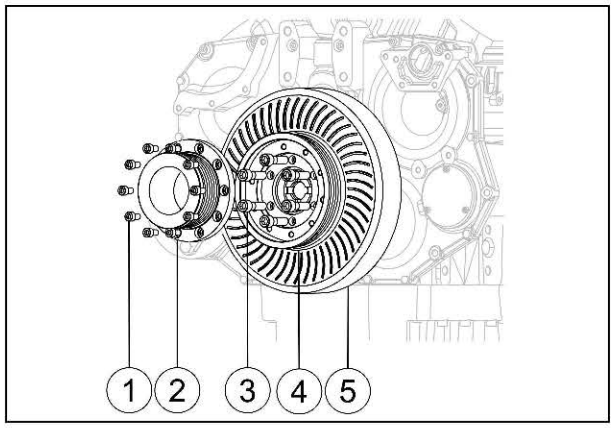


Fig. 777

(1) Screws of the top belt pulley
(2) Top belt pulley
(3) Screws of the bottom belt pulley
(4) Bottom belt pulley
(5) Vibration damper

2.25.4 Install the belt pulley

Procedure

1. Install the bottom belt pulley on top of the vibration damper.
2. Install the screws of the bottom belt pulley into their position.
3. Tighten the screws of the bottom belt pulley to 200 Nm.
4. Install the top belt pulley.
5. Install the screws of the top belt pulley into their position.
6. Tighten the screws of the top belt pulley to 80 Nm.

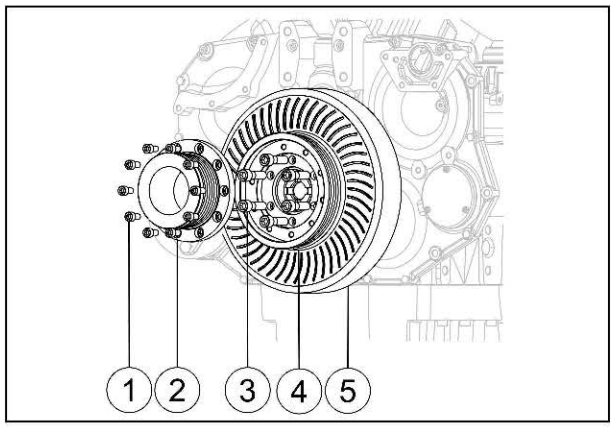


Fig. 778

(1) Screws of the top belt pulley
(2) Top belt pulley
(3) Screws of the bottom belt pulley
(4) Bottom belt pulley
(5) Vibration damper

2.26 Lubrication system

2.26.1 Do a check for the oil pressure regulating valve

If the pressure of the engine lubricating oil is not sufficient or the pressure changes, you must do a check for the oil level. If it is necessary, do a check for the oil pressure regulating valve after the check of the oil level.

Procedure

1. Drain the engine oil.
2. Remove the oil sump.
3. Remove the nut (1) and the lock plate (2).
4. Remove the larger spring (3) and the smaller spring (4).
5. Clean the parts.
6. Make sure that the sealing surfaces are not damaged.

   Damaged parts must be replaced.
7. Install the springs.
8. Install the lock plate and the nut.

   NOTE: *Make sure that the lock plate goes under the nut.*
9. Tighten the nut to 210 ± 10 Nm.
10. Install the oil sump.
11. Fill in the lubricating oil.

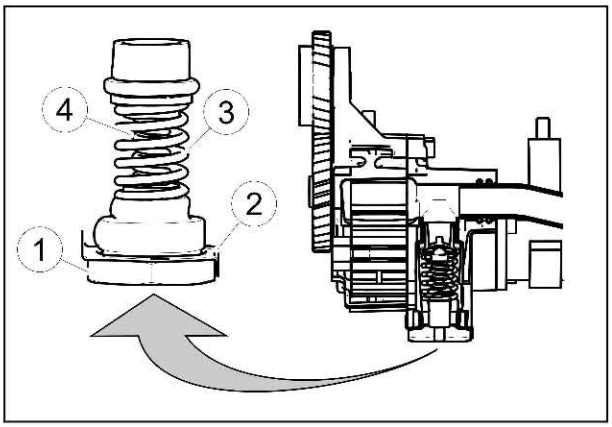


Fig. 779

(1) Nut
(2) Lock plate
(3) Larger spring
(4) Smaller spring

Related Links

Fitting the oil sump gasket page 2-329
Oil quality requirements page 2-239
Oil sump capacity page 2-330

2.26.2 Removing the oil pump

Procedure

1. Drain the engine oil.
2. Remove the oil sump.
3. Remove the oil pump suction and pressure pipe.
4. Remove the oil pump together with any shims between the oil pump and the cylinder block.

2.26.3 Fitting the oil pump

Procedure

1. Fit the oil pump.

2. Check the tooth backlash.
   a) Check the backlash between the crankshaft gear and idle gear.
   b) Check the backlash between the idle gear and the oil pump gear.

   NOTE: *When measuring the tooth backlash, the engine should be the correct way up as the crankshaft bearing clearance affects the tooth backlash.*

   The clearance is adjusted with shims between the pump body and the cylinder block. One shim increases/decreases the backlash by about 0.07 mm.

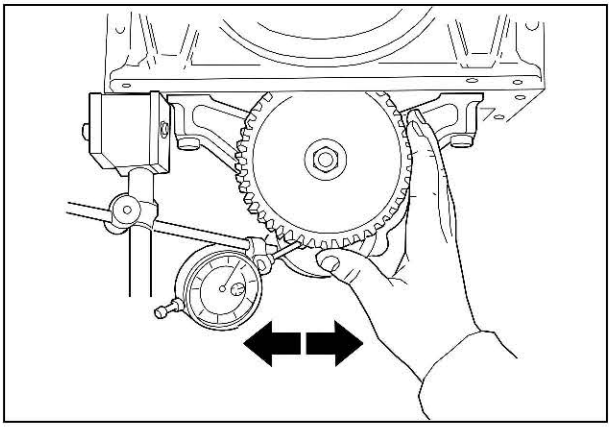


Fig. 780

3. Connect the oil pump suction and pressure pipes using new seals.
4. Apply thread sealer Loctite 242 to oil sump bolts (engines with steel sump).
5. Fit the oil sump.
6. Fill in the lubrication oil.

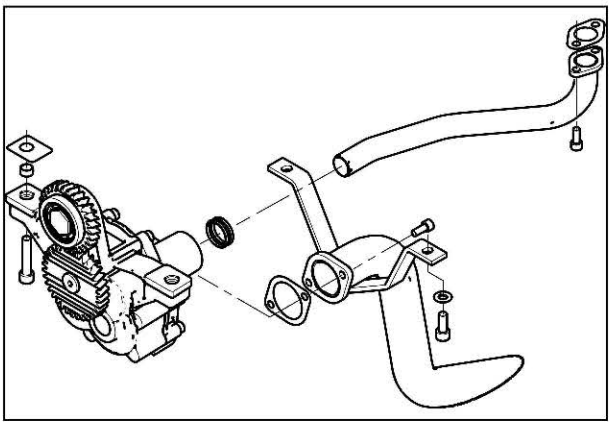


Fig. 781

Related Links

Fitting the oil sump gasket page 2-329
Oil quality requirements page 2-239
Oil sump capacity page 2-330

2.26.4 Piston cooling nozzles

The engines with high output have piston cooling nozzles. You can remove the piston cooling nozzles after the oil sump. The nozzles have a valve with an opening pressure of 2.3±0.25 bar.

Procedure

1. Remove the valve from the engine and do a check for its function.

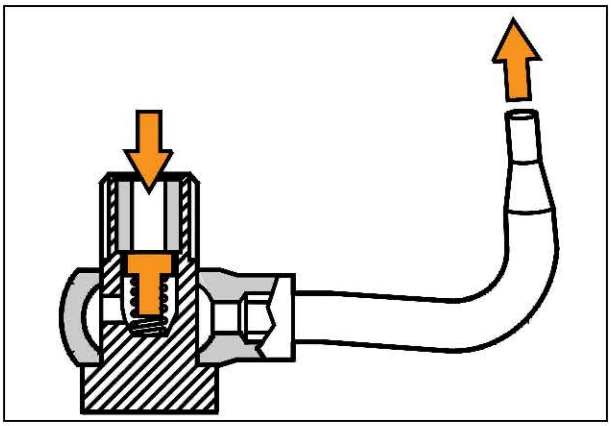


Fig. 782

2. Use tool V920243710 to have the correct position for the piston cooling nozzle.

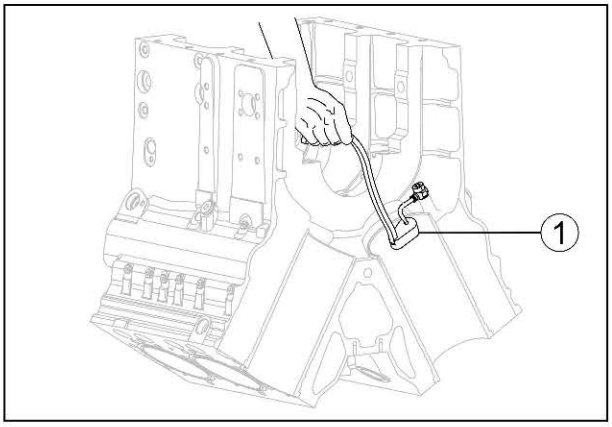


Fig. 783

(1) Installation tool for piston cooling nozzle V920243710

3. Install the nozzle pipe at a 95° angle to the center line of the crankshaft.
4. Tighten the valve to 30 Nm.
5. Make sure that the pipe does not touch the pistons, connecting rods or the counterweights of the crankshaft when the engine is running.

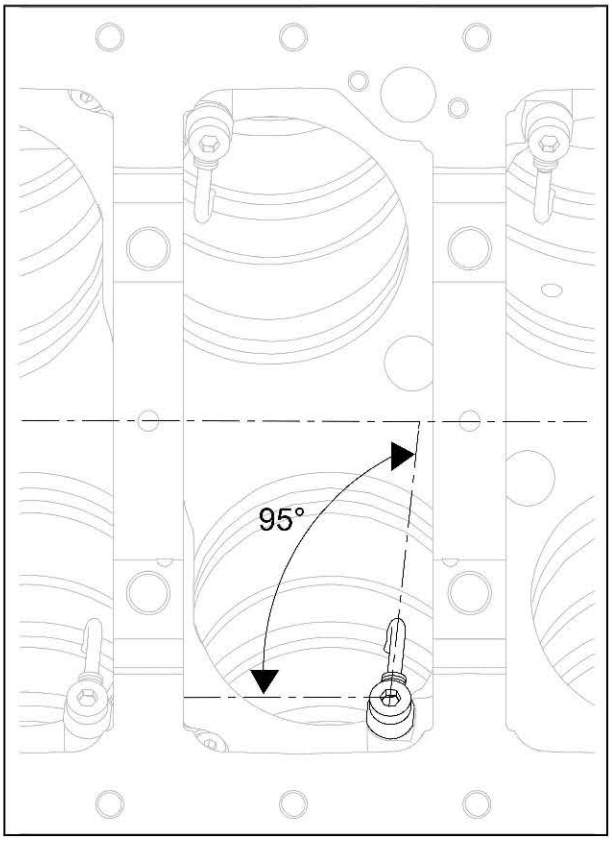


Fig. 784

2.26.5 Fitting the oil sump gasket

Procedure

1. Fit the oil sump gasket against the cylinder block.
2. Make sure that the oil sump gasket is fitted in correct position.

   There is a cut for the oil pressure pipe flange on the left side of the oil sump gasket. The oil sump gasket must not remain under the oil pressure pipe flange. If the oil sump gasket remains under the oil pressure pipe flange, it can result in oil leak.

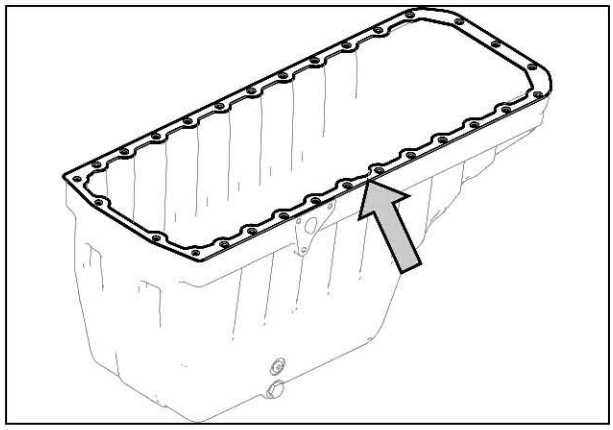


Fig. 785

2.26.6 Removing the oil cooler

Procedure

1. Remove the turbo oil pipes and the oil pressure pipe.
2. Remove the CCV pressure oil pipe.
3. Remove the oil filter.
4. Drain the oil into a container.
5. Remove the oil cooler from the engine and simultaneously remove the coolant pipes from the oil cooler.
6. Unscrew the cell screws and remove the cell from the mounting bracket.
7. Clean all the parts.

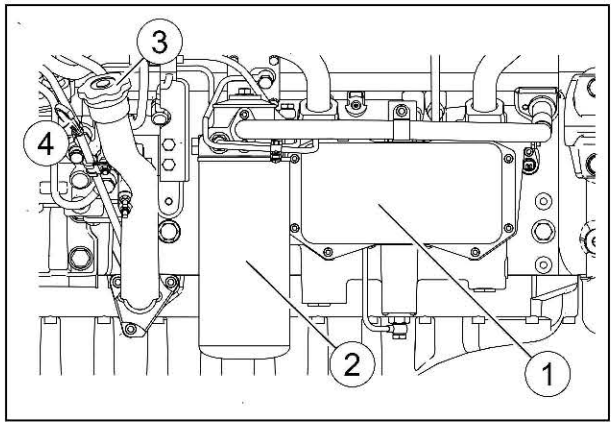


Fig. 786

(1) Oil cooler
(2) Oil filter
(3) Oil filler plug
(4) Oil dipstick

Related Links

Change oil filter page 2-331

2.26.7 Fitting the oil cooler

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Procedure

1. Fit the cell to the mounting bracket.
   - After fitting the cell to the mounting bracket, the oil side can be pressure tested. Test pressure is 4 bar.
   - After fitting the cell to the mounting bracket, the water side can be pressure tested. Test pressure is 4 bar.
2. Fit the oil cooler to the engine and simultaneously fit the coolant pipes to the oil cooler.
3. Fit the oil pipes.
4. Replace the oil filter.
5. Fill the coolant system.
6. Start the engine and check for leakages.

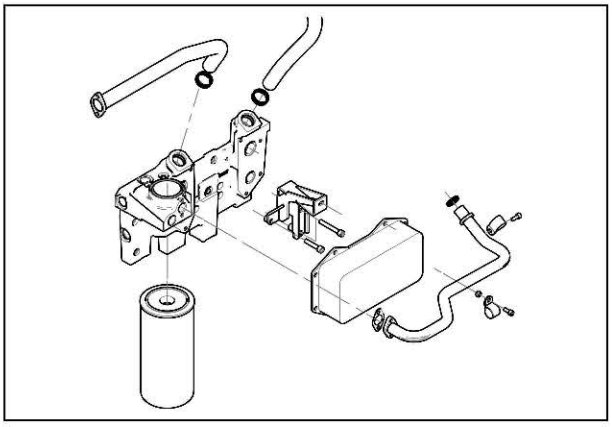


Fig. 787

Related Links

Change oil filter page 2-331
Coolant quality requirements page 2-239

2.26.8 Oil sump capacity

Oil sump capacity

- minimum: 55 litres
- maximum: 62 litres

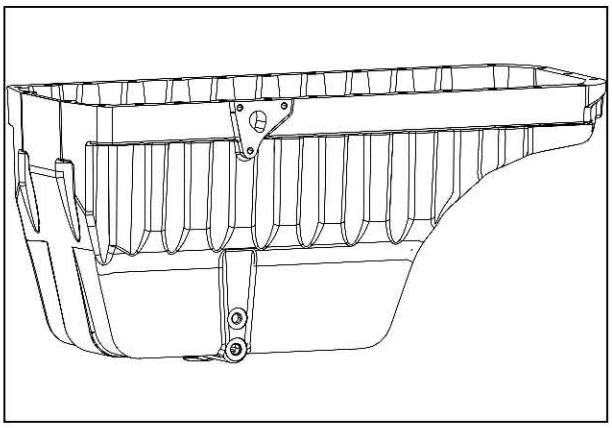


Fig. 788

2.26.9 Closed crankcase ventilation

The engine has a closed crankcase ventilation (CCV) with filtering of ventilation gases. This is to prevent oil and soot getting into engine air intake with ventilation gases. The CCV system is maintenance-free.

2.26.9.1 Installing the closed crankcase ventilation system components

The CCV filter is mounted on the front end of the cylinder block with a mounting bracket. Centrifugal filter is connected to engine oil circulation with a pipe. The ventilation gases are circulated from valve cover to inlet piping with rubber hoses.

Procedure

1. Replace the mounting bracket O-ring and shaped gasket, if the CCV filter has been removed
2. Fit the CCV system hoses.

   Make sure that there are no unnecessary bends or creases on the CCV system hoses.

   The hose line must be straightforwardly ascending as shown in the figure.
3. Make sure that the monitoring hole for ambient pressure is not blocked.

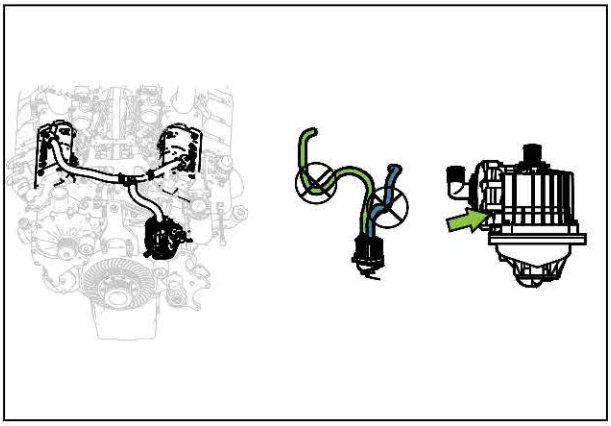


Fig. 789

2.26.10 Change oil filter

NOTE:
Make sure that you obey all the requirements of the engine warranty. You must obey the maintenance schedule recommended by the manufacturer. Use only the filters that have approval by the manufacturer or those of equivalent quality.

Procedure

1. Before removing the oil filter clean the surroundings of it.
2. Use the loop tool to remove the used oil filter.
3. Lubricate slightly the rubber gasket of the new oil filter with clean motor oil and clean the sealing faces.
4. Rotate the new oil filter carefully until the gasket touches the opposite surface.
5. Tighten the oil filter one (1) full round. Use an appropriate tool for tightening if necessary.
6. Wipe off any oil run onto the chassis.
7. Do a check for the quantity of oil in the engine.
8. If it is necessary, add oil.
9. Start the engine. Do not race.
10. Make sure that no oil is leaking from the oil filter.
11. Take the used oil filter to a proper disposal point.

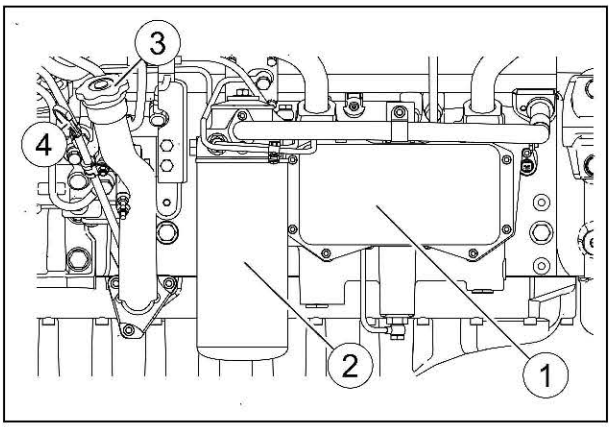


Fig. 790

(1) Oil cooler
(2) Oil filter
(3) Oil filler plug
(4) Oil dipstick

Related Links

Oil quality requirements page 2-239
Oil sump capacity page 2-330

2.27 Cooling system

2.27.1 Remove the thermostats

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

Procedure

1. Remove the primary ECU.
2. Remove the mounting brackets of the primary ECU.
3. Open the clamps of the coolant pipes connected to the thermostat housing.
4. Open the thermostat housing cover screws.
5. Disconnect the wiring from the coolant temperature sensor.

   NOTE: *Be careful with the thermostats. If it is necessary to have more space to disconnect the wiring from the coolant temperature sensor, move the thermostat housing cover.*

   a) Move carefully the thermostat housing cover parallel with the thermostat housing away from the engine until there is sufficient space to disconnect the wiring of the coolant temperature sensor.
   b) Disconnect the wiring of the coolant temperature sensor.
   c) Move carefully the thermostat housing cover parallel with the thermostat housing back to its position.
6. Remove the silicone hoses of the coolant pipes.
7. Remove the thermostat housing cover.
8. Remove the thermostats.
9. Clean the sealing surfaces.

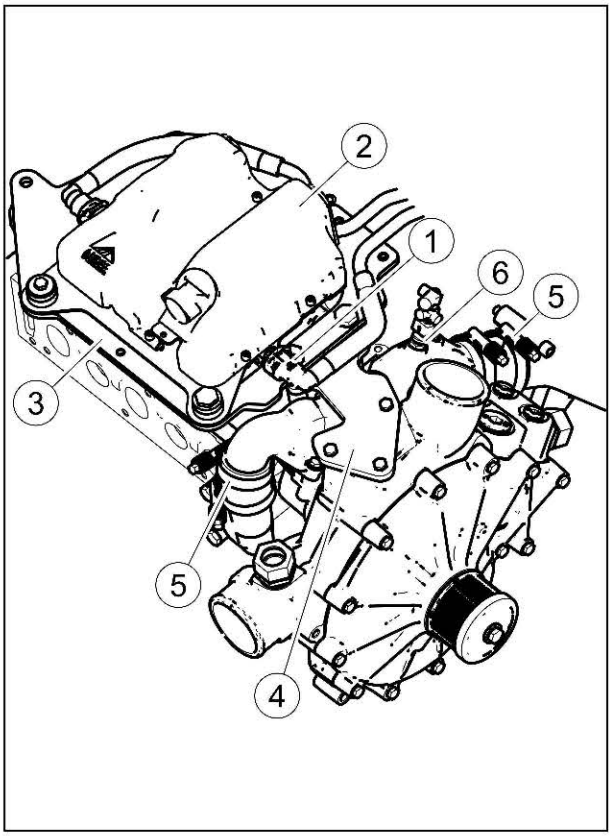


Fig. 791

(1) Fuel pipe connector
(2) Primary ECU (electronic control unit)
(3) Mounting bracket
(4) Mounting bracket
(5) Clamp
(6) Coolant temperature sensor

2.27.2 Testing the thermostat

Procedure

1. Lower the thermostat into a vessel of boiling water so that it does not touch the sides or bottom.
2. Opening of the thermostat must begin after less than 20 seconds.
3. The thermostat must be fully open in less than 50 seconds. See the technical data of the thermostat.

2.27.3 Replace the thermostat

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

Procedure

1. Lubricate the seal rings with liquid soap and put the thermostats in the thermostat housing.
2. Install the thermostat housing cover.

   Do not tighten the thermostat housing cover screws.
3. Install the silicone hoses of the coolant pipes.
4. Connect the wiring to the coolant temperature sensor.

   If it is necessary to have more space to connect the wiring to the coolant temperature sensor, move the thermostat housing cover.

   a) Move carefully the thermostat housing cover parallel with the thermostat housing away from the engine until there is sufficient space to connect the wiring of the coolant temperature sensor.

   NOTE: *Be careful with the thermostats.*

   b) Connect the wiring of the coolant temperature sensor.

   c) Move carefully the thermostat housing cover parallel with the thermostat housing back to its position.
5. Tighten the thermostat housing cover screws.
6. Tighten the clamps of the coolant pipes.
7. Install the mounting brackets of the primary ECU.
8. Install the primary ECU.

   See the instructions for installing the ECU.

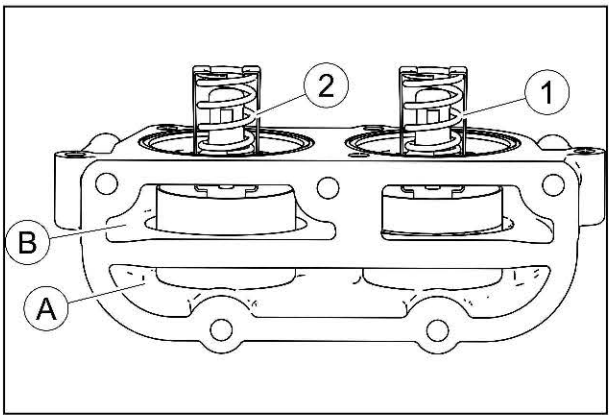


Fig. 792

(1) Thermostat 82°C
(2) Thermostat 79°C
(A) Cold coolant circuit
(B) Hot coolant circuit

Related Links

Replace the electronic control unit page 2-388

2.27.4 Reconditioning the coolant pump

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Procedure

1. Drain the coolant.
2. Remove the coolant pump cover.
3. Remove the belt pulley by opening the belt pulley fixing screw.
4. Remove the impeller.
5. Tap out the water seal and the shaft.
6. Remove the bearings and the intermediate sleeve from the shaft.
7. Clean the parts and inspect the condition of the parts.
8. Replace faulty or worn parts with new ones.
9. Fit the bearings and the intermediate sleeve onto the shaft.
10. Grease the bearings with heat-resistant ball bearing grease (NLGI 2).
11. Fit the shaft and the bearings into the coolant pump.

    Ensure the ball bearings do not transmit the pressure.

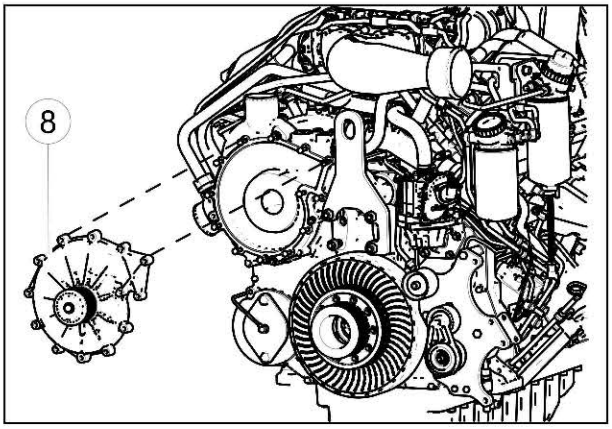


Fig. 793

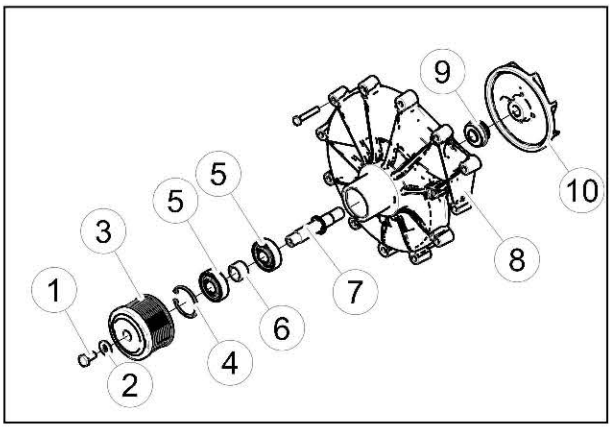


Fig. 794

(1) Belt pulley fixing screw
(2) Washer
(3) Belt pulley
(4) Lock spring
(5) Bearing
(6) Intermediate sleeve
(7) Shaft
(8) Coolant pump cover
(9) Water seal
(10) Impeller

12. Fit the water seal with drift.

Use coolant as a lubricating liquid between the shaft and the seal.

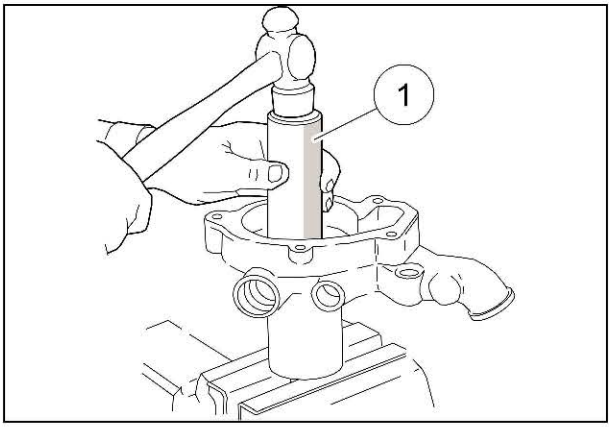


Fig. 795

(1) Drift ACW2322830

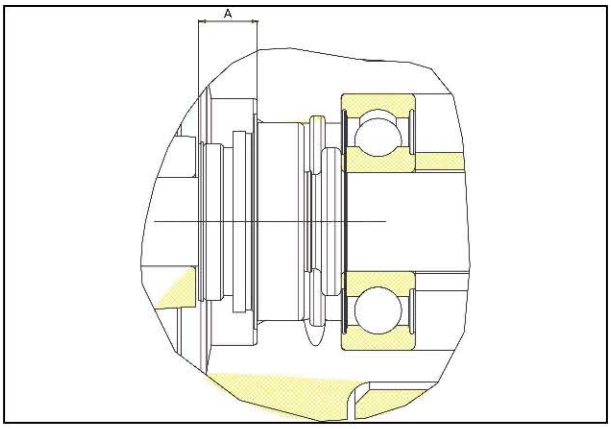


Fig. 796

(A) Mounting dimension for the water seal, A = 11.15 ± 0.18 mm

13. Press the impeller into position.

At the same time, support the shaft at the other end.

The mounting depth for the impeller is B = 3.8 mm ± 0.1 mm.

Ensure the shaft can rotate freely.

14. Fit the belt pulley by fixing the belt pulley fixing screw.

15. Fit the coolant pump cover.

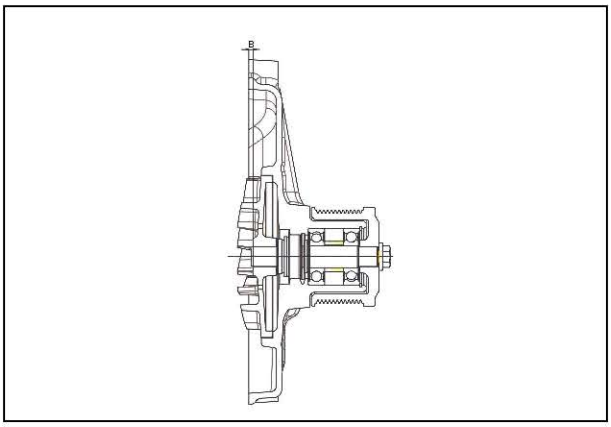


Fig. 797

(B) Mounting dimension for the impeller, B = 3.8 mm ± 0.1 mm

2.27.5 Installing the cylinder head connection part

Procedure

1. Install the cylinder head connection part and the return pipes with the gaskets.

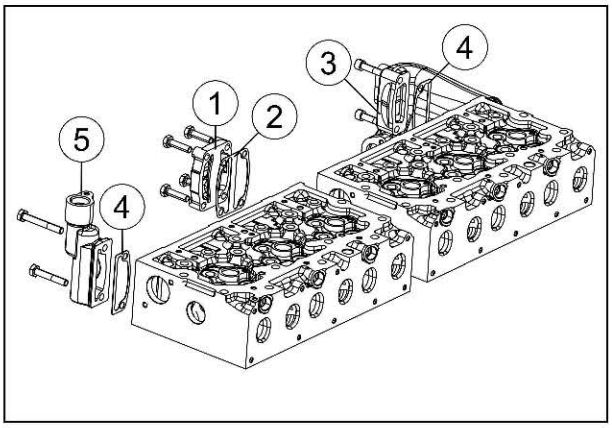


Fig. 798

(1) Cylinder head connection part
(2) Gasket, cylinder head connection part
(3) Coolant pump return pipe
(4) Gasket
(5) EGR return pipe

2. Tighten the screws in crosswise sequence.

   The tightening torque is 50 Nm.

2.27.6 Remove the rear distribution unit of the coolant

Procedure

1. Remove the coolant pipes between the front distribution unit and the rear distribution unit.
2. Remove the coolant pipes between the rear distribution unit and the EGR actuator.
3. Remove the coolant pipes between the rear distribution unit and the actuators of the high-pressure turbochargers.
4. Remove the rear distribution unit.

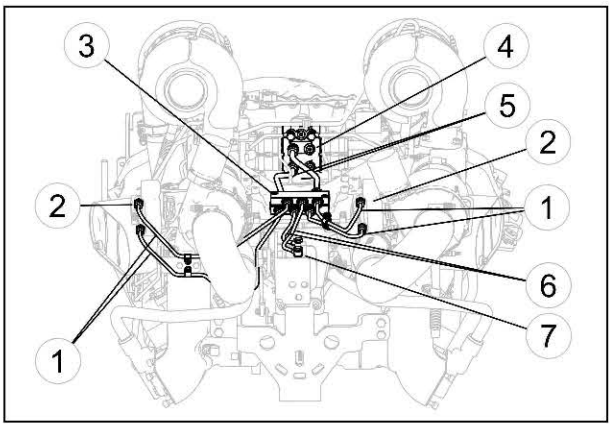


Fig. 799

(1) Coolant pipe for the actuator of the high-pressure turbocharger
(2) Actuator of the high-pressure turbocharger (wastegate actuator)
(3) Rear distribution unit of the coolant
(4) Front distribution unit of the coolant
(5) Coolant pipe between the front distribution unit and the rear distribution unit
(6) Coolant pipe for the EGR actuator
(7) EGR actuator

2.27.7 Install the rear distribution unit of the coolant

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Procedure

1. Install the rear distribution unit.
2. Install the coolant pipes between the rear distribution unit and the actuators of the high-pressure turbochargers.
3. Install the coolant pipes between the rear distribution unit and the EGR actuator.
4. Install the coolant pipes between the front distribution unit and the rear distribution unit.

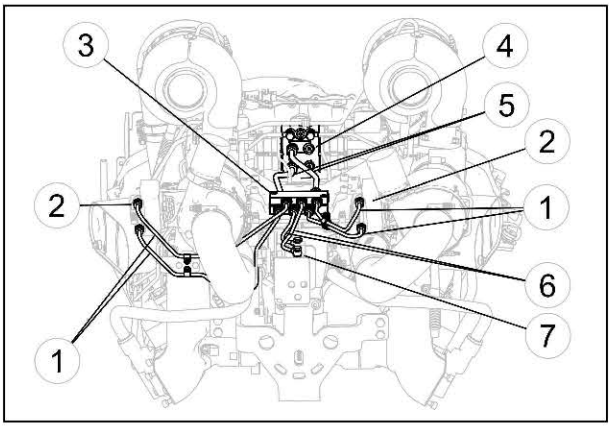


Fig. 800

(1) Coolant pipe for the actuator of the high-pressure turbocharger
(2) Actuator of the high-pressure turbocharger (wastegate actuator)
(3) Rear distribution unit of the coolant
(4) Front distribution unit of the coolant
(5) Coolant pipe between the front distribution unit and the rear distribution unit
(6) Coolant pipe for the EGR actuator
(7) EGR actuator

2.28 Air control system maintenance

2.28.1 Checking the air cleaner

The engine performance and length of service life depend to a great extent on the state of the air cleaner. A defective air cleaner allows impurities to pass through, which in time damages the turbocharger and the engine. A blocked air cleaner reduces the engine output and also causes oil leakage through the sealing ring on the turbocharger shaft.

See the instructions of the machine manufacturer for checking or cleaning the air cleaner.

2.28.2 Do a check for the inlet and exhaust pipes

If there are leaks in the inlet or exhaust system, those drastically decrease the effectiveness of the turbocharger. Because of the pressure, even small leaks in the manifold or the turbine inlet contact flange quickly increase in size. Because of this, it is necessary to repair all leaks immediately.

Inlet air

Exhaust gases

Lubrication oil

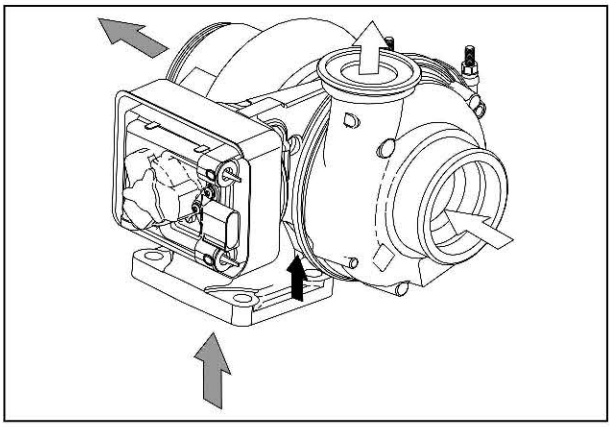


Fig. 801

Procedure

1. Do a check for the pipes and sealing surfaces between the air cleaner and the turbocharger.
2. Do a check for the pipes and sealing surfaces between the turbocharger and the intake manifold.
   a) If there is dust in the intake manifold, there is a leak in the air cleaner or the inlet pipes.
   b) Repair the leak.
3. Clean the sealing surface of the intake manifold.
   a) Do a check that the sealing surface is flat, use a straight ruler.
   b) Machine or renew the intake manifold, if the sealing surface is not flat or the sealing surface has scratches on it.
4. Make sure that the cylinder heads are parallel.
5. Use a new gasket and install the intake manifold.

   Tighten the intake manifold attaching screws to 30 Nm.
6. Install the air pipes carefully.
7. Do a check that the exhaust manifold is airtight.
   a) Tighten the exhaust manifold nuts to 50 Nm.
   b) Do a check that there is not a damage (cracks, deformation, corrosion etc.)
   c) Do a check for the connection between the turbocharger and the exhaust manifold.
8. If it is necessary, remove the exhaust manifold.
   a) Clean the sealing surfaces and remove any carbon deposits.
   b) Do a check that the sealing surfaces are flat.
   c) Machine the attaching flanges or renew the exhaust manifold, if the attaching flanges are twisted or there are scratches on the sealing surfaces.
9. Make sure that there are not loose objects or impurities in the exhaust pipe or the silencer.

Any loose objects or impurities can increase the back pressure for the exhaust gases from the turbine wheel.

2.28.3 Remove the exhaust manifold

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

Procedure

1. Remove the nuts and spacer pieces of the exhaust manifold.

   Do not mix the spacer pieces, they are of different lengths.

2. Remove the exhaust manifold.

3. Remove the stud bolts of the exhaust manifold.

   Do not mix the stud bolts, they are of different lengths.

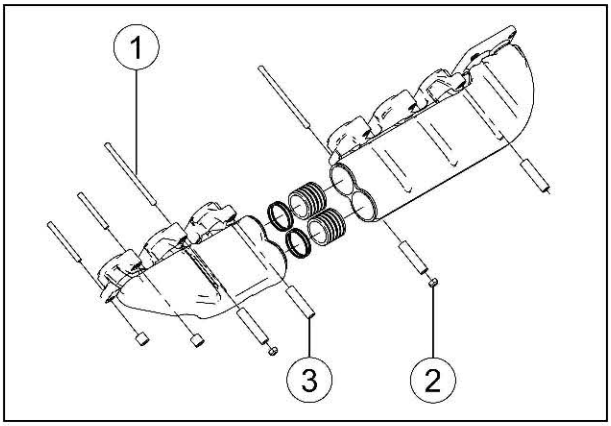


Fig. 802
(1) Stud bolt
(2) Nut
(3) Spacer piece

2.28.4 Install the exhaust manifold

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Procedure

1. Clean the sealing surfaces and remove carbon deposit.

2. Make sure that the sealing surfaces are flat.

3. Examine for damage (cracks, deformation, corrosion etc.).

4. Machine the fastening flanges or renew the exhaust manifold, if the fastening flanges are twisted or there are scratches on the sealing surfaces.

5. Install the stud bolts of the exhaust manifold to the cylinder head and tighten to 25 Nm.

   Make sure that the stud bolts are in correct sequence.

6. Install the exhaust manifold to the stud bolts.

7. Install the nuts and spacer pieces of the exhaust manifold.

   Do not mix the spacer pieces.

8. Tighten the nuts of the exhaust manifold to 50 Nm.

9. Make sure that the exhaust manifold is airtight.

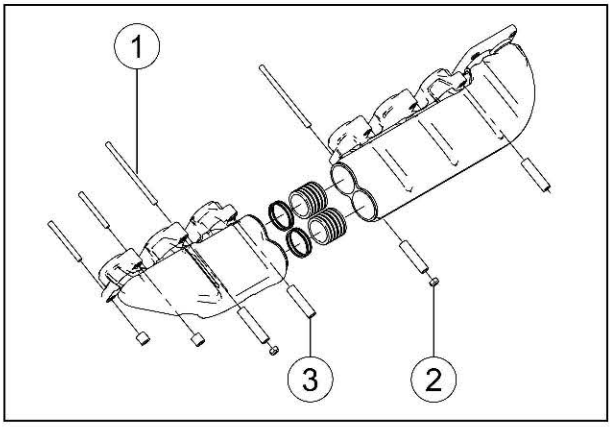


Fig. 803

(1) Stud bolt
(2) Nut
(3) Spacer piece

10. Make sure that the connection between the turbocharger and the exhaust manifold is airtight.

2.28.5 Remove the inlet manifold

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

1. Attach the inlet manifold to a lifting device.

   It is not necessary to remove the air pipe, the air-intake heater or the EGR pipe from the inlet manifold.

2. Remove the screws of the inlet manifold.

   Do not mix the attaching screws of the inlet manifold, they are of different lengths.

3. Remove the inlet manifold with the air pipe, the air-intake heater and the EGR pipe.

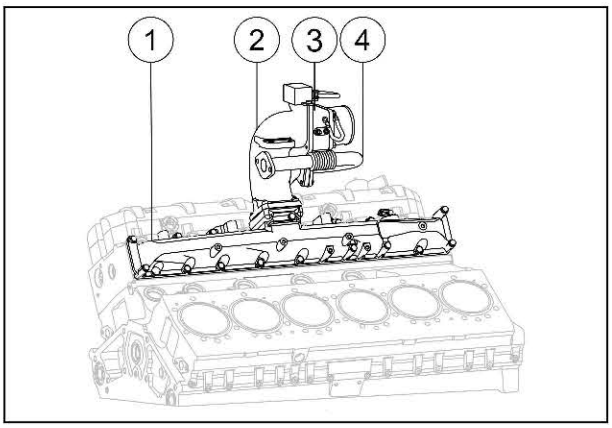


Fig. 804

(1) Inlet manifold
(2) Air pipe
(3) Air-intake heater
(4) EGR pipe

2.28.6 Install the inlet manifold

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

1. Clean the sealing surface of the inlet manifold.
2. Make sure that the sealing surfaces are flat.
3. Examine for damage (cracks, deformation, corrosion etc.).
4. Clean the inner surfaces of the inlet manifold.
5. Install stud bolts as guide pins.
6. Install the inlet manifold.

   It is possible to install the inlet manifold with the air pipe, the air-intake heater and the EGR pipe.
7. Install the attaching screws of the inlet manifold.

   Make sure that the attaching screws are in correct sequence.

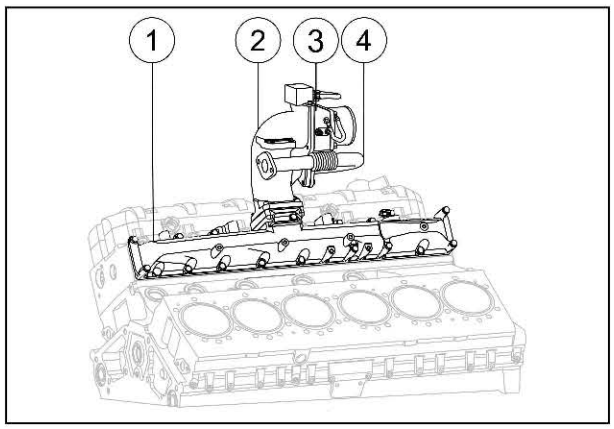


Fig. 805
(1) Inlet manifold
(2) Air pipe
(3) Air-intake heater
(4) EGR pipe

8. Tighten the attaching screws of the inlet manifold to 30 Nm.
9. Make sure that the inlet manifold is at the same level with the cylinder head.

2.28.7 Remove the actuator of the turbocharger

Procedure

1. Disconnect the wiring from the actuator of the turbocharger.
2. Remove the cooling pipes and the cooling pipe supports of the actuator.
3. Remove the actuator from the turbocharger without removing the mounting bracket of the actuator from the turbocharger.

   NOTE: *Do not remove the link rod of the actuator.*

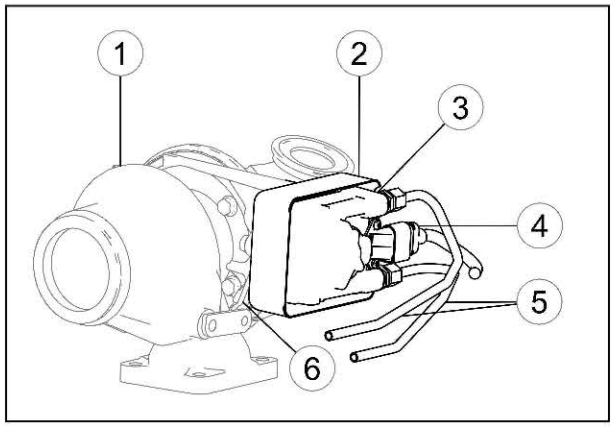


Fig. 806
(1) Turbocharger
(2) Mounting bracket of the actuator
(3) Actuator of the turbocharger
(4) Wiring
(5) Cooling pipes
(6) Link rod of the actuator

2.28.8 Install the actuator of the turbocharger

Procedure

1. Install the actuator to the turbocharger.
2. Install the cooling pipes and the cooling pipe supports.
3. Install the wiring to the actuator of the turbocharger.
4. Finally, remove the air from the cooling system by using the highest bleeding plug of the engine.

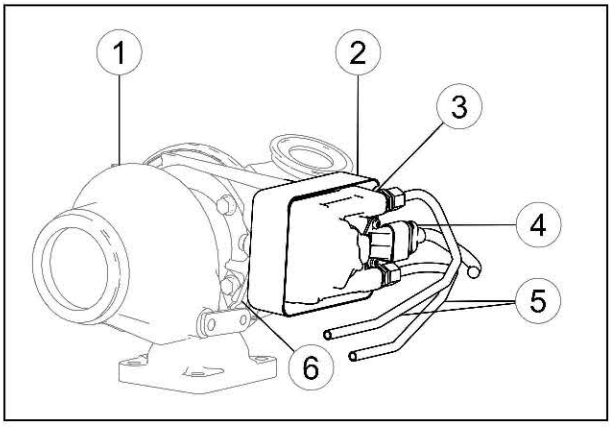


Fig. 807

(1) Turbocharger
(2) Mounting bracket of the actuator
(3) Actuator of the turbocharger
(4) Wiring
(5) Cooling pipes
(6) Link rod of the actuator

2.28.9 Remove the low-pressure turbochargers with the mounting bracket

Before starting the procedure

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

NOTE:
Before the removal of pipes, attach a written label on each of the pipes. Labels make it easier to install the pipes back to the engine.

Procedure

1. Disconnect the wiring from the actuators of the high-pressure turbochargers.
2. Disconnect the wiring from the EGR actuator.
3. Remove the coolant pipes for the actuators of the high-pressure turbochargers.
4. Remove the coolant pipes for the EGR actuator.
5. Remove the coolant pipes between the distribution units of the coolant.
6. Remove the rear distribution unit of the coolant from the rear end of the engine.
7. Remove the bleeding pipes for the EGR coolers.
8. Remove the bleeding pipes for the ICACs (interstage charge air coolers).
9. Remove the oil pipes for the low-pressure turbochargers.
10. Open the clamps of the boost hoses between the low-pressure turbochargers and the high-pressure turbochargers.
11. Remove the boost hoses between the low-pressure turbochargers and the high-pressure turbochargers.
12. Open the clamps of the boost hoses between the low-pressure turbochargers and the ICACs.

13. Remove the boost hoses between the low-pressure turbochargers and the ICACs.

14. Open the top screws of the vertical supports for the low-pressure turbochargers.

15. Open the screws holding the mounting bracket for the low-pressure turbochargers.

16. Remove the low-pressure turbochargers with the mounting bracket.

    The vertical supports stay to the mounting bracket of the ICACs.

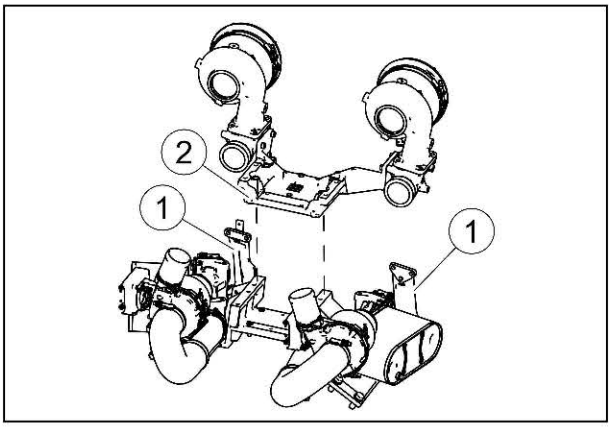


Fig. 808
(1) Vertical support
(2) Mounting bracket

2.28.10 Install the low-pressure turbochargers with the mounting bracket

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

CAUTION: Risk of engine damage.

Clearance between the component and the contact surface can cause large forces in the parts and cause engine damage.

When you install heavy components, make sure that the parts are parallel to the contact surface.

Procedure

1. Install the low-pressure turbochargers with the mounting bracket.

2. Tighten the screws holding the mounting bracket for the low-pressure turbochargers.

3. Tighten the top screws of the vertical supports for the low-pressure turbochargers.

4. Install the boost hoses between the low-pressure turbochargers and the ICACs (interstage charge air cooler).

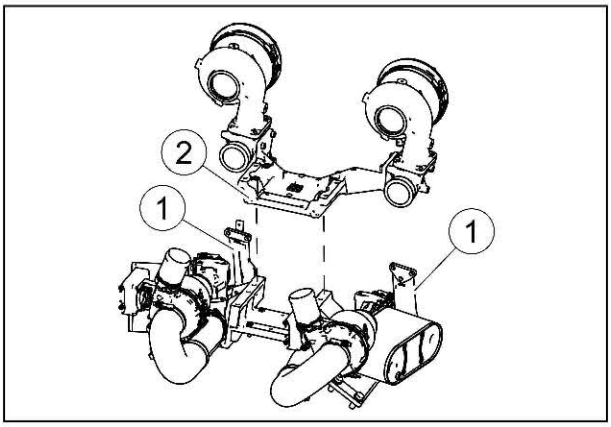


Fig. 809
(1) Vertical support
(2) Mounting bracket

5. Tighten the clamps of the boost hoses between the low-pressure turbochargers and the ICACs.

6. Install the boost hoses between the low-pressure turbochargers and high-pressure turbochargers.

7. Tighten the clamps of the boost hoses between the low-pressure turbochargers and the high-pressure turbochargers.

8. Install the oil pipes for the low-pressure turbochargers.
9. Install the bleeding pipes for the ICACs.
10. Install the rear distribution unit of the coolant in the rear end of the engine.
11. Install the bleeding pipes for the EGR coolers.
12. Install the coolant pipes between the distribution units of the coolant.
13. Install the coolant pipes for the EGR actuator.
14. Install the coolant pipes for the actuators of the high-pressure turbochargers.
15. Connect the wiring for the EGR actuator.
16. Connect the wiring for the actuators of the high-pressure turbochargers.

2.28.11 Removing the turbocharger

Procedure

1. Remove the inlet and exhaust pipes and pressure and return oil pipes from the turbocharger.
2. Untighten the clamp between the high pressure turbocharger and the intermediate piece of the turbochargers.
3. Remove the cooling pipes of the actuator and the actuator wire.
4. Remove the fixing nuts and remove the turbocharger.

2.28.12 Checking the turbocharger

If a fault is suspected in the turbocharger, it can be located in the following way:

Procedure

1. Visually inspect the turbine and compressor wheels. The vanes must not show any signs of damage, deformation or wear caused by foreign objects.
2. Investigate any oil leaks through the sealing rings on the shaft in the turbine and compressor housing.

   NOTE: *At low idling speed there is always a certain amount of oil leakage on the compressor side. However, this should not cause too much concern unless the oil consumption is too great.*

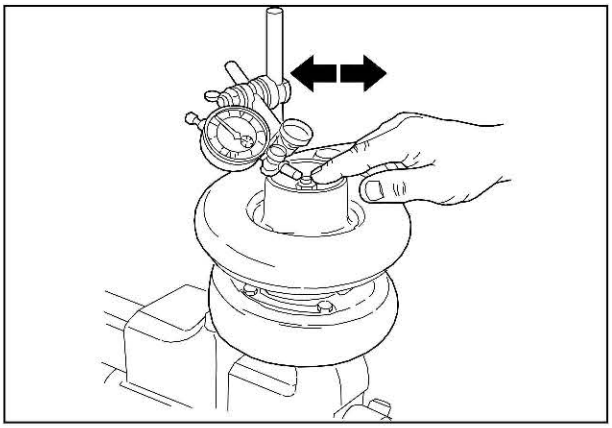


Fig. 810

3. Check the turbine shaft running clearance. Place the stylus of a dial gauge against the shaft and move the shaft sideways. Refer to the clearance given in the specifications. See **Technical data, Turbocharger**.

4. Check the shaft end float. Place the stylus of the dial gauge against the end of the shaft and move the shaft axially. Refer to the clearance given in the specifications. See **Technical data, Turbocharger**.

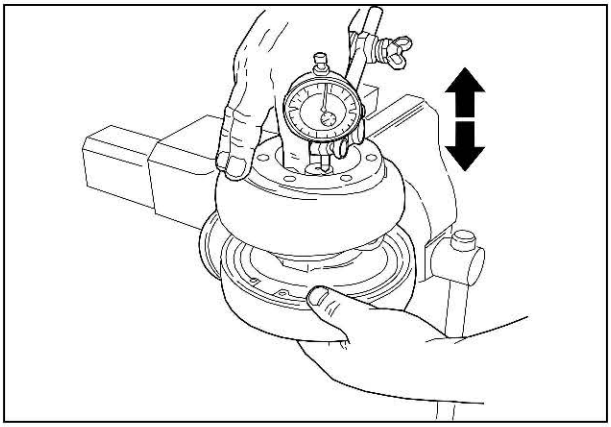


Fig. 811

Result of the procedure

If any defects or wear are detected, the turbocharger should be replaced.

If the engine does not work correctly and the turbocharger is not defective or too worn, the fault could be traced to one of the following items:

- Blocked air filter.
- Leakage in the inlet or exhaust systems. Leaking flange seal.
- Defective high-pressure pump or engine control unit.
- Defective or wrongly adjusted injectors.
- Low fuel pressure (e.g. blocked fuel filter).
- Low compression, wrong valve clearance.

Related Links

Turbocharger page 2-238

2.28.13 Install the high-pressure turbocharger

Find the cause of the defects on the turbocharger. Remedy the fault before you install a new turbocharger.

In order for the turbocharger to operate satisfactorily, it is important that the engine oil is in good condition. Likewise, the oil must be of the correct quality specification. Refer to the specification of the Operator's Manual to do the servicing of the air filter and the oil filter.

The adjusting of the engine control system has an effect to the function of the turbocharger. The adjusting must be made referring to the instructions of the manufacturer.

Tightening torque for the clamp of the inlet and exhaust pipes of the turbocharger is 12 Nm.

Procedure

1. Examine the tightness of the intake and exhaust manifolds, and that the manifolds are securely fastened.
2. Make sure that there are no loose carbon or rust particles, or other foreign objects in the manifolds.
3. Connect the turbocharger to the exhaust manifold and tighten using a new gasket.
4. Install the clamp between the high-pressure turbocharger and the connecting part of the turbochargers.
5. Connect the inlet pipe and the exhaust pipe to the turbocharger.
6. Connect the actuator cooling pipe and actuator wire.

7. Put approximately 0.1 litres of pure engine oil into the bearing housing before attaching the pressure oil pipe.

   This is very important in order to make sure that the turbocharger is lubricated when starting.

8. Connect the pressure and return oil pipes.
   a) Use a new seal.
   b) Make sure that there is no tension in the pipes when tightening.

9. Remove the air from the cooling system by using the highest bleeding plug of the engine.

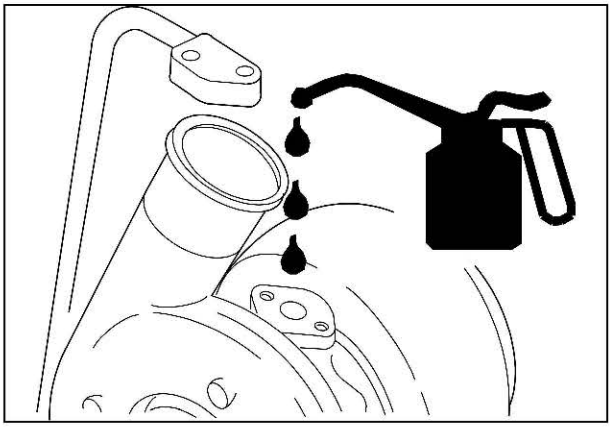


Fig. 812

10. Start the engine and check that there are no leaks.

2.28.14 Remove the EGR actuator

Procedure

1. Remove the coolant pipes of the EGR actuator.
2. Disconnect the EGR actuator wire.
3. Disconnect the actuator from the EGR link rod by opening the screw of the EGR actuator lever.

   NOTE: *Do not change the length of the EGR link rod.*

4. Open the attaching nuts of the EGR actuator.
5. Remove the EGR actuator from its mounting bracket.

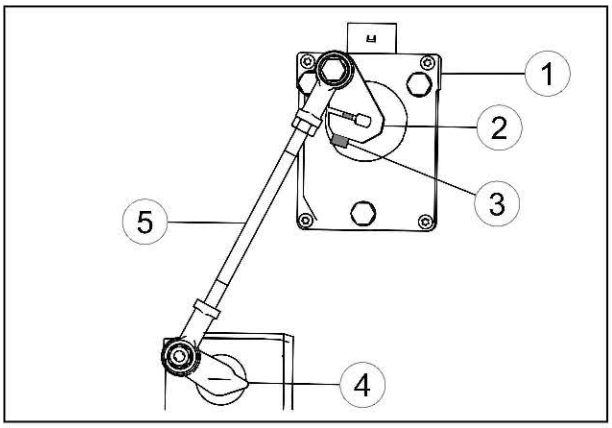


Fig. 813

(1) EGR actuator
(2) EGR actuator lever
(3) Screw of the EGR actuator lever
(4) EGR valve lever
(5) EGR link rod

2.28.15 Install the EGR actuator

Procedure

1. Install the EGR actuator into its mounting bracket and tighten the attaching nuts.
2. Connect the EGR link rod to the actuator and tighten the screw of the EGR actuator lever.

   NOTE: *See the information for the correct position of the levers and the correct length of the EGR link rod.*
3. Connect the coolant pipes of the EGR actuator and the EGR actuator wire.
4. Remove the air from the cooling system.

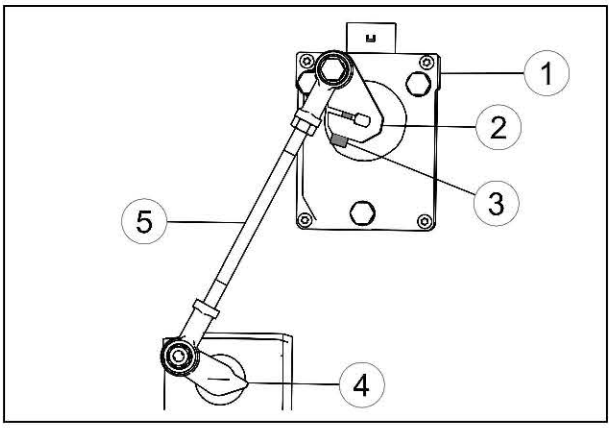


Fig. 814

(1) EGR actuator
(2) EGR actuator lever
(3) Screw of the EGR actuator lever
(4) EGR valve lever
(5) EGR link rod

Related Links

EGR link rod page 2-347

2.28.16 EGR link rod

The length of the EGR link rod must be adjusted very carefully. It is measured (1) from the ball joint centre of the EGR actuator lever to the ball joint centre of the EGR valve lever. The correct length of the link rod in static state is 203 mm.

Assembly is done by having the EGR valve in its off position. It is important that the EGR valve lever (A) and the EGR actuator lever (B) have an angle of 34°.

The EGR actuator will be calibrated automatically by the ECU every time, when the ignition power is turned on.

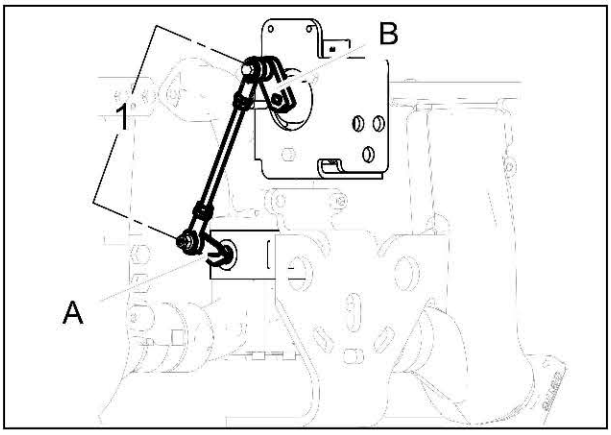


Fig. 815

2.28.17 Checking the EGR actuator voltages

The EGR actuator calibrates itself automatically (minimum position) before every start of the engine.

When the engine is running, the EGR actuator operates the EGR valve according to engine speed and load% (stepless control). When the engine is idling, the EGR valve remains closed. At engine speeds over 1500 rpm and when the load is heavy enough, the EGR actuator starts to adjust the EGR valve.

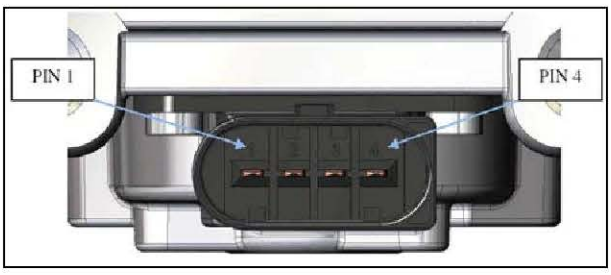


Fig. 816

The EGR actuator is controlled via can-bus and operated with 12V supply voltage.

In case of actuator malfunction the electronic control unit (ECU) activates an error code, which reduces engine power and running speed. Power is limited to ~75% of the maximum and the speed is limited to 1800 rpm.

Check the supply voltage to the EGR actuator and the can-bus voltages carefully.

Pin Number	Assignment
1	Vbat
2	GND
3	CAN low
4	CAN high

Procedure

1. Switch on the primary ECU.
2. Measure the voltage between wire 3 from the ECU and ground 2. The voltage should be approximately 2V.
3. Measure the voltage between wire 4 from the ECU and ground 2. The voltage should be approximately 3V.
4. Measure the voltage between wire 1 from the ECU and ground 2. The voltage should be approximately 12V.

2.28.18 Removing the ICACs with the mounting bracket

Before starting the procedure

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

NOTE:
Before the removal of pipes, attach a written label on each of the pipes. Labels make it easier to install the pipes back to the engine.

Procedure

1. Remove the low pressure turbochargers with the mounting bracket.
2. Remove the ECUs.
3. Remove the fuel filters with the mounting bracket.
4. Remove the mounting brackets of the ECUs.
5. Remove the EGR actuator.
6. Remove the EGR actuator mounting bracket.
7. Remove the thermal protection for the EGR actuator.
8. Remove the EGR coolers.
9. Remove the ICAC cooling pipes.
10. Open the ICAC mounting bracket screws.

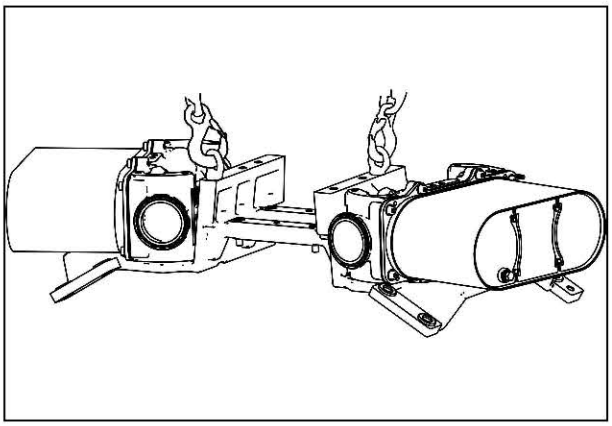


Fig. 817

11. Remove the ICACs with the mounting bracket.

Related Links

Remove the low-pressure turbochargers with the mounting bracket page 2-342
Remove the fuel filters with the fuel filter bracket page 2-354
Remove the EGR actuator page 2-346
Remove the EGR coolers with the air pipes and the high-pressure turbochargers page 2-350

2.28.19 Fitting the ICACs with the mounting bracket

Before starting the procedure

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

CAUTION: Risk of engine damage.

Clearance between the component and the contact surface can cause large forces in the parts and cause engine damage.

When you install heavy components, make sure that the parts are parallel to the contact surface.

Procedure

1. Fit the ICACs with the mounting bracket.
2. Tighten the ICAC mounting bracket screws.
3. Fit the ICAC cooling pipes.
4. Fit the EGR coolers.
5. Fit the thermal protection for the EGR actuator.
6. Fit the EGR actuator mounting bracket.
7. Fit the EGR actuator.
8. Fit the mounting brackets of the ECUs.
9. Fit the fuel filters with the mounting bracket.
10. Fit the ECUs.
11. Fit the low pressure turbochargers with the mounting bracket.

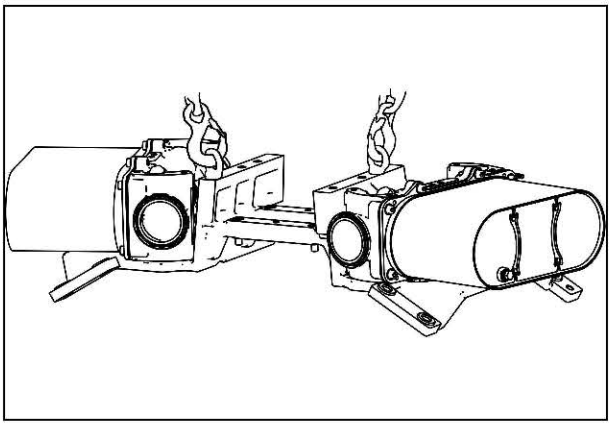


Fig. 818

Related Links

Install the EGR coolers with the air pipes and the high-pressure turbochargers page 2-351
Install the EGR actuator page 2-347
Install the fuel filters with the fuel filter bracket page 2-355
Install the low-pressure turbochargers with the mounting bracket page 2-343

2.28.20 Remove the EGR coolers with the air pipes and the high-pressure turbochargers

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

1. Remove the exhaust manifolds.
2. Remove the low-pressure turbochargers with the mounting bracket.
3. Disconnect the coolant pipes between the cylinder head and the EGR coolers.
4. Disconnect the bleeding pipes between the distribution unit and the EGR coolers.
5. Disconnect the EGR pipes from the EGR coolers.
6. Disconnect the coolant pipes between the EGR coolers and the coolant pump.

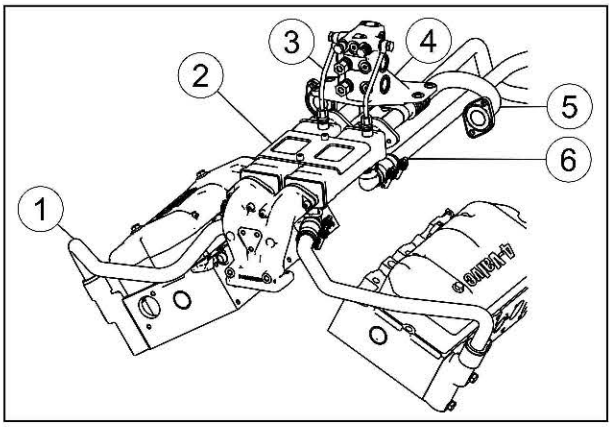


Fig. 819

(1) Coolant pipe between the cylinder head and the EGR cooler
(2) EGR cooler
(3) Bleeding pipe between the distribution unit and the EGR coolers
(4) Distribution unit
(5) EGR pipe
(6) Coolant pipe between the EGR cooler and the coolant pump

7. Disconnect the oil pipes from the high-pressure turbochargers.
8. Attach the lifting device to the lifting bracket.
9. Remove the screws between the connection flange of the low-pressure turbocharger and the vertical connection flange next to the ICAC.
10. Remove the attaching screws of the lifting bracket from the flywheel housing.
11. Make sure that the lift is balanced.
12. Remove the EGR coolers, air pipes and the high-pressure turbochargers as one assembly.

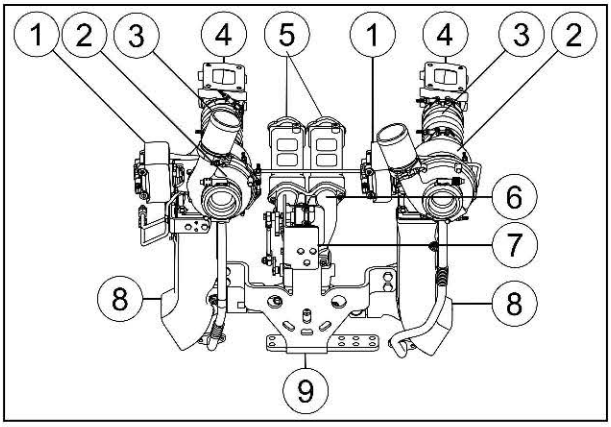


Fig. 820

(1) Actuator of the high-pressure turbocharger
(2) High-pressure turbocharger
(3) Air pipe of the high-pressure turbocharger
(4) Connection flange of the low-pressure turbocharger
(5) EGR coolers
(6) Air pipe of the EGR
(7) EGR actuator
(8) Connection flange of the exhaust manifold
(9) Lifting bracket

Related Links

Remove the exhaust manifold page 2-339
Remove the low-pressure turbochargers with the mounting bracket page 2-342

2.28.21 Install the EGR coolers with the air pipes and the high-pressure turbochargers

CAUTION: Heavy components.

Injury to persons or machine damage.

Make sure that you know the precautions to prevent injury or damage to the machine. Use the correct lift equipment.

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

1. Clean the sealing surfaces.

2. Attach the lifting device to the lifting bracket.
3. Make sure that the lift is balanced.
4. Lift the EGR coolers, air pipes, and the high-pressure turbochargers as one assembly to its position.
5. Tighten the screws between the connection flange of the low-pressure turbocharger and the vertical connection flange adjacent to ICAC .
6. Tighten the attaching screws of the lifting bracket.
7. Connect the oil pipes to the high-pressure turbochargers.

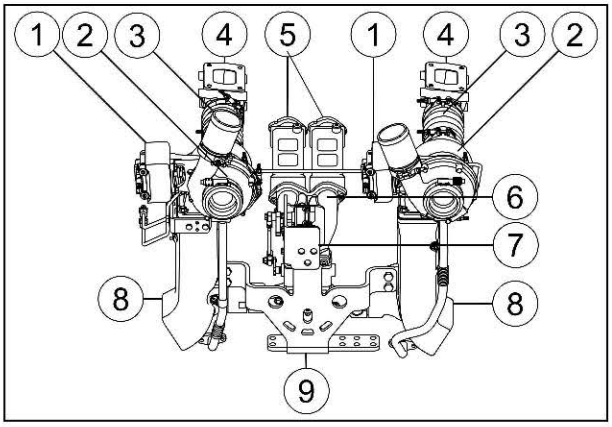


Fig. 821

(1) Actuator of the high-pressure turbocharger
(2) High-pressure turbocharger
(3) Air pipe of the high-pressure turbocharger
(4) Connection flange of the low-pressure turbocharger
(5) EGR coolers
(6) Air pipe of the EGR
(7) Actuator of the EGR
(8) Connection flange of the exhaust manifold
(9) Lifting bracket

8. Connect the coolant pipes between the EGR coolers and the coolant pump.
9. Connect the EGR pipes to the EGR coolers.
10. Connect the bleeding pipes between the distribution unit and the EGR coolers.
11. Connect the coolant pipes between the cylinder head and the EGR coolers.
12. Install the low-pressure turbochargers with the mounting bracket.
13. Install the exhaust manifolds.

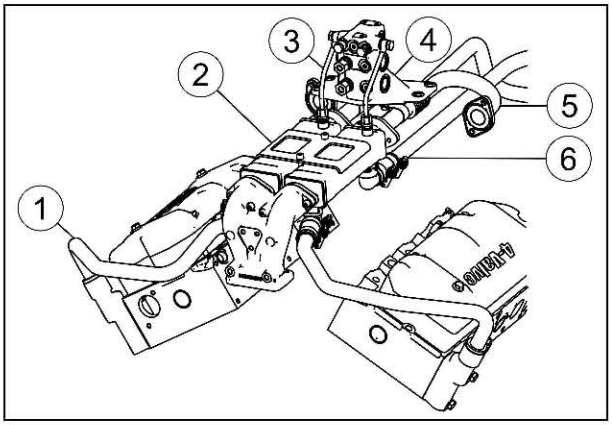


Fig. 822

(1) Coolant pipe between the cylinder head and the EGR cooler
(2) EGR cooler
(3) Bleeding pipe between the distribution unit and the EGR coolers
(4) Distribution unit
(5) EGR pipe
(6) Coolant pipe between the EGR cooler and the coolant pump

Related Links

Install the low-pressure turbochargers with the mounting bracket page 2-343
Install the exhaust manifold page 2-339

2.29 Fuel system

2.29.1 Bleed the fuel system

WARNING: High pressure fuel during and after engine operation.

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

CAUTION: Diesel fuel.

Diesel fuel can cause irritation if you touch or breathe it.

Use protective gloves, when you do work with fuel equipment.

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

NOTE: *Use eye protection, safety clothing and safety gloves during the work.*

Procedure

1. Open the bleeding plug on the pre-filter bracket.
2. Put a transparent hose in the plug hole and lead it into a suitable container.
3. Pump fuel with the hand pump on top of the pre-filter.
4. Pump with the hand pump until there are no air bubbles in the fuel stream.
5. Remove the hose and turn in the bleeding plug.
6. Clean the engine of eventual overspill fuel.

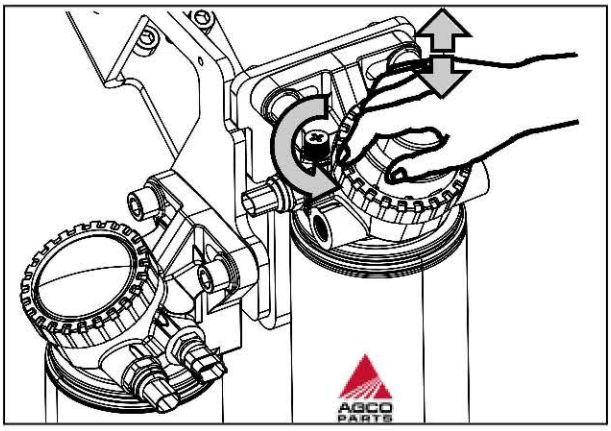


Fig. 823

7. Start the engine. The fuel system removes automatically the air left in the system.

   NOTE: *Do not use the hand pump when the engine is running. Do not use any tools or excessive force on the pre-filter hand pump.*

   NOTE: *The fuel system is equipped with a pressure sensor that alarms before interference has developed. Reasons can be for instance:*

   - *Empty fuel tank.*
   - *Clogged fuel filters.*
   - *Suction piping clogged or leaking air.*
   - *Unsuitable fuel (e.g. summer fuel in the winter).*

   NOTE: *Use of spirits as antifreeze is not useful or recommended at all. It makes the fuel solidify and weakens the lubricating qualities of the fuel and increases the possibility of corrosion.*

2.29.2 Measuring fuel feed pressure

Procedure

1. Clean the pre-filter, the fuel filter and the related fuel pipes from the outside.
2. Disconnect the fuel pressure sensor (1) from the fuel filter and connect the pressure gauge instead (the thread is M10x1).
3. Run the engine at low idling speed for a while and compare the gauge reading with the prescribed value (3,5 - 13 bar).

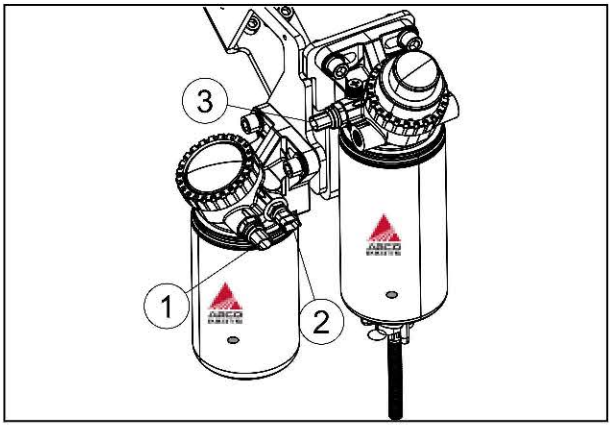


Fig. 824
(1) Fuel pressure sensor
(2) Fuel temperature sensor
(3) Fuel pressure sensor

Result of the procedure

If the pressure is below the prescribed value, this may be caused by:

- Clogged fuel filters.
- Suction piping clogged or leaking air.
- Empty fuel tank or unsuitable fuel (e.g. summer fuel in the winter).

2.29.3 Remove the fuel filters with the fuel filter bracket

You can remove the fuel filters with the fuel filter bracket. It is also possible to remove a larger assembly, including the ECU bracket and the bracket between the ECU brackets.

Procedure

1. Remove the air pipe and the throttle valves as one assembly.
2. Remove the cover of the ECU.

   Do the same step for the right side and the left side of the engine.
3. Remove the ECU.

   Do the same step for the right side and the left side of the engine.

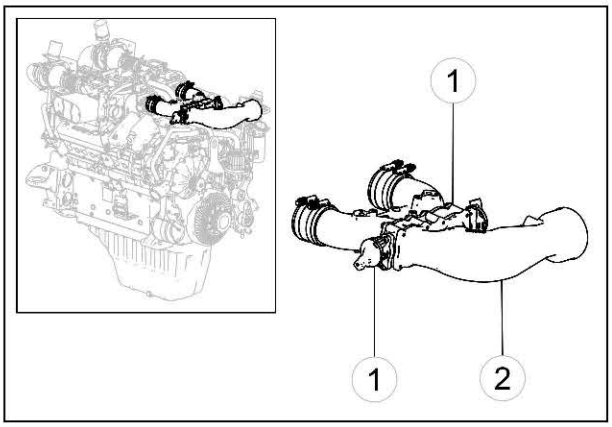


Fig. 825
(1) Throttle valve
(2) Air pipe

4. Disconnect the wires from the fuel pressure sensor, the fuel temperature sensor and the water detector.
5. Clean the high-pressure pump and the surroundings.
6. Remove the fuel pipes from the high-pressure pump and from the fuel filters.
7. Loosen the screws of the ECU bracket on the right side of the engine and remove the ECU bracket.
8. Loosen the screws of the ECU bracket on the left side of the engine.
9. Remove the fuel filters, fuel filter bracket, ECU bracket and the bracket between the ECU brackets as one assembly.

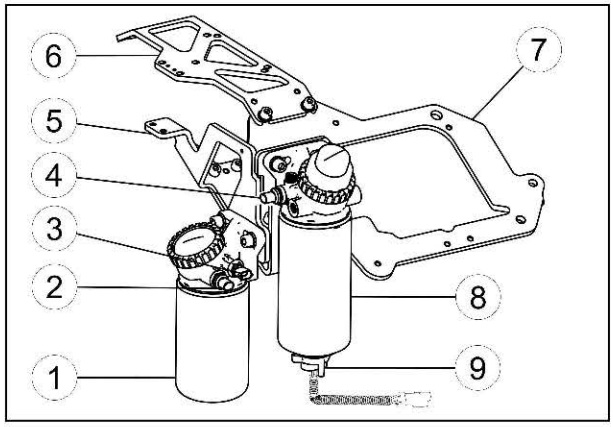


Fig. 826

(1) Fuel filter
(2) Fuel pressure sensor
(3) Fuel temperature sensor
(4) Fuel pressure sensor
(5) Fuel filter bracket
(6) Bracket between the ECU brackets
(7) ECU bracket
(8) Fuel pre-filter
(9) Water detector

2.29.4 Install the fuel filters with the fuel filter bracket

You can install the fuel filters with the fuel filter bracket. It is also possible to install a larger assembly, including the ECU bracket and the bracket between the ECU brackets.

CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

Procedure

1. Clean the high-pressure pump and the surroundings.
2. Install the fuel filters, fuel filter bracket, ECU bracket and the bracket between the ECU brackets as one assembly.
3. Tighten the screws of the ECU bracket.

Thread	Strength class		
	8.8	10.9	12.9
M8	25 Nm	35 Nm	40 Nm
M10	50 Nm	75 Nm	85 Nm
M12	85 Nm	125 Nm	145 Nm
M14	135 Nm	200 Nm	235 Nm
M16	210 Nm	310 Nm	365 Nm

4. Install the ECU bracket on the right side of the engine and tighten the screws.
5. Attach the fuel pipes to the high-pressure pump and to the fuel filters.
   a) Tighten the fuel pipes to the high-pressure pump with a torque of 25 Nm.
   b) Tighten the fuel return pipe from the rail to the high-pressure pump with a torque of 25 Nm.

6. Install the overflow line of the fuel system to the rail and to the fuel filter.

7. Connect the wires to the fuel pressure sensor, the fuel temperature sensor and the water detector.

8. Install the ECU.

   See for more instructions, how to install the ECU.

   Do the same step for the right side and the left side of the engine.

9. Install the cover of the ECU.

   Do the same step for the right side and the left side of the engine.

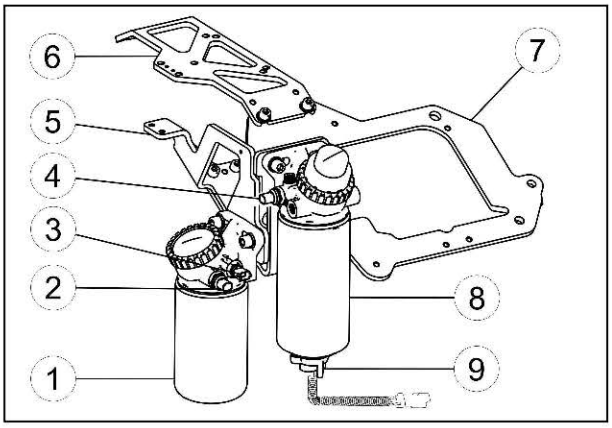


Fig. 827

(1) Fuel filter
(2) Fuel pressure sensor
(3) Fuel temperature sensor
(4) Fuel pressure sensor
(5) Fuel filter bracket
(6) Bracket between the ECU brackets
(7) ECU bracket
(8) Fuel pre-filter
(9) Water detector

10. Install the air pipe and the throttle valves as one assembly.

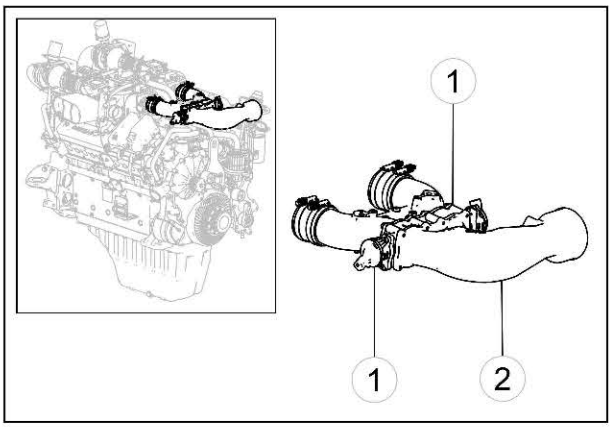


Fig. 828

(1) Throttle valve
(2) Air pipe

Related Links

Replace the electronic control unit page 2-388

2.29.5 Remove the injector overflow pipe

Procedure

1. Remove the banjo bolts from the overflow pipe.
2. Remove the overflow pipe.

2.29.6 Install the injector overflow pipe

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

1. Put the injector overflow pipe to correct position.
2. Tighten the banjo bolts of the overflow pipe lightly.
3. Tighten the fuel pipe of the rail to the injector overflow pipe.
4. Tighten the banjo bolts of the injector overflow pipe to the correct torque.

2.29.7 Inspecting injectors

WARNING: High pressure fuel during and after engine operation.

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

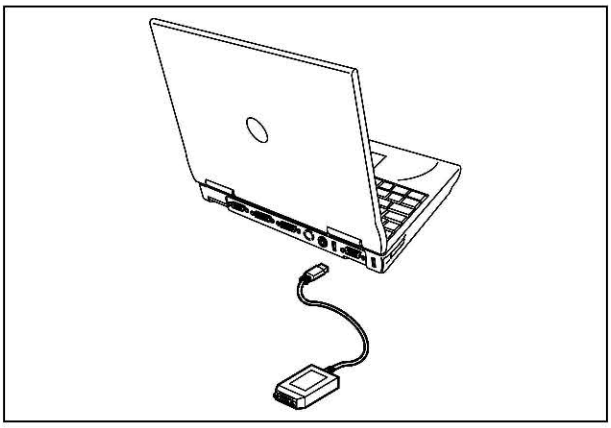


Fig. 829

The function of the injectors can be tested using service tool (so-called "Run-up test"). For more detail, please see the service tool manual.

NOTE: *The nozzle on the injector cannot be changed. Instead a spare injector is available.*

2.29.7.1 Remove the injectors (CRIN3)

Procedure

1. Clean the high-pressure pipes and surroundings.
2. Remove the valve cover.
3. Remove the high-pressure pipes.

   NOTE: *Prevent fuel flow to the engine via overflow pipe in the cylinder head (if the fuel tank is above the engine).*

4. Remove the locking ring of the injector wiring harness from the valve cover frame.

5. Push the connector of the injector wiring harness through the valve cover frame.

6. Remove the injector wiring harness carefully.

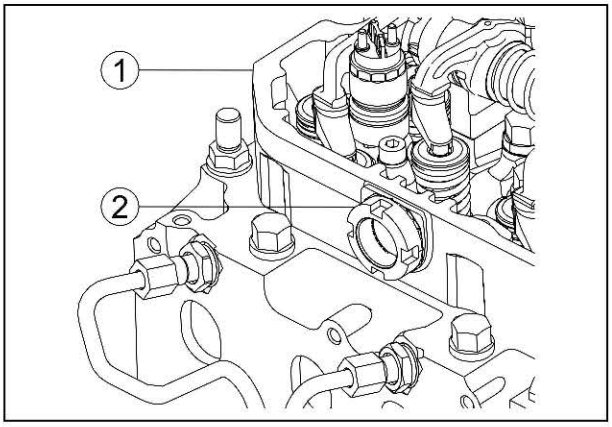


Fig. 830

(1) Valve cover frame
(2) Locking ring of the injector wiring harness

7. If you use the injector feeding pipes again, do a mark to identify which direction is up.

   NOTE: *It is necessary to do the installation to the same position.*

8. Loosen the attaching nut of the injector feeding pipe, do not remove it.

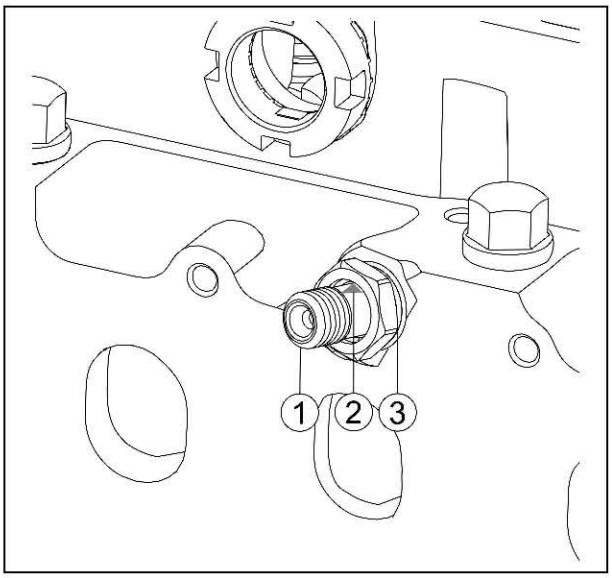


Fig. 831

(1) Injector feeding pipe
(2) Direction mark for the injector feeding pipe
(3) Attaching nut of the injector feeding pipe

9. Use the high-pressure pipe as puller to remove the injector feeding pipe from the cylinder head.

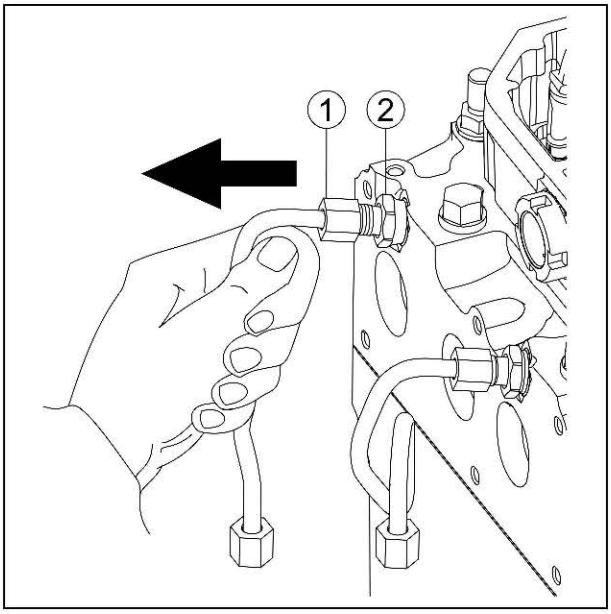


Fig. 832

(1) High-pressure pipe
(2) Attaching nut of the injector feeding pipe

10. Remove the injector attaching screw.

11. Use the injector fastener and an applicable tool to remove the injector from the cylinder head.

12. Plug plastic covers into all the connection points.

NOTE: *The injector and the feeding pipe are calibrated as couple. Do not mix them up.*

13. If it is necessary, remove the injector seal ring from the cylinder head (it can come out with the injector also).

14. Blow the injector and feeding pipe locations dry.

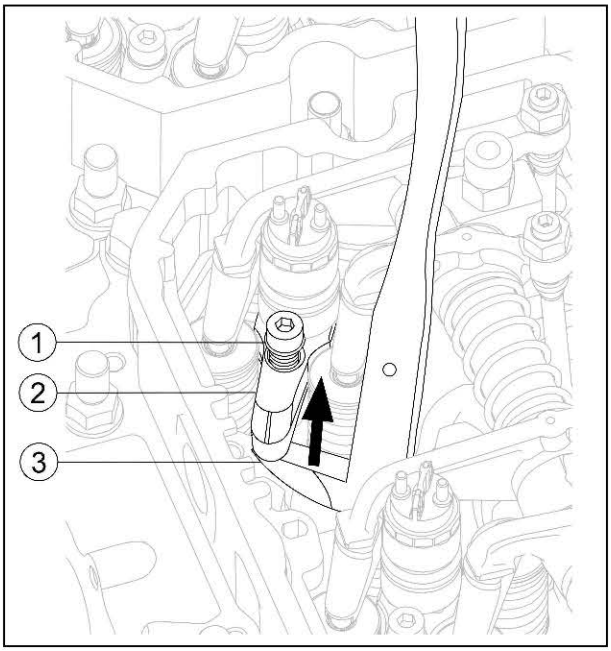


Fig. 833

(1) Injector attaching screw
(2) Injector fastener
(3) Example tool for removing the injector

Related Links

Remove the parts on top of the long block engine page 2-266

2.29.7.2 Install the injectors (CRIN3)

Before starting the procedure

NOTE:
Refer to the machine manual for the correct fastener torques.

Procedure

1. Make sure that the injector seat on the cylinder head is clean.
2. Replace the old seal ring and the O-rings with new ones.
3. Lubricate the O-rings.
4. Install the injector and feeding pipe on the cylinder head.

   Pay attention to the position of the feeding pipe. Adjust the feeding pipe control balls (shown with an arrow on the figure) so that they line up with the grooves in the cylinder head.
5. Tighten the fastening screw and nut progressively.
   a) Pre-tighten the fastening screw (2) to 15 Nm
   b) Loosen the fastening screw
   c) Pre-tighten the fastening nut (6) to 15 Nm
   d) Tighten the fastening screw (2) to 40 Nm
   e) Tighten the fastening nut (6) to 50 Nm

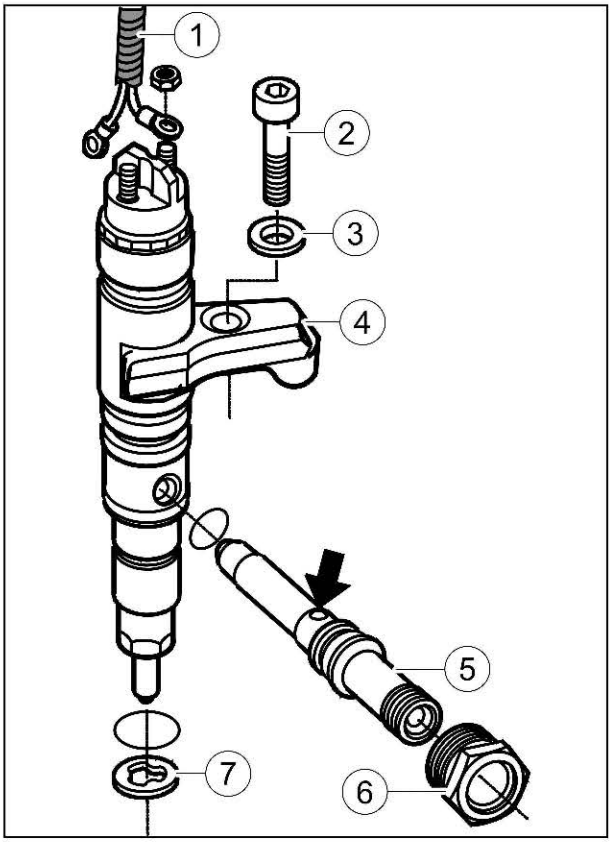


Fig. 834

(1) Injector wiring
(2) Fastening screw
(3) Washer
(4) Fastener
(5) Feeding pipe
(6) Fastening nut
(7) Seal ring

6. Install the high-pressure pipe.
7. Tighten the high-pressure pipe to correct torque value.
8. Install the injector wire.
9. Tighten the injector wire to correct torque value (nut M4).
10. Replace the valve cover seals.
11. Install the valve cover.
12. Tighten the valve cover to correct torque value.

Related Links

Install the parts on top of the long block engine page 2-273

2.29.8 High-pressure pump

You can use the high-pressure test of the EDT to examine the operation of the high-pressure pump. See the instructions in the EDT for more information.



Fig. 835

2.29.8.1 Removing the high-pressure pump

Before starting the procedure

WARNING: High pressure fuel during and after engine operation.

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

NOTE:
Before the removal of pipes, attach a written label on each of the pipes. Labels make it easier to install the pipes back to the engine.

Procedure

1. Disconnect the electric main switch.
2. Clean the high-pressure pump and surroundings.
3. Disconnect the MPROP wire.
4. Remove the fuel pipes connected to the high-pressure pump.
5. Insert protective plugs on the fuel pipe connections.

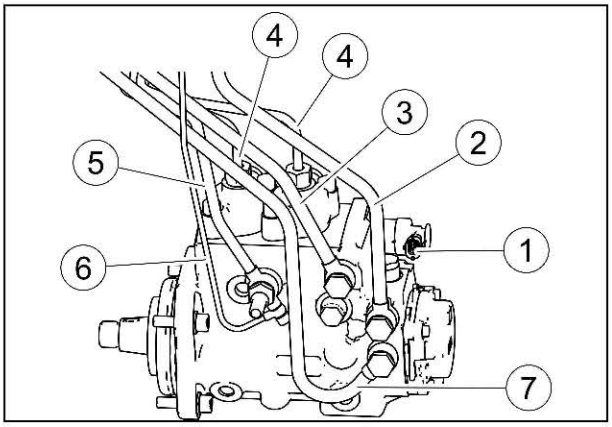


Fig. 836

(1) Magnetic proportional valve (MPROP)
(2) Fuel pipe from fuel pre-filter
(3) Fuel pipe from fuel filter
(4) Fuel pipe to rail
(5) Return pipe from rail
(6) Bleeding pipe from fuel filter
(7) Fuel pipe to main filter

6. Remove the cover.
7. Open the high-pressure pump gear nut.
8. Remove the high-pressure pump gear from the high-pressure pump.

   Use a puller to remove the high-pressure pump gear.

   Removing the gear housing cover is not necessary. The high-pressure pump gear remains inside the timing gear housing.
9. Open the high-pressure pump fixing screws.
10. Remove the high-pressure pump.

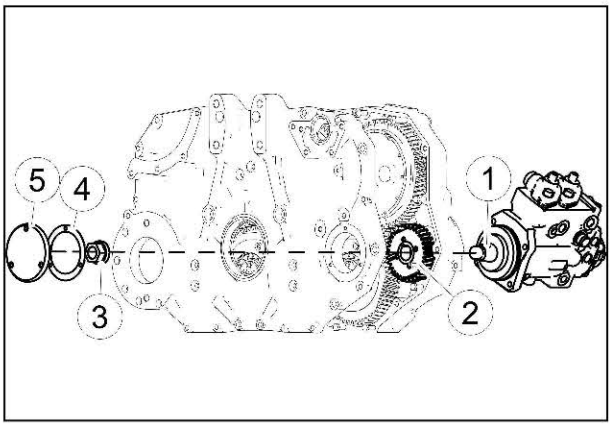


Fig. 837

(1) Key
(2) High-pressure pump gear
(3) High-pressure pump gear nut
(4) Seal
(5) Cover

Result of the procedure

The high-pressure pump can be taken to Bosch Diesel agent or to the AGCO Power Inc. to be reconditioned.

2.29.8.2 Install the high-pressure pump

Before starting the procedure

NOTE:
Refer to the machine manual for the correct fastener torques.

Procedure

1. Lubricate all O-rings.

2. Install the high-pressure pump.

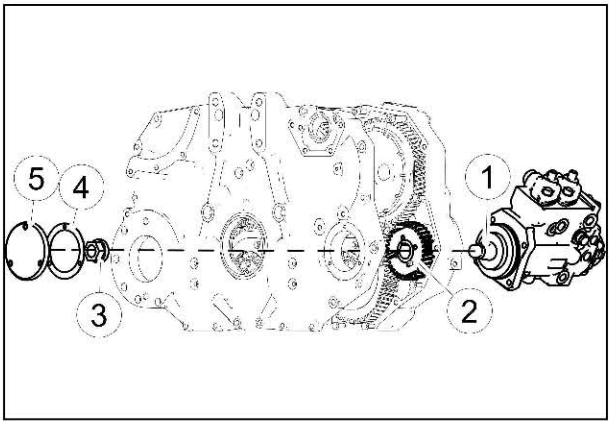


Fig. 838

(1) Guide pin
(2) Gear of the high-pressure pump
(3) Gear nut of the high-pressure pump
(4) Seal
(5) Cover

3. Make sure that the guide pin of the injection timing engages the gear of the high-pressure pump.

You can examine the location from the gear hole of the high-pressure pump in the front cover of the engine.

NOTE:
If the guide pin is not in its position:

- *The injection timing will not be correct.*
- *The gear of the high-pressure pump can be loose, which can cause an engine failure.*

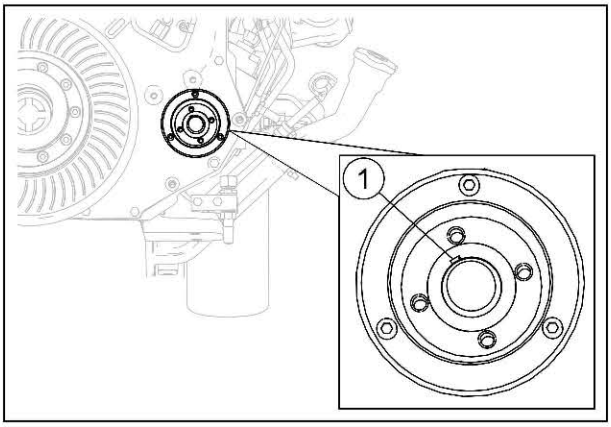


Fig. 839

(1) Guide pin of the injection timing in the gear groove

4. Tighten the fixing screws of the high-pressure pump.

5. Tighten the gear nut of the high-pressure pump.

6. Install the cover.

7. Attach the fuel pipes to the high-pressure pump.

8. Connect the MPROP wire.

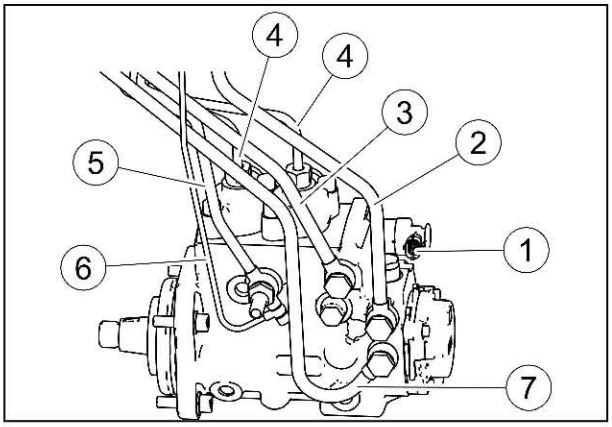


Fig. 840

(1) Magnetic proportional valve (MPROP)
(2) Fuel pipe from fuel pre-filter
(3) Fuel pipe from fuel filter
(4) Fuel pipe to rail
(5) Return pipe from rail
(6) Bleeding pipe from fuel filter
(7) Fuel pipe to fuel filter

2.29.9 Rail

WARNING: High pressure fuel during and after engine operation.

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.

NOTE:
If a high-pressure pipe leaks after assembly, replace it with a new high-pressure pipe.

The 168 engine has two rails. Both rails have pressure sensors. The rail on the left-hand side has pressure control valve (PCV).

The rail is attached to the intake manifold.

(1) Pressure sensor
(2) Pressure control valve (PCV)

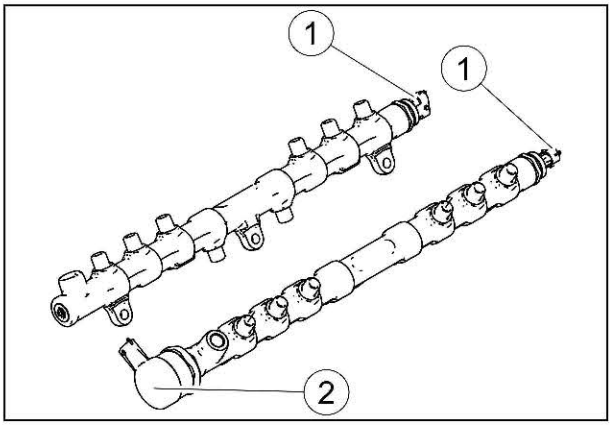


Fig. 841

2.29.9.1 Removing the rail



WARNING: High pressure fuel during and after engine operation.

If a high pressure jet of fuel gets through your skin it can cause injury, get medical aid immediately.

Do not do work on the high pressure side of the fuel system when the engine is in operation. Do not start work for more than 30 seconds after you stop the engine. Loosen the high pressure components slowly, this decreases the pressure in the high pressure side of the fuel system.



DANGER: Risk of fire.

Fuel leaks on an engine that is hot can cause fire.

Prevent fuel leaks. When you disconnect the fuel connections, install plugs on the fuel connections.



CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

Procedure

1. Remove the ICACs (interstage charge air cooler) with the mounting bracket.
2. Clean the rail and the surroundings.
3. Disconnect the wire connector from the pressure control valve (PCV).
4. Disconnect the wire connector from the pressure sensor.
5. Disconnect the fuel pipes from the rail.
   a) Prevent fuel from leaking to the ground.
   b) Insert plugs where fuel connectors have been removed.
6. Open the rail fixing screws.
7. Remove the rail.

2.29.9.2 Fitting the rail



CAUTION: Contamination.

Dirt and contamination can cause system malfunction.

Clean the maintenance components and adjacent area carefully, before the maintenance work starts.

NOTE:
Refer to the machine manual for the correct fastener torques.

Procedure

1. Fit the rail.
2. Tighten the rail fixing screws.
3. Connect the fuel pipes to the rail.
4. Connect the wire connector to the pressure control valve (PCV).
5. Connect the wire connector to the pressure sensor.

6. Fit the ICACs with the mounting bracket.

2.29.9.3 Removing the pressure control valve

The pressure control valve (PCV) will be delivered as a spare part for the rail. The rail needs to be removed before changing the PCV. Alternatively, the complete rail can be replaced.

NOTE: *PCV must not be reused!*

Procedure

1. Remove the rail.
2. Mark the position of the PCV.

   The PCV needs to be fitted in the same position.
3. Clean interface area of the PCV using proper degrease materials and compressed air for drying.

   NOTE: *Cleaning material must not penetrate the electric contacts.*
4. Remove the PCV.
   a) Loosen the PCV using an open ended insert tool 30.
   b) Grasp the PCV by hand.
   c) Pull the PCV out simultaneously turning it counter-clockwise.
5. Clean the thread and the sealing surface of the rail.
6. Close the orifice using a plastic cap after removing the PCV.
7. Inspect the sealing surface of the rail.

   Only concentric grooves are allowed. No cuts in radial direction are tolerable.

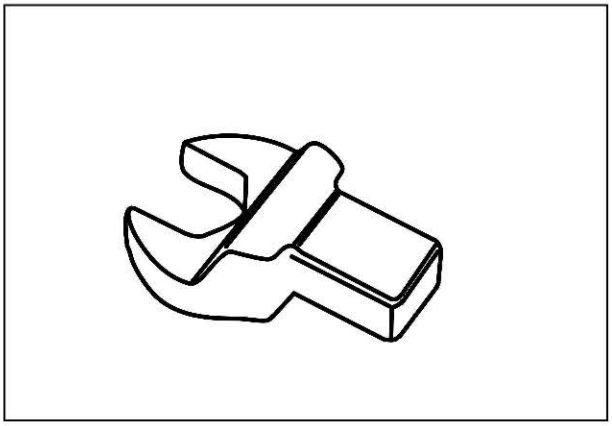


Fig. 842

2.29.9.4 Fitting the pressure control valve

The pressure control valve (PCV) will be delivered as a spare part for the rail. The rail needs to be removed before changing the PCV. Alternatively, the complete rail can be replaced.

NOTE: *PCV must not be reused!*

Procedure

1. Lubricate the sealing rings with fuel.
2. Insert the PCV manually and position the electric connection orientation.
3. Screw in the flange screw manually maintaining the orientation of the connector.
4. Tighten the PCV using the open ended insert tool 30 counteracting with a wrench 45 at the hexagon of the housing.
   a) Tighten the PCV first to torque of 80 Nm ± 4 Nm.
   b) Loosen the PCV 90°.
   c) Tighten the PCV to final torque value of 85 Nm ± 5 Nm.

   NOTE: *The electric cable must not be under tension.*

2.29.9.5 Removing the pressure sensor

Procedure

1. Disconnect the electrical connector.
2. Remove the pressure sensor.
3. Check the condition of the end sealing surface of the pressure sensor.

   Radial scratch is not permissible.

2.29.9.6 Fitting the pressure sensor

The pressure sensor will be delivered as a spare part for the rail. The pressure sensor can be changed while the rail is in position. Alternatively, the complete rail can be replaced.

The ICACs need to be removed with the mounting bracket before rails and pressure sensors can be reached.

Procedure

1. Clean the sealing surface and thread of the rail.
2. Lightly lubricate the pressure sensor thread and sealing surface.
3. Tighten the sensor into its position to a torque of 70 Nm.
4. Connect the electrical connector.

2.30 SCR system

2.30.1 Selective Catalyst Reduction (SCR) system maintenance

The AGCO POWER Selective Catalyst Reduction (SCR) system makes sure that the engine is in compliance with emission regulations. In usual use only replacement of the main filter is necessary. The AGCO POWER Selective Catalyst Reduction (SCR) system has on-board diagnostics. The on-board diagnostics will tell the operator or limit the use of the machine if a problem occurs in the system (for example leaks or line blockages).

NOTE:
Engines with the aftertreatment system are in compliance with EU97/68/EC Stage IV and EPA 40 CFR 1039 Tier 4 final emission regulations.

When you do maintenance you must use replacement parts that are equivalent in performance and specification to AGCO Parts. The responsibility of AGCO POWER on the correct compliance of the emission specification is removed when:

- You do not use AGCO Parts
- The maintenance is incorrect or not done on time.



CAUTION: Make sure that you use Diesel Exhaust Fluid (DEF) (DIN 70070 or ISO 22241 certified) in the Selective Catalyst Reduction (SCR) system.

The engine is not in compliance with emission regulations.

Do not mix the Diesel Exhaust Fluid (DEF) with other materials, this can cause damage to the Selective Catalyst Reduction (SCR) system.



CAUTION: Decreased engine power because of a fault in the Selective Catalyst Reduction (SCR) system.

When the Diesel Exhaust Fluid (DEF) quality sensor identifies a problem with the Diesel Exhaust Fluid (DEF) quality, it send a CAN signal to the ECU. The ECU decreases the engine power output.

Make sure that Diesel Exhaust Fluid (DEF) (DIN 70070 or ISO 22241 certified) is used in the Selective Catalyst Reduction (SCR) system.



CAUTION: The diesel fuel can cause damage to the gaskets of the Selective Catalyst Reduction (SCR) system.

The engine is not in compliance with emission regulations. The Selective Catalyst Reduction (SCR) system does not operate correctly.

Do not put diesel fuel in Diesel Exhaust Fluid (DEF) tank.



CAUTION: Decreased performance.

Engine is not in compliance with emission regulations.

Make sure that the Diesel Exhaust Fluid (DEF) in storage is at a temperature of less than 30°C, and away from sunlight.

2.30.2 Mounting of SCR system components

Dosing module (DM)

Dosing module is mounted with three M6x20 screws. Tightening is done in two stages:

1 Tighten the screws in sequence shown in picture until the gasket is pressed evenly to its mounting surface on the exhaust.
2 Tighten the screws to 8 Nm torque in sequence shown in picture.

NOTE: *Always change the gasket when opening the dosing module joint.*

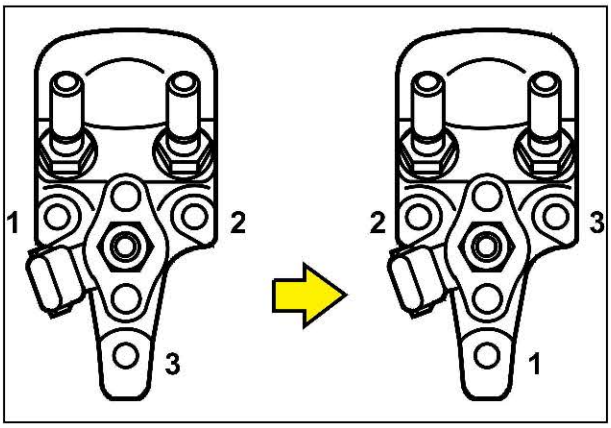


Fig. 843

NOx sensor

NOx sensor includes a control unit and a separate sensor head.

Mounting: 2 sensors on the exhaust line, before DOC catalytic converter and after the SCR catalytic converter.

- Sensor head thread: M20x1,5
- Sensor head torque: 50 Nm
- Voltage 12 V or 24 V

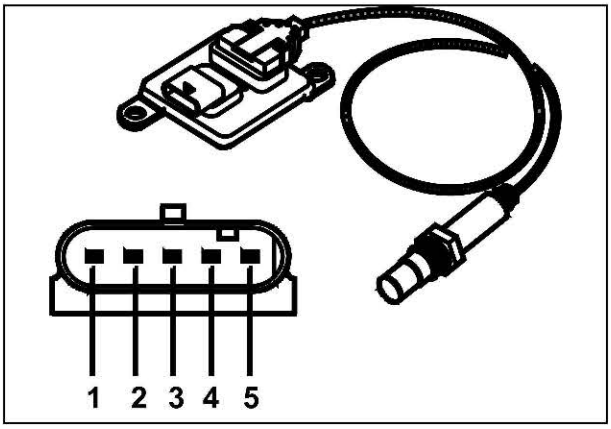


Fig. 844

Exhaust gas temperature sensor

Mounting: 3 sensors on the exhaust line, before the DOC catalytic converter, before and after the SCR catalytic converter.

- Thread: M14x1,5
- Torque: 40 Nm

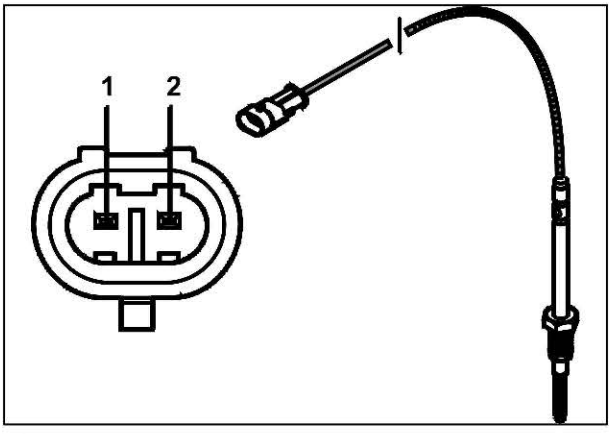


Fig. 845

2.30.3 Removing the supply module

Before starting the procedure

Make sure that cleaning cloths and protection caps for hydraulic and electrical connectors are available.

Reserve a suitable container for the DEF, which can drain out of the hoses.

Procedure

1. Remove any components which can prevent the removal of the supply module.
2. Loosen all tubing and wiring supports which can prevent the removal of the supply module.
3. Open the hydraulic connectors and install protection caps to the supply module connectors.
4. Remove the electrical plug and install a protection cap.
5. Remove the bolts that connect the supply module to the holder.
6. Clean the supply module.

2.30.4 Installing the supply module

Procedure

1. Tighten the bolts that connect supply module to the holder with 19 ± 20% Nm torque.
2. Remove the protection cap from the electrical connector and connect.
3. Remove protection caps from hydraulic connectors and install pipe lines.
4. Clean the supply module from any DEF leakage.
5. Install wiring and tubing supports.

2.30.5 Removing the hydraulic connectors

Removing of the supply module is important in order to replace the hydraulic connectors. By removing the supply module can be made sure that torque wrench can be used and that cleanliness can be guaranteed.

Procedure

1. Remove the supply module.
2. Remove the hydraulic connector.

2.30.6 Installing the hydraulic connectors

Procedure

1. Connect the hydraulic connectors.
2. Tighten the hydraulic connector to 4,5 ± 0,5 Nm.
3. Install the supply module.

2.30.7 Replace the main filter and the inlet filter of the supply module

The main filter is on the supply module below the filter cover. No special tools are necessary for the replacement of the main filter and the inlet filter.

The inlet filter is in the Diesel Exhaust Fluid (DEF) connector. The inlet filter is only available with the Diesel Exhaust Fluid (DEF) connector.

(1) Main filter
(2) Diesel Exhaust Fluid (DEF) connector with inlet filter

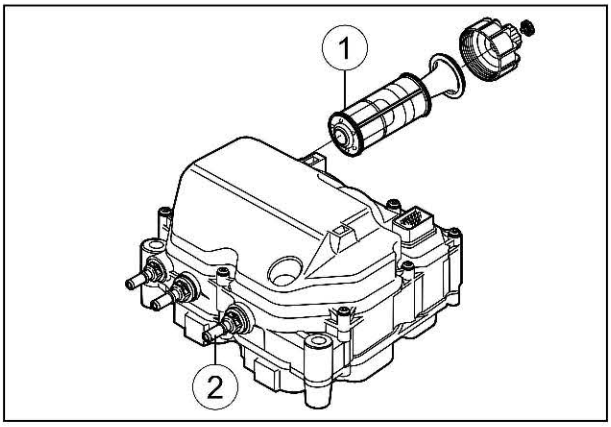


Fig. 846

CAUTION: Contamination of the Selective Catalyst Reduction (SCR) system.

The engine is not in compliance with emission regulations. The Selective Catalyst Reduction (SCR) system does not operate correctly.

Make sure that all seal surfaces are fully clean and that there is no damage when you install the components.

CAUTION: Contamination of the Selective Catalyst Reduction (SCR) system.

It is possible that engine damage or Selective Catalyst Reduction (SCR) system damage is caused by unsatisfactory filtered Diesel Exhaust Fluid (DEF).

Do not install a used or a wet main filter, or a used equalizer.

CAUTION: Teflon layer damage on the seals.

Unsatisfactory operation and leaks can occur.

Do not use mineral or silicone lubricating oils and grease on the filter seals.

Procedure

1. Make sure that the supply module is fully clean.
2. Make sure that there are no cracks in the supply module.
   a) If there are cracks in the supply module, replace it.
3. Make sure that there are no cracks in the filter cover of the main filter.
   a) If there are cracks in the filter cover, replace it.
4. Turn the filter cover counterclockwise with a 27 mm (1.1 in) spanner and remove the filter cover.
5. Pull out the equalizer.
6. Pull out the main filter with an applicable tool.

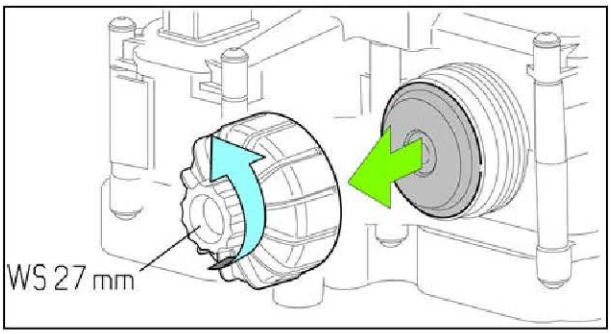


Fig. 847

7. **NOTE:**
   Make sure that the area is fully clean before you install the new main filter.

   Install a new main filter and a new equalizer.

8. Install the filter cover and tighten to a torque of 22.5 Nm (17 lbf ft) ± 2.5 Nm (2 lbf ft) with a 27 mm (1.1 in) spanner.

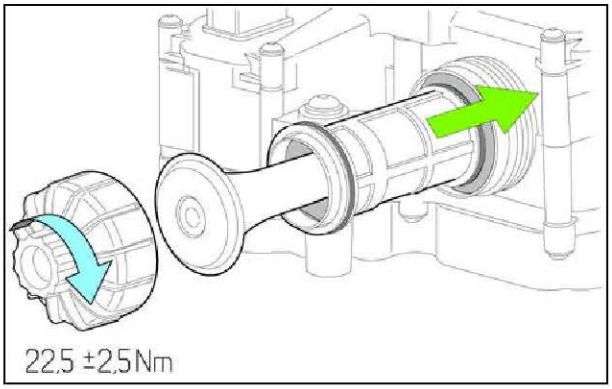


Fig. 848

9. **IMPORTANT:**
Dirt in the inlet connector can cause a failure of the DENOX2.2-system.

Make sure that the surface around the DEF connector is fully clean.
a) Use a vacuum cleaner to remove all particles around the DEF connector.
b) Examine the parts for solid DEF particles.
c) If necessary, clean the parts carefully with warm and clean water.
d) Dry the parts carefully.

Do not use compressed air!

10. **NOTE:**
Do not let dirt go into the DEF line or the connector on the supply module.

Remove the DEF line and remove the DEF connector.

11. Install the new DEF connector.
a) Install a new O-ring.
b) Lubricate the O-ring with a glycerin type lubricant.

Do not use oil!
c) Tighten to a torque of 4 Nm (3 lbf ft) - 5 Nm (4 lbf ft).

12. Dispose of the parts you removed. Refer to your local regulations for correct disposal.

2.30.8 SPN 521008 FMI 1

SPN code	FMI code	Description
521008	1	SCR system ERROR: DEF pressure build-up failure

During a long standstill period the pump membrane of the DNOX2.2 supply module can dry out. Suction performance of a "dry pump" can be lower than required for filling the dosing system. After moisturizing the pump with fresh DEF, the supply module will operate in a normal way again.

Normally the EEM4 engine management system starts to pressurize the dosing system after the exhaust line has warmed up to approximately 145°C (293°F). If the dosing system pressurization does not immediately succeed, EEM4 engine management system will automatically try to help the filling of the dosing system by opening the dosing valve momentarily during pumping. This function helps removing the excess air from the DEF lines. If the system pressurization still does not succeed in 30 minutes after first start of the dosing system, EEM4 system activates the pressure build-up fault code.

This fault code indicates that the pressure build-up has not been successful. Since DEF dosing is not possible, exhaust emissions will be too high and the engine power limitation will be activated.

Related Links

SCR system tools page 2-258

Solve the DEF pressure build-up failure page 2-373
Supply module lifting capacity test page 2-375
Solve the failure when the SM lifting capacity test is not OK page 2-376
Solving the failure when the SM lifting capacity test is OK page 2-378

2.30.8.1 Solve the DEF pressure build-up failure

Procedure

1. If the outdoor temperature is below -10°C, make sure that the defrosting system has worked correctly and the DEF is not frozen.
2. Do a visual check for the SCR system to find possible leakages or damage in the DEF lines and connectors.
3. Fill the DEF tank with 5-10 liter of fresh DEF to make sure that there is enough DEF in the DEF tank.

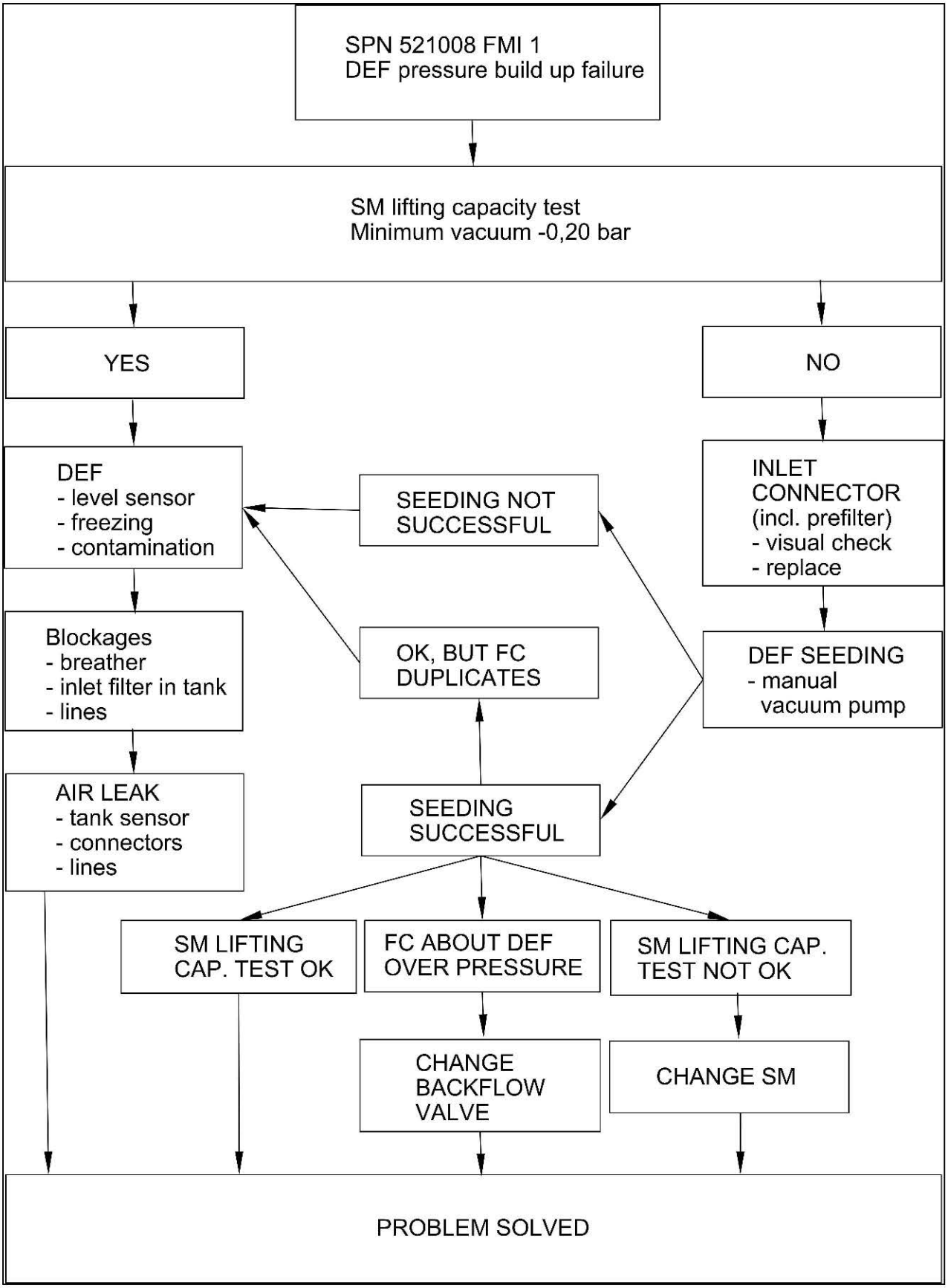


Fig. 849

4. Obey the DEF pressure build-up failure solving process shown in the figure.

2.30.8.2 Supply module lifting capacity test

Procedure

1. Remove the inlet hose from the supply module.
2. Connect the vacuum pressure gauge to the inlet connector of the supply module.

   The vacuum pressure gauge can be found in the SCR tool kit.
3. Turn the ignition on and open the SCR pressure build-up test from the EDT.

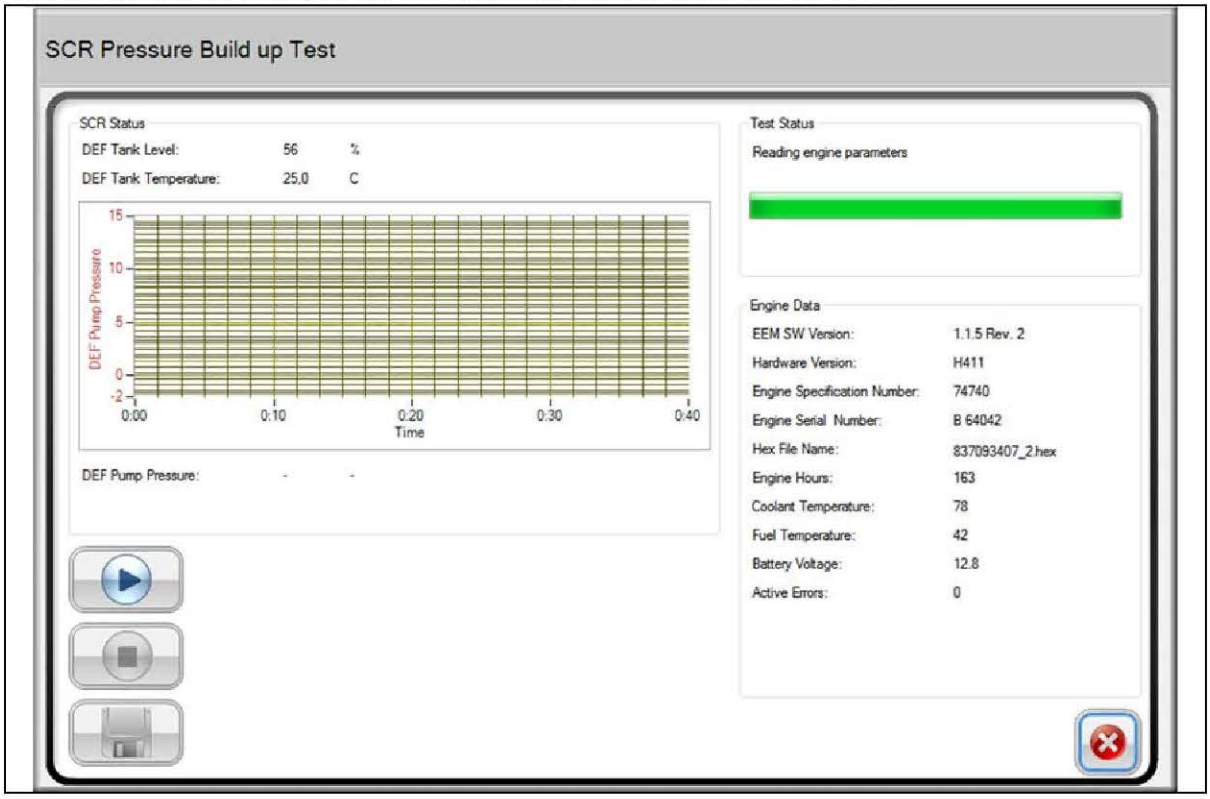


Fig. 850

4. Run the SCR pressure build-up test and monitor the vacuum pressure gauge.

   Supply module must generate at least 0,2 bar underpressure.
5. Press the Abort button, when the underpressure is authenticated.

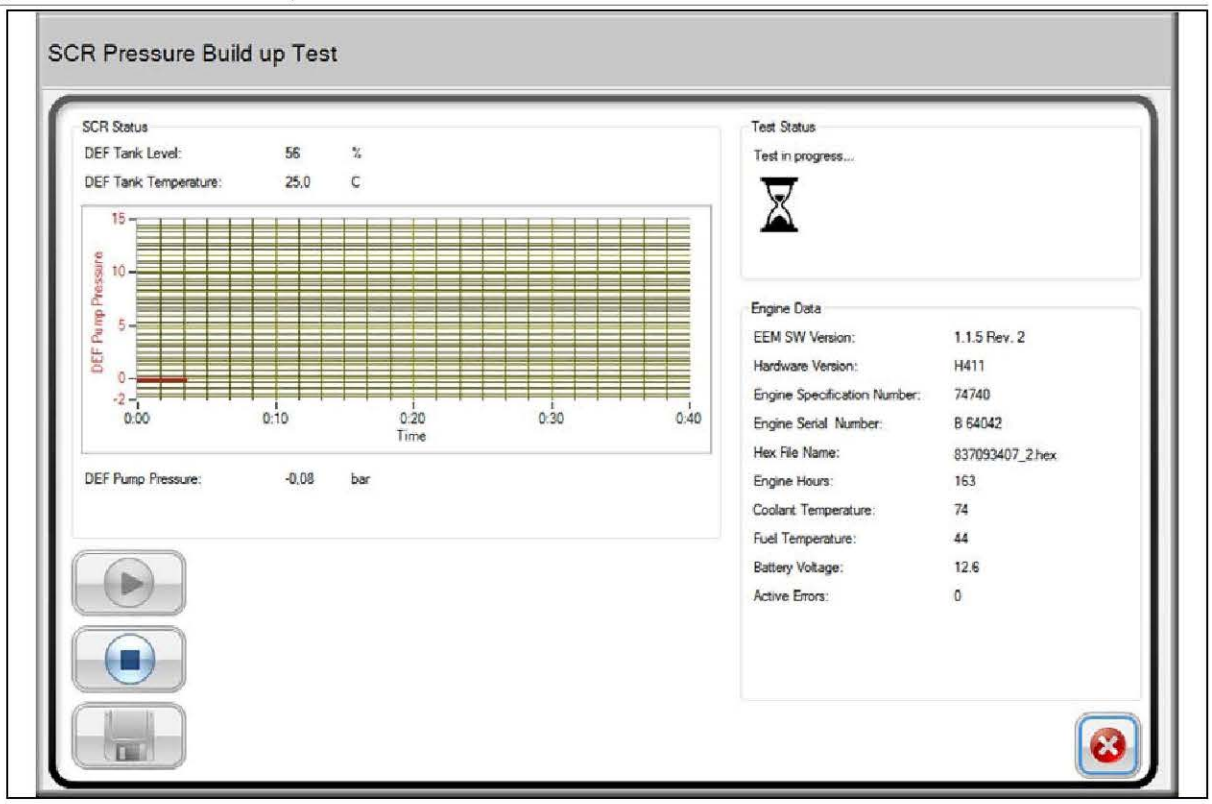


Fig. 851

2.30.8.3 Solve the failure when the SM lifting capacity test is not OK

If the supply module (SM) lifting capacity test is not OK, follow the next procedure when solving the SPN 521008 FMI 1, DEF pressure build-up failure.

The manual vacuum pump and pressure gauge can be found in the SCR tool kit.

Procedure

1. Examine the inlet connector.
   a) Examine that the inlet connector filter is not clogged.
   b) Replace the inlet connector, if it is necessary.



Fig. 852

2. DEF seeding.



Fig. 853

a) Find the DEF pressure line.
b) Use a vacuum cleaner to remove all particles around the DEF pressure line and the dosing module.
c) If necessary, clean the parts carefully with warm and clean water.

   Do not use compressed air!
d) Connect the manual vacuum pump to the DEF pressure line in the dosing module end of the hose.



Fig. 854

e) Use the manual vacuum pump to fill the Denox system with DEF until the DEF comes out to the suction pump container.

   This will make the pump membrane to work again and flushes the possible dirt particles out from the membrane chamber.
f) Disconnect the vacuum pump and connect the DEF pressure line to the dosing module.
g) Start the SCR pressure build-up test from the diagnostic tool.

   When the DEF enters the supply module membrane, the dosing system pressure starts to increase normally.

   NOTE: *The test will start only if the engine is not running and the catalyst temperature is lower than 100°C.*
h) Monitor the pressure with a pressure gauge, connected between the dosing module and the pressure line.

   Normal pressure is 8-9 bar (relative).



Fig. 855

3. If the DEF seeding is successful, continue the failure solving procedure.
   - If the DEF seeding is not successful, see the instructions for solving the failure when the supply module lifting capacity test is OK.
   - If the DEF seeding is successful, but the fault code is activated again, see the instructions for solving the failure when the supply module lifting capacity test is OK.
4. Make the supply module lifting capacity test.

   Result

   If the supply module lifting capacity test is OK, the DEF pressure build-up failure is solved.
5. If the DEF over pressure fault code is activated, change the backflow valve.

   There is a check valve inside the backflow connector. If the check valve is clogged, the pressure handling of the supply module is interrupted. See the instructions for changing the hydraulic connectors.

   Result

   The DEF pressure build-up failure is solved.
6. If the supply module lifting capacity test is not OK, replace the supply module.

   NOTE: *If the broken supply module has been requested to be sent to AGCO for inspection, install protecting tubes on the DEF connectors to cover the supply module against dirt and oxygen.*

   Result

   The DEF pressure build-up failure is solved.

2.30.8.4 Solving the failure when the SM lifting capacity test is OK

If the supply module (SM) lifting capacity test is OK, follow the next procedure when solving the SPN 521008 FMI 1, DEF pressure build-up failure.

Procedure

1. Check the DEF.
   a) Check the DEF tank level reading from the service tool and write the reading down.
   b) Drain the DEF tank through the drain plug.
   c) Check if the DEF is dirty.
   d) If dirt or debris is found, check the DEF tank filter.
   e) Check the DEF tank level from the service tool.

      If the value is not close to 0%, the cause can be a DEF tank sensor connector corrosion, a DEF tank sensor failure or a wiring harness failure.
   f) Fill the DEF tank with fresh DEF.

      Make sure that the DEF tank level reading on dashboard changes accordingly, showing a full DEF tank.

NOTE: *The DEF level display can rise slowly because of the the level signal filtering.*

2. Make sure that there are no blockages in the breather, in the inlet filter in the DEF tank or in the lines.

   See the instructions of the machine manufacturer.

3. Make sure that there are no air leaks in the tank sensor, in the connectors or in the lines.

   See the instructions of the machine manufacturer.

Result of the procedure

The DEF pressure build-up failure is solved.

2.30.9 SPN 521025 FMI 31, SPN 521026 FMI 31

SPN code	FMI code	Description
521025	31	SCR system malfunction: SCR efficiency not OK
521026	31	SCR system malfunction: SCR efficiency not OK after DEF refill (possible bad quality)

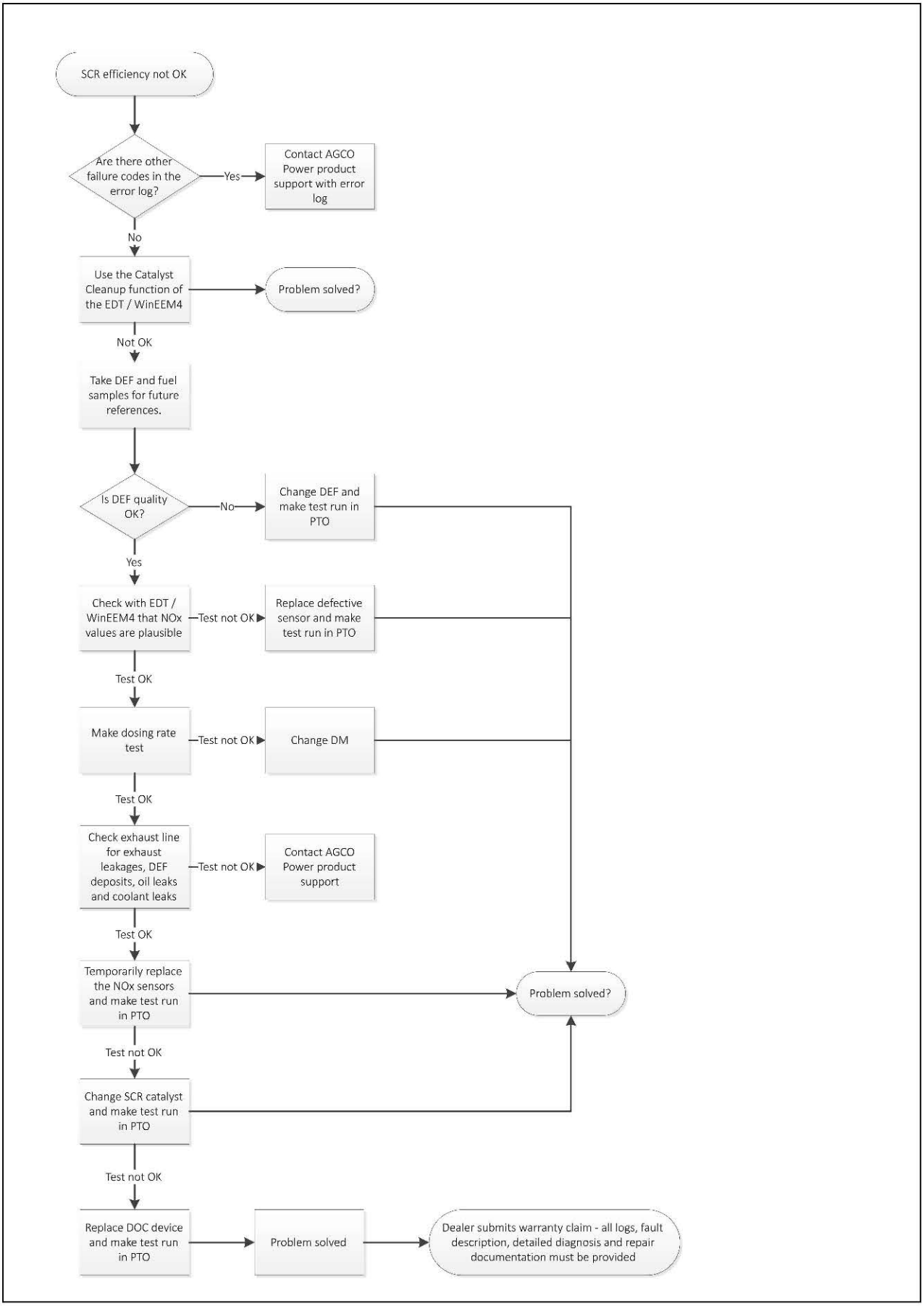


Fig. 856

Related Links

SCR system tools page 2-258
Make the dosing rate test page 2-382
Checking the quality of DEF page 2-386

2.30.9.1 Cleanup of the SCR catalyst

SCR catalyst cleanup procedure is necessary if the SCR catalyst has a sulphur poisoning. The source of the sulphur can be diesel fuel or engine oil, which can absorb on surfaces of the SCR catalyst. That can cause the performance of the SCR catalyst to decrease.

The sulphur accumulates to the SCR catalyst in low exhaust gas temperatures, with low engine load. If a machine is operated extended periods on low loads, sulfur level of the SCR catalyst can increase to a level that starts to decrease the NOx reduction performance of the SCR system.

Sulphur concentration of the diesel fuel has a strong influence on the sulphur accumulation to the SCR catalyst. In AGCO POWER Tier 4 Final / Stage IV engines, use of diesel fuel with ultra low sulphur (ULSD < 15ppm) is necessary. Diesel fuel with ultra low sulphur keeps the effects of sulphur on the SCR catalyst in minimum. Operating a Tier 4 Final / Stage IV engine with fuel that has a higher sulphur content causes an increased rate of sulphur accumulation to the SCR catalyst.

Sulphation is a reversible process and it is possible to restore the performance of the SCR system by desulphating the SCR catalyst. That occurs in temperatures above 500°C.

A desulphation procedure removes the sulphur from the SCR catalyst and keeps the performance of the SCR system. The Catalyst Cleanup procedure is a process, where a servicing function of the engine increases the SCR catalyst temperature to remove the sulphur.

Do the cleanup of the SCR catalyst

The diagnostics of the exhaust aftertreatment system in Tier 4 Final / Stage IV engines can activate 1 of the fault codes that follows:

- SPN 521025 FMI 31, SCR efficiency not OK.
- SPN 521026 FMI 31, SCR efficiency not OK.

The fault code can show up during a usual machine operation or after filling DEF. A sulphur poisoning of the SCR catalyst is 1 possible root cause for the fault code.

Special tools for the procedure:

- AGCO EDT service tool (EEM4F plugin version 5.2 or newer)

Procedure

1. Make sure that the software version of the EDT is sufficient.

   It is necessary that the EDT has the EEM4F plugin version 5.2 or a newer version.

   a) Do an update for the software, if it is necessary.

2. Use the EDT and examine, if new software is available for the engine.

   It is necessary that the software version of the engine ECU is 1.2.7 or a newer version.

   a) Do an update for the engine software, if it is possible.

3. 

   WARNING: Risk of fire.

   A fire can cause a personal injury and machine damage.

   Carefully clean the machine of all flammable material.

   Clean all exhaust line components from all flammable material, eg. dust.

4. Make sure that the machine is on a safe area.

   a) Make sure that there is no flammable material near the outlet of the exhaust line.

5. Let the engine run for approximately 5 minutes to let the conditions become stable.

6. Before you can start the Catalyst Cleanup, make sure that the coolant temperature is above 40°C.
7. Make sure that the transmission is on a neutral position.
8. Make sure that you stop the PTO and other devices.
9. Put the parking brake on.
10. Make sure that the acceleration pedal is in neutral position.

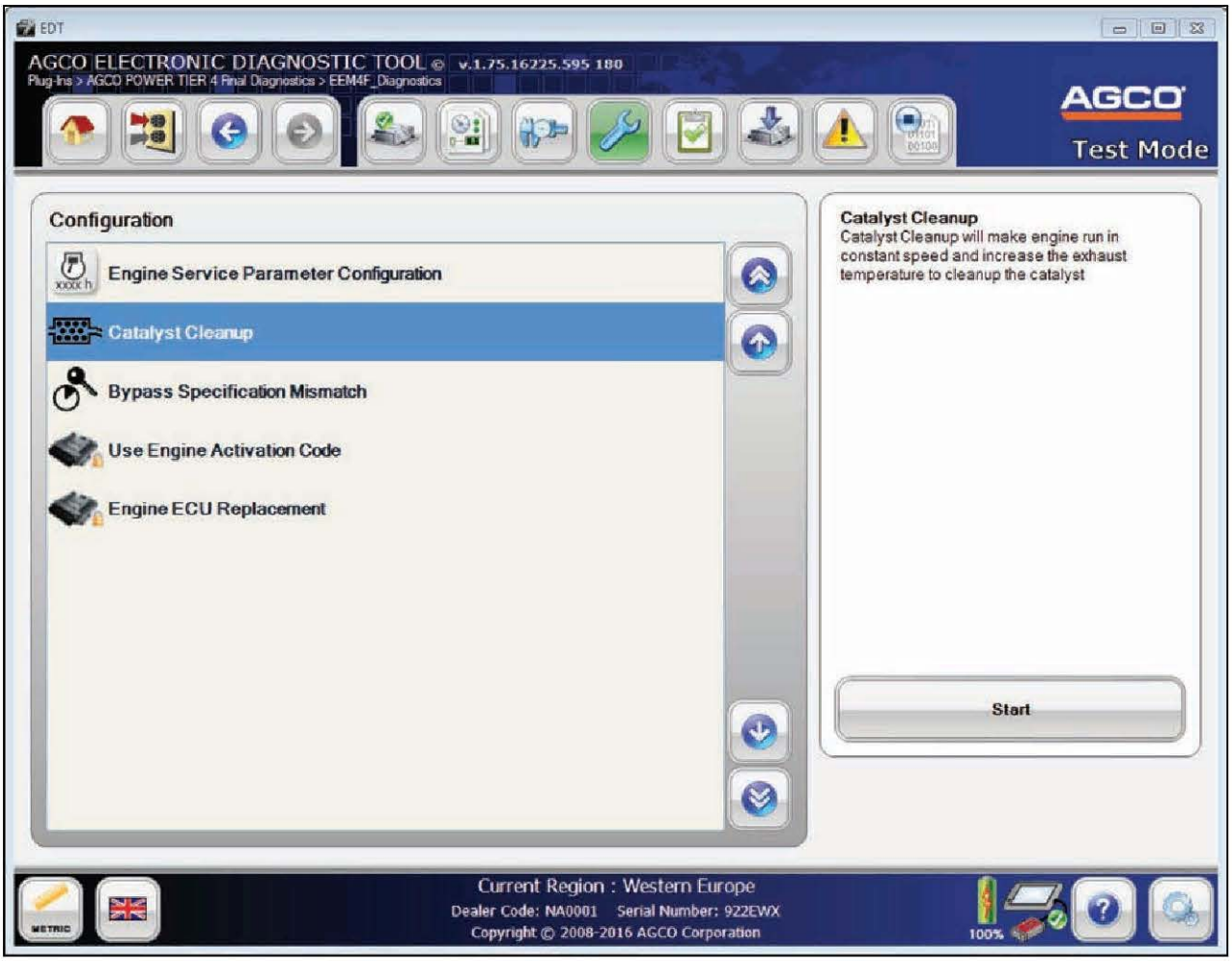


Fig. 857

11. Start the Catalyst Cleanup function with the EDT.
    a) Do not let the machine run without supervision during the Catalyst Cleanup function!
12. Let the engine idle for minimum of 2 minutes before you stop the engine.

2.30.9.2 Make the dosing rate test

The dosing rate test is used to find, if the SCR dosing system operates correctly and if the dosing quantity is correct. Decreased dosing rate can be one possible root cause for fault codes:

- SPN 521025 FMI 31, SCR system malfunction: SCR efficiency not OK
- SPN 521026 FMI 31, SCR system malfunction: SCR efficiency not OK after DEF refill (possible bad quality)

Special tools needed for the procedure:

- SCR tool kit V837091048
- AGCO EDT service tool

Procedure

1. Disconnect the DEF pressure line and the electrical connector from the dosing module.

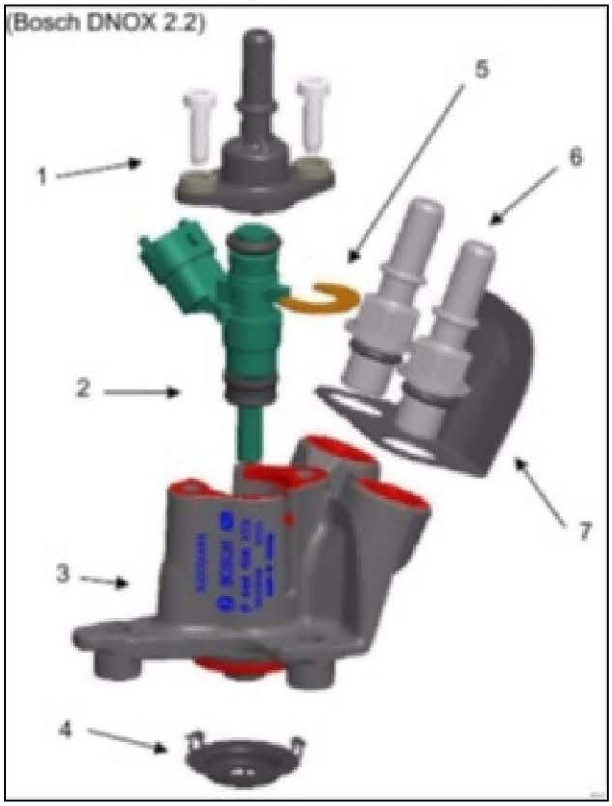


Fig. 858

(1) Connection to the DEF pressure line
(2) Dosing valve
(3) Dosing module frame
(4) Dosing module gasket
(5) Clamp holder
(6) Connections to the coolant lines
(7) Guard plate

2. Remove 2 torx screws (T25) that hold the dosing valve in the dosing module frame.
3. Carefully pull the dosing valve from the dosing module frame, use a small flathead screwdriver.



Fig. 859

4. Install the dosing valve to the measuring jug found from the SCR tool kit.



Fig. 860

NOTE: *Do not push the measuring jug cover too tight. A small air hole is necessary to enable ventilation of the jug during the test!*

5. Use the extension hose found from SCR tool kit to connect the dosing valve to the vehicle.



Fig. 861

6. Turn ignition on.

7. Make the dosing rate test.

a) Open the dosing rate test in the EDT.

b) Press "Run test".

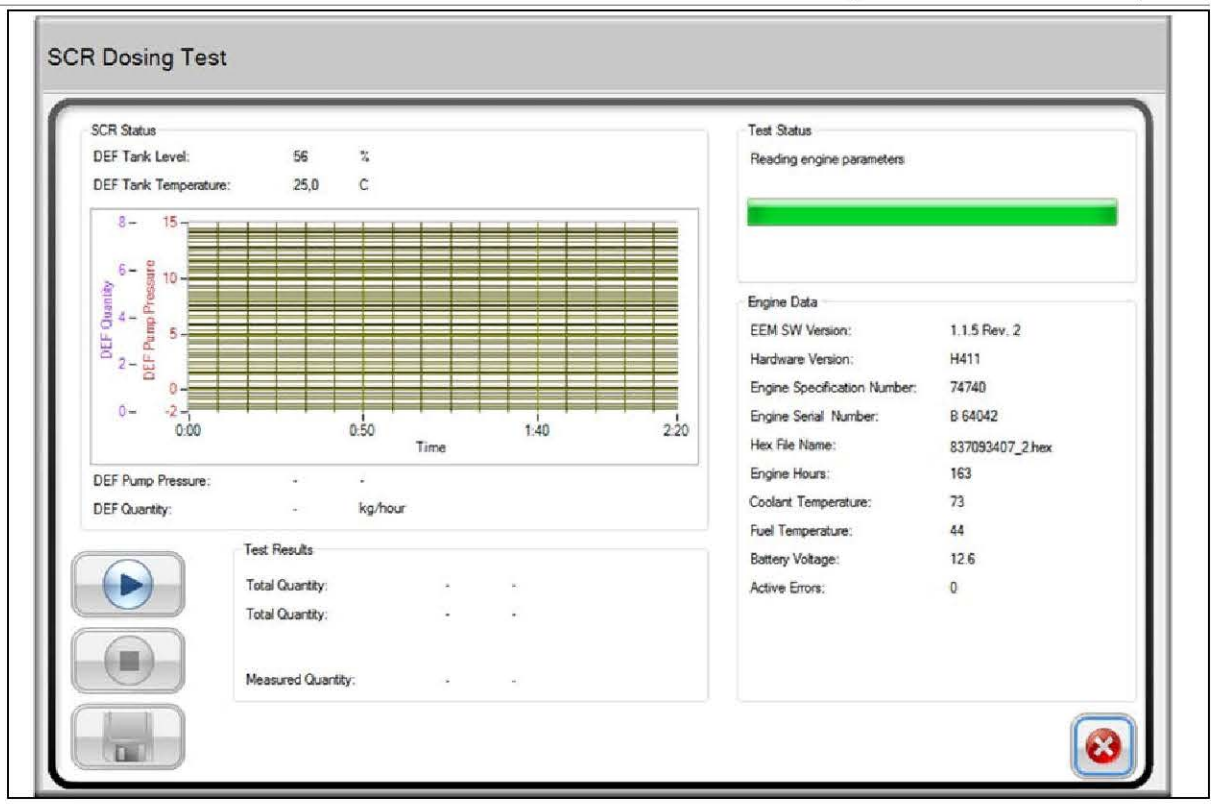


Fig. 862

8. After the dosing rate test is completed, read the capacity from the measuring cup.

Tolerance is 165-202 ml.



Fig. 863

9. Drain the SCR system manually.

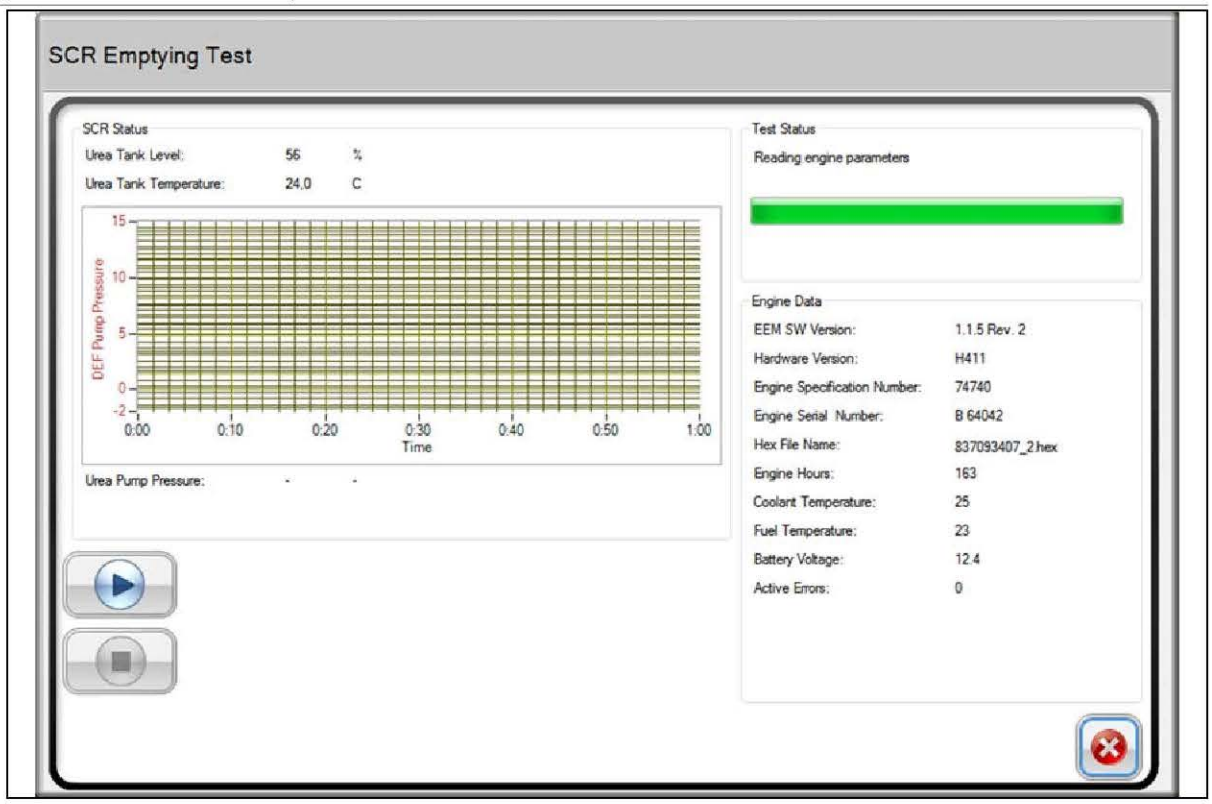


Fig. 864

Use the SCR system emptying test of the EDT

2.30.9.3 Checking the quality of DEF

The service life and the efficiency of the SCR catalytic converter depend on the quality of the DEF reduction agent. In order for the catalytic converter to work constantly and for emissions to be diffused in a continuous and uniform manner, DEF must meet the following requirements:

- an optimal mixture ratio of 32.5% urea and 67.5% demineralised water
- no contamination, e.g. by mineral oils or particles

The SCR tool kit V837091048 is needed for checking the quality of DEF. The urea-water mixture ratio can be checked with a refractometer. Dirt from hydrocarbons, for example petrol, heating oil, lubricating oil, etc., can be detected with oil test paper.

Procedure

1. Check the urea-water mixture ratio with a refractometer.



Fig. 865

(1) Flap
(2) Prism
(3) Eyepiece

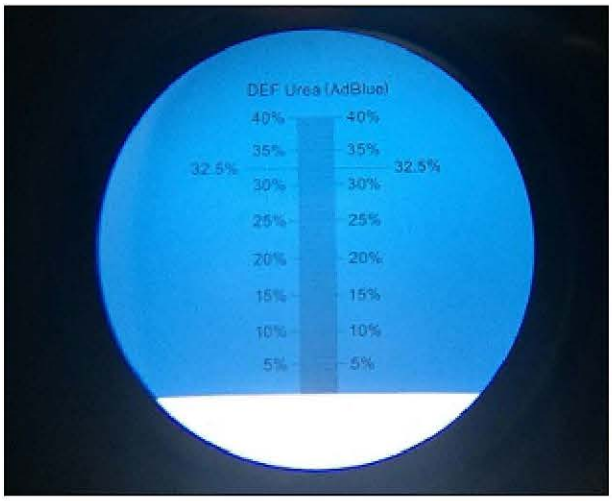


Fig. 866

a) Open the flap and check if the prism and the flap are clean.
b) Use the pipette supplied with the refractometer and put a drop of the fluid to be tested on the prism.
c) Close the flap to spread out the drop.
d) Turn the eyepiece to adjust the focus.
e) Read the value on the scale at light-dark boundary line.

2. Check that there is no contamination in the DEF by using the oil test paper.
a) The oil test paper must be dipped back and forth to the DEF.

The pale blue test paper is neither wet nor discolored by oil-free water.

If oil is present, the paper will turn dark blue. The intensity and size of the spots are indicative of the amount of oil.

2.31 Engine control system

2.31.1 Replace the electronic control unit

(1) Type plate of the production installed ECU
(2) Type plate of the spare part ECU

NOTE: *The type plate of an empty spare part ECU does not have the engine serial number.*

The electronic control unit (ECU) is formatted with AGCO Power software.

- You can send an order for an empty ECU and load the necessary software version into it with the AGCO Electronic Diagnostic Tool.
- You can send an order for an ECU with the necessary software version pre-loaded.

If you send an order for an ECU with the necessary software version pre-loaded, you must give the engine serial number. The engine serial number is on the type plate of the ECU.

The primary ECU is on the right side of the engine and the secondary ECU is on the left side of the engine.

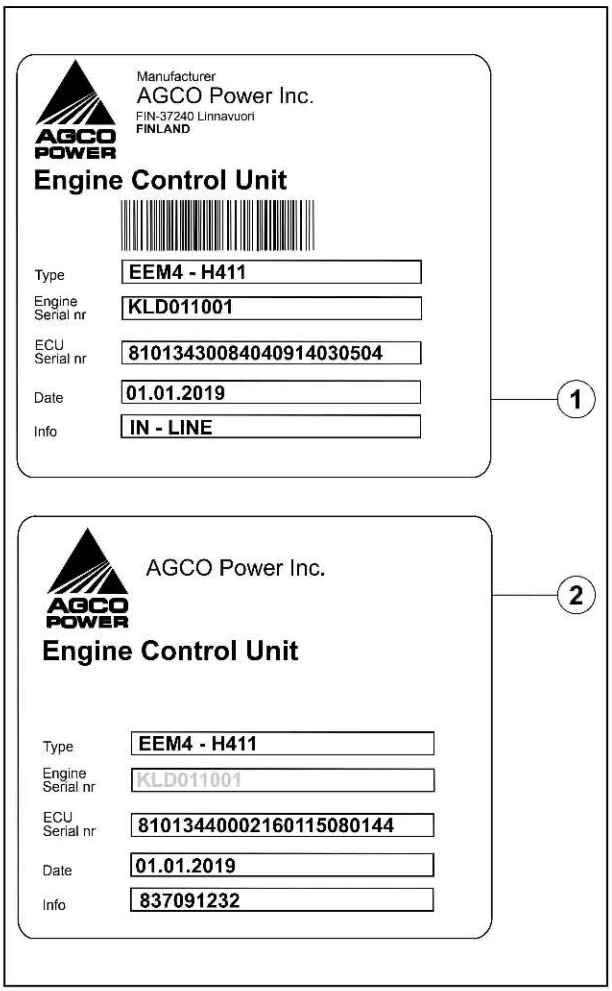


Fig. 867

Procedure

1. Turn the main switch to the OFF position or disconnect the battery connectors.
2. Remove the plastic cover and disconnect the multipole connectors.

   Do not touch the connector poles.

   Note the position of the ground wire.
3. Remove the control unit from the bracket.
4. Make sure that the bracket rubber dampers are in good shape.

   Replace the bracket rubber dampers, if it is necessary.

   Torque for the fixing screws is 30 Nm.

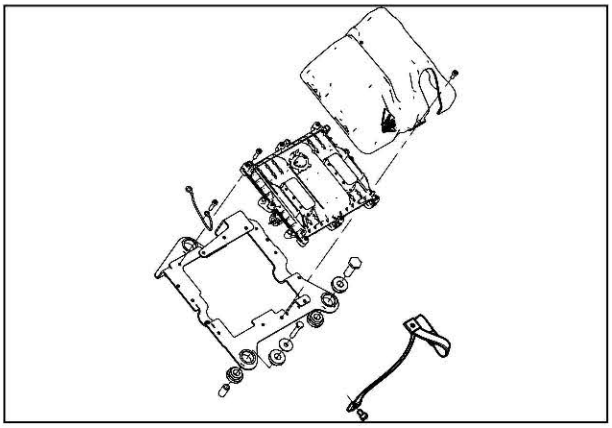


Fig. 868

5. Attach the new control unit.
   a) Tighten the screws to 10 Nm in the order shown in the figure.
   b) Note the position of the ground wire.
6. Connect the multipole connectors.
7. Attach the plastic cover.
8. Turn the main switch to the ON position.

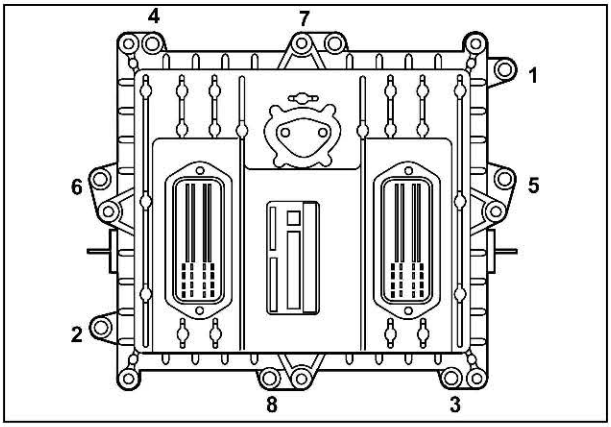


Fig. 869

2.31.2 Replace an empty electronic control unit (ECU)

Before starting the procedure

You can load the necessary software version with the AGCO Electronic Diagnostic Tool (EDT). The EDT requires Internet access during the activation of the spare part ECU. If no Internet access is available, the activation process can be started at the vehicle and then paused until an Internet connection is established. The activation process can then be continued offline back at the vehicle.

Procedure

1. Connect the EDT to the vehicle and to the engine, which has the old ECU installed.
2. Select configuration page (wrench icon).
3. To replace the ECU, follow the instructions of the EDT.

Phase 1. First operation will deactivate the old ECU.

4. If the EDT cannot connect to the old ECU, read the ECU serial number and engine serial number from the ECU label.
5. Switch the ignition key to OFF.

Phase 2.

6. Connect the new ECU.
7. Switch the ignition key to ON.

   EDT will read the serial number of the new ECU automatically.

Phase 3. The EDT requires an Internet connection to be able to receive an activation file from the AGCO server.

8. If no Internet connection is available, interrupt the process and move to a location where an Internet access is available.
9. Once the Internet access is established, open the EDT with the same vehicle settings as before and resume the activation process.

Phase 4.

10. Once the EDT has received the activation file, return to the vehicle and connect the EDT.
11. Continue with the ECU activation.
12. Once the ECU is activated, make sure that the latest possible software is uploaded to the ECU with the EDT.

2.31.3 Replace the engine wiring harness

2.31.3.1 Prepare the wiring harness replacement

See the instructions of the machine manufacturer for more information.

Before starting the procedure

1. Make sure that you have applicable containers for all drained liquids.
2. Make sure that you have necessary lifting devices, support stands and pallets for the parts of the machine and the engine.

Procedure

1. Drain the coolant.

2. Remove the engine cover.
   a) Open the engine cover.
   b) Attach the lifting device to the engine cover.
   c) Remove the gas springs of the engine cover.
   d) Remove the engine cover and lift it carefully.

3. Remove the boost pipes.

4. Remove the air-intake components of the machine.

5. Remove the DOC catalyst.

6. Remove the bracket of the DOC catalyst.

2.31.3.2 Engine wiring harness, main

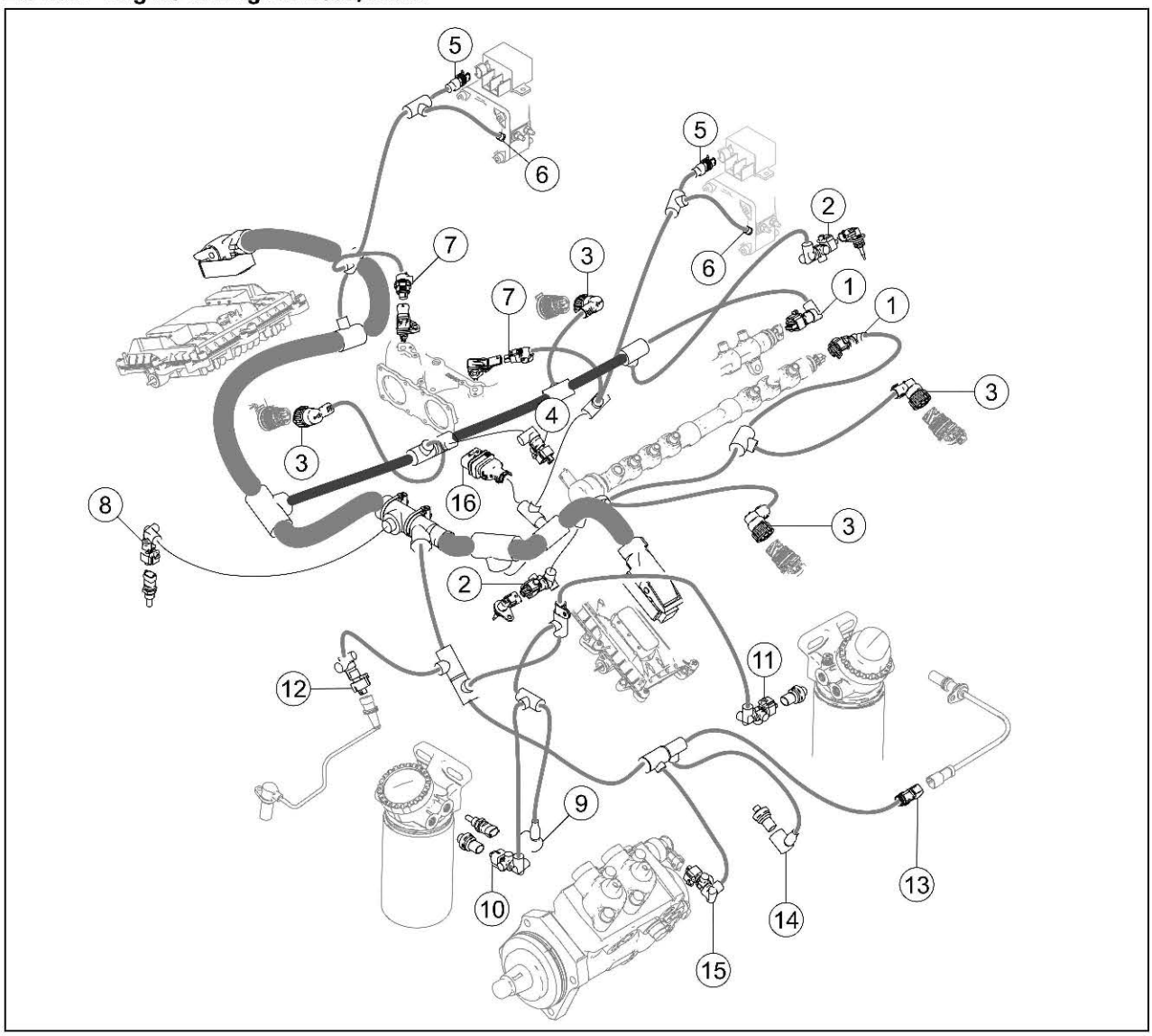


Fig. 870

(1) Pressure sensor of the rail
(2) Temperature sensor of the intake manifold
(3) Injectors
(4) PCV (pressure control valve)
(5) Solenoid
(6) Air-intake heater
(7) Boost pressure sensor
(8) Coolant temperature sensor
(9) Fuel temperature sensor
(10) Fuel pressure sensor
(11) Fuel pressure sensor
(12) Speed sensor (camshaft)
(13) Speed sensor (crankshaft)
(14) Oil pressure sensor
(15) MPROP
(16) Connection for the engine wiring harness of the actuators

2.31.3.3 Engine wiring harness of the actuators

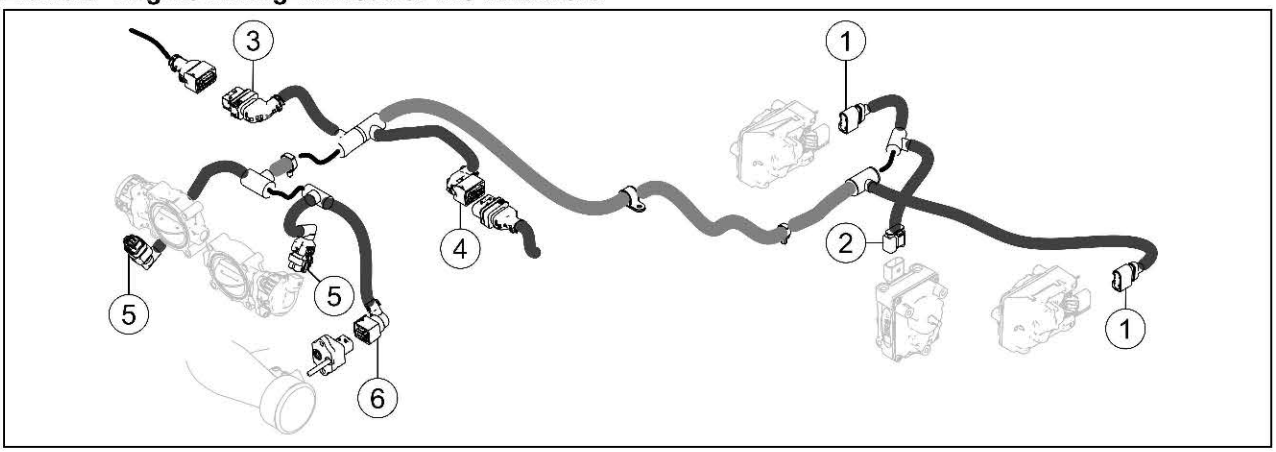


Fig. 871

(1) Actuator of the high-pressure turbocharger
(2) EGR actuator
(3) Engine wiring harness of the machine connection
(4) Engine wiring harness connection
(5) Throttle valve
(6) MAF sensor

2.31.3.4 Remove the engine wiring harness of the actuators

Procedure

1. Remove the cable ties attached to the engine wiring harness of the actuators.
2. Disconnect the wire connectors from the actuators of the high-pressure turbochargers.
3. Disconnect the wire connector from the EGR actuator.
4. Remove the wire clip from the front distribution unit.
5. Disconnect the wire connectors from the engine wiring harness of the machine connection and from the engine wiring harness.
6. Disconnect the wire connectors from the throttle valves.
7. Disconnect the wire connector from the MAF sensor (Mass Air Flow sensor).

2.31.3.5 Remove the engine wiring harness, main

Procedure

1. Remove the cable ties attached to the engine wiring harness always when it is possible.
2. Open the 3 hose clips of the air pipe.
3. Open and remove the attaching screws of the air pipe (5 pcs).
4. Disconnect the wire connectors of the boost pressure sensors.

5. Remove the air pipe and the throttle valves as one assembly.

6. Remove the plastic covers of the electronic control units (ECU).

7. Disconnect the engine wiring harness and the engine wiring harness of the machine connection from the primary ECU and from the secondary ECU.

8. Remove the both ECUs with the brackets.
a) Disconnect all the necessary wires.
b) Remove the bracket of the expansion tank pipe from the ECU bracket of the left side.
c) Remove the boost pipe between the low-pressure turbocharger and the ICAC from the right side.
d) Remove the attaching screws of the ECU brackets.
e) Remove the ECUs with the brackets.

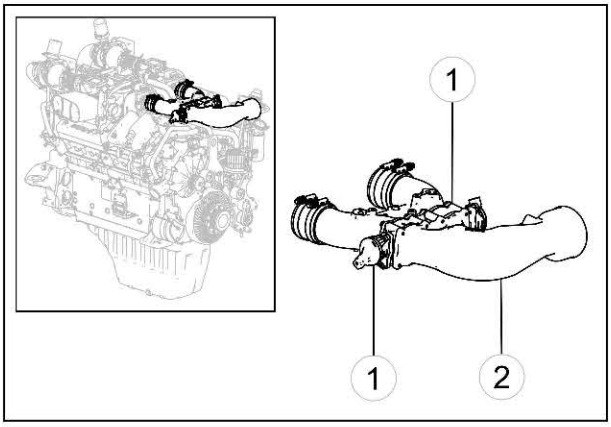


Fig. 872
(1) Throttle valve
(2) Air pipe

9. Remove the pressure oil pipes of the low-pressure turbochargers.
a) Open the clamps of the pressure oil pipes from the ICAC bracket of the left side.
b) Remove the both pressure oil pipes from the low-pressure turbochargers and from the oil distribution unit.

10. Remove the boost pipe between the low-pressure turbocharger and the ICAC from the left side.

11. Disconnect the return oil pipes from the low-pressure turbochargers.
a) Open the clamps from the bracket of the ICAC from both sides.
b) Remove the attaching screws of the return oil pipes from both low-pressure turbochargers.

Return oil pipes stays in their positions.

12. Remove the boost pipes between the high-pressure turbochargers and the ICACs from both sides.
a) Open the clamps of the boost pipes.

NOTE: *Use a long 10 mm socket.*
b) Remove the boost pipes.

13. Remove the rear distribution unit of the coolant.

a) Disconnect the 2 coolant pipes from the front distribution unit.
b) Open the necessary hose clips.
c) Disconnect the coolant pipes from the 3 actuators.
d) Remove the attaching screws of the rear distribution unit (2 pcs).
e) Remove the rear distribution unit with the coolant pipes.

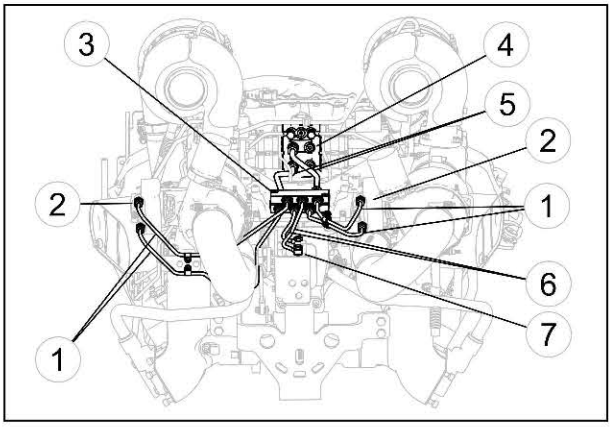


Fig. 873

(1) Coolant pipe for the actuator of the high-pressure turbocharger
(2) Actuator of the high-pressure turbocharger (wastegate actuator)
(3) Rear distribution unit of the coolant
(4) Front distribution unit of the coolant
(5) Coolant pipe between the front distribution unit and the rear distribution unit
(6) Coolant pipe for the EGR actuator
(7) EGR actuator

14. Remove the low-pressure turbochargers with the mounting bracket and the air pipes.

a) Open the clamps of the high-pressure turbochargers from the both sides.
b) Remove the attaching screws for the pressure oil pipe of the right side high-pressure turbocharger from the bracket of the low-pressure turbochargers.
c) Open the top screws of the vertical supports for the low-pressure turbochargers.
d) Open the screws (6 pcs) holding the mounting bracket for the low-pressure turbochargers.
e) Remove the low-pressure turbochargers with the mounting bracket and the air pipes.

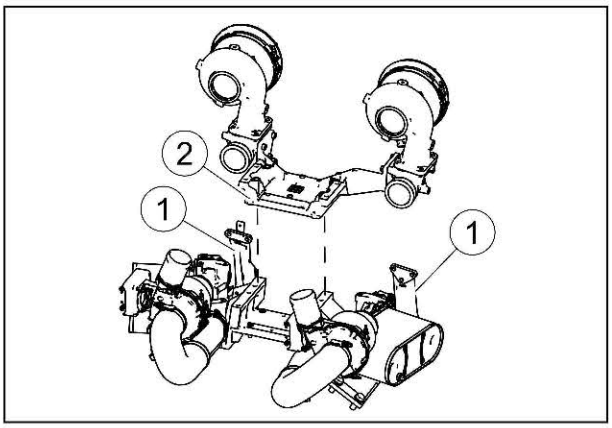


Fig. 874

(1) Vertical support
(2) Mounting bracket

The vertical supports stay to the mounting bracket of the ICACs.

15. Remove the pressure oil pipe of the high-pressure turbocharger from the right side.

16. Remove the EGR coolers.

a) Remove the EGR link rod.
b) Remove the EGR actuator from the bracket.
c) Remove the bracket of the EGR actuator.
d) Remove the coolant pipes of the EGR between the EGR coolers and the cylinder head.
e) Remove the lift eye from the front end of the engine.
f) Open the hose clips of the EGR coolant pipes.
g) Open the first hose clips attaching the coolant pipes to the rubber hoses.
h) Open the coolant pipes of the EGR from the coolant pump.
i) Pull the coolant pipes in the direction of the coolant pump to get the coolant pipes off the rubber hoses.

NOTE: *Do not remove the coolant pipes fully.*

j) Remove the bleeding pipes from the front distribution unit of the coolant.
k) Remove the bracket on top of the EGR coolers.
l) Remove the heat shield of the EGR coolers.
m) Remove the attaching screws of the EGR coolers from the front and from the rear.

NOTE: *If it is necessary, use lubrication.*

n) Remove the EGR coolers.

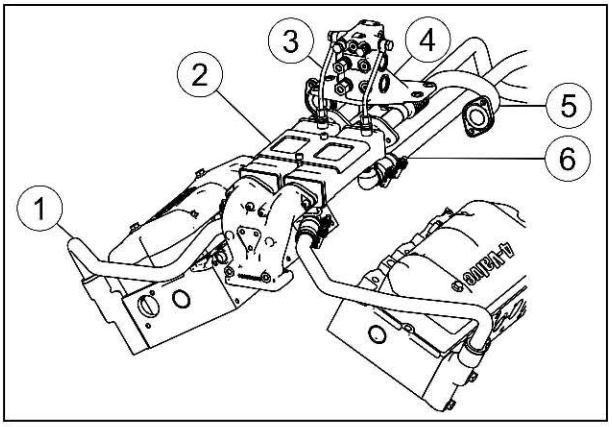


Fig. 875

(1) Coolant pipe between the cylinder head and the EGR cooler.
(2) EGR cooler
(3) Bleeding pipe between the distribution unit and the EGR coolers
(4) Distribution unit
(5) EGR pipe
(6) Coolant pipe between the EGR cooler and the coolant pump

17. Remove the ICACs with the mounting bracket.

a) Loosen the hose clips of the ICAC coolant pipes.
b) Disconnect the coolant pipes of the ICAC from the front distribution unit of the coolant.
c) Remove the attaching screws of the ICAC mounting bracket from the cylinder heads (4 screws on each side).
d) Disconnect the oil distribution unit from the bracket of the ICAC.

Oil distribution unit stays in its position.

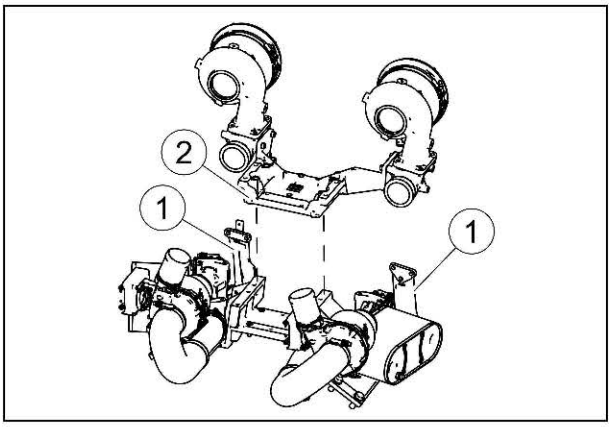


Fig. 876

e) Remove the attaching screws in the middle of the ICAC mounting bracket (4 pcs).
f) Remove the ICACs with the mounting bracket.

18. Remove the engine wiring harness.

a) Remove the cable ties attached to the engine wiring harness.
b) Disconnect the wire connectors from the pressure sensors of the rails.
c) Disconnect the wire connectors from the temperature sensors of the intake manifolds.
d) Disconnect the wire connectors from the injectors.
e) Disconnect the wire connector from the PCV (pressure control valve).
f) Disconnect the wire connectors from the solenoid and from the air-intake heater.
g) Disconnect the wire connector from the coolant temperature sensor.

h) Disconnect the wire connectors from the fuel filters.
i) Disconnect the wire connectors from the camshaft speed sensor and from the crankshaft speed sensor.
j) Disconnect the wire connector from the oil pressure sensor.
k) Disconnect the wire connector from the MPROP.

2.31.3.6 Install the engine wiring harness, main

NOTE:
Always replace the engine gaskets, seals and washers when you open joints.

Procedure

1. Make sure that the wires do not make sharp turns and that sharp parts do not cause damage to the wires.

2. Install the engine wiring harness.

NOTE: *Make sure that the wiring harness does not touch the hot areas of the engine.*

NOTE: *Attach the wiring harness sufficiently with cable ties to prevent the vibration of the wiring harness.*

a) Connect the wire connectors for the pressure sensor of the rail, the injectors and the temperature sensor of the intake manifold on the left side.
b) Attach with 3 cable ties to the coolant pipe.
c) Connect the wire connectors for the fuel filters.
d) Attach the wire of the pre-filter pressure sensor with a hose clip to the fuel filter bracket.
e) Pull the wire with the connectors of the crankshaft speed sensor, oil pressure sensor and MPROP below the fuel filter bracket.
f) Connect the wire connectors.
g) Attach the wire of the crankshaft speed sensor to the oil pipes with cable ties.
h) Attach the joint of the oil pressure sensor and the MPROP to the support bracket between the oil cooler and the high-pressure pump.
i) Connect the wire connector for the camshaft speed sensor.
j) Pull the wire with the connectors of the right side below the engine wiring harness of the machine connection.
k) Connect the wire connectors for the temperature sensor of the intake manifold, the pressure sensor of the rail and the injectors on the right side.
l) Attach with 3 cable ties to the coolant pipe.
m) Connect the wire connector for the PCV (pressure control valve).
n) Connect the wire connector for the coolant temperature sensor.
o) Cut the long ends of the cable ties.

3. Install the ICACs with the mounting bracket.

a) Make sure that the extensions of the lifting eyes are tight.
b) Lift ICACs with the mounting bracket carefully to their position.
c) Connect the coolant pipes of the ICACs to the front distribution unit of the coolant.
d) Put the rubber hoses to the correct position.
e) Install the attaching screws of the ICAC mounting bracket.
f) Tighten the attaching screws of the ICAC mounting bracket.
g) Attach the oil distribution unit to the mounting bracket of the ICACs.
h) Tighten the hose clips.

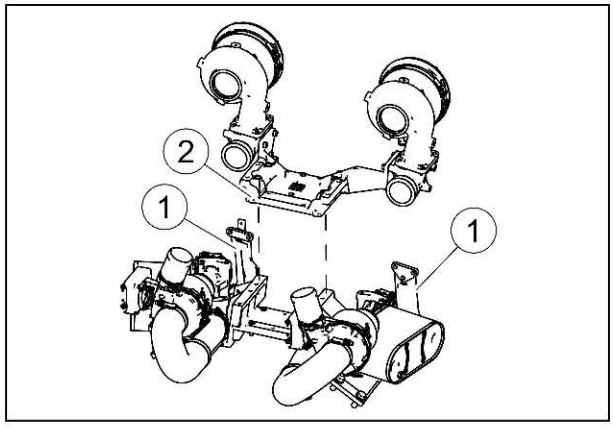


Fig. 877

4. Install the EGR coolers.

a) Lift the EGR coolers to their position.
b) Install the heat shield, the gaskets and the attaching screws to the rear end of the EGR coolers.
c) Install the gaskets and the attaching screws to the front end of the EGR coolers.
d) Connect the rubber hoses with the coolant pipes under the EGR coolers and tighten the hose clips from both sides.

NOTE: *Use new hose clips if the used ones does not tighten correctly.*

e) Tighten the both nuts of the coolant pipes to the coolant pump.
f) Install the lift eye to the front end of the engine.
g) Install the bracket on top of the EGR coolers.
h) Install the bleeding pipes to the front distribution unit of the coolant.
i) Install the bracket of the EGR actuator.
j) Install the EGR actuator to the bracket.
k) Install the EGR link rod.
l) Install the coolant pipes between the EGR coolers and the cylinder heads to the both sides.
m) Put the rubber hoses to the correct position and tighten the hose clips from both sides.

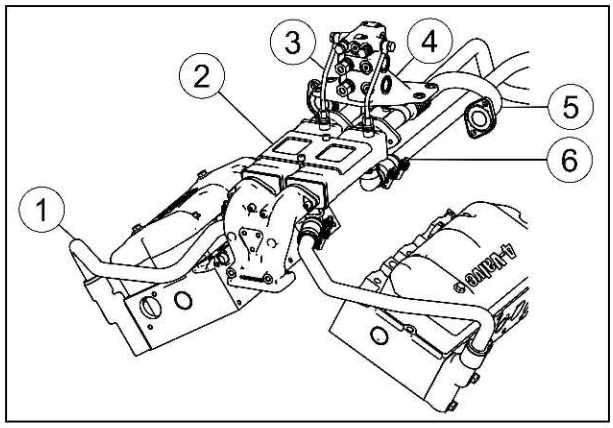


Fig. 878

(1) Coolant pipe between the cylinder head and the EGR cooler.
(2) EGR cooler
(3) Bleeding pipe between the distribution unit and the EGR coolers
(4) Distribution unit
(5) EGR pipe
(6) Coolant pipe between the EGR cooler and the coolant pump

5. Install the pressure oil pipe of the high-pressure turbocharger to the right side.

6. Install the low-pressure turbochargers with the mounting bracket.

a) Clean the sealing surfaces of the low-pressure turbochargers and the return oil pipes.
b) Lift the low-pressure turbochargers to their position.
c) Install the attaching screws to the mounting bracket (6 pcs).
d) Install the top screws of the vertical supports for the low-pressure turbochargers (3 pcs on each side).
e) Install the attaching screws for the pressure oil pipe of the right side high-pressure turbocharger to the bracket of the low-pressure turbochargers.
f) Install the clamps of the high-pressure turbochargers to the both sides.

NOTE: *Use a long 10 mm socket to make sure that the clamp tightens correctly.*

g) Install the return oil pipe of the right side low-pressure turbocharger.
h) Install the return oil pipe of the left side low-pressure turbocharger.
i) Tighten the hose clips of the both sides return oil pipes.

7. If it is necessary, replace the vehicle harness at this point.

8. Install the both ECUs with the brackets.
a) Install the ground cable to the bracket of the ECU.
b) Install the ECU with the bracket to the engine.
c) Install the attaching screws.
d) Connect the wiring harnesses to the ECU.
e) Attach the wires with the cable ties to the bracket of the ECU.
f) Install the plastic cover of the ECU.
g) Do the same procedure for the right side and the left side of the engine.
h) Install the bracket of the expansion tank pipe to the ECU bracket of the left side.

9. Install the air pipe and the throttle valves as one assembly.
a) Install new cable ties for the connectors of the engine wiring harness of the actuators.
b) Lift the air pipes and the throttle valves to their position.
c) Install the air pipe to the rubber hose of the fan.
d) Connect the 2 air pipes with the pipes of the intake manifold.
e) Install the attaching screws (3 pcs).
f) Install the attaching screws of the air pipe (2 pcs).
g) Install the hose clips to the rubber hose of the fan and to the pipes of the intake manifold.

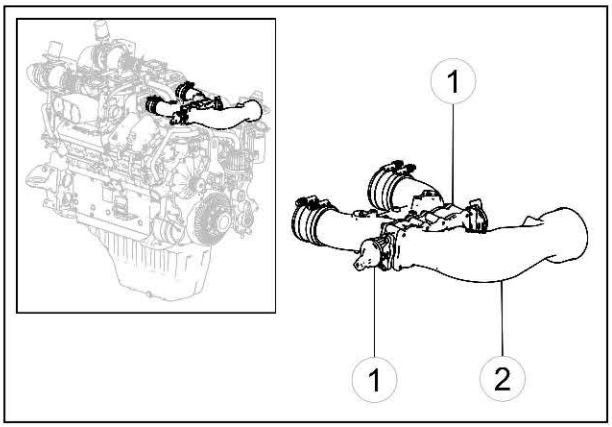


Fig. 879
(1) Throttle valve
(2) Air pipe

h) Connect the wire connectors for the solenoid and the air-intake heater.
i) Connect the wire connectors for the boost pressure sensors.

10. Install the boost pipes.
a) Install the boost pipes between the ICACs and the low-pressure turbochargers.
b) Install the clamps to the both sides.

NOTE: *Use a long 10 mm socket to make sure that the clamp tightens correctly.*

11. Install the pressure oil pipes of the low-pressure turbochargers.
a) Attach the pressure oil pipe of the right side to the oil distribution unit and to the low-pressure turbocharger.
b) Attach the hose clips to the mounting bracket of the ICACs, to the vertical support of the low-pressure turbochargers and to the front distribution unit of the coolant.
c) Attach the pressure oil pipe of the left side to the oil distribution unit and to the low-pressure turbocharger.
d) Attach the hose clips to the mounting bracket of the ICACs and to the vertical support of the low-pressure turbochargers.

12. Install the rear distribution unit of the coolant.

a) Connect the 2 coolant pipes to the front distribution unit.
b) Connect the coolant pipes to the 3 actuators.
c) Install the attaching screws of the rear distribution unit (2 pcs).
d) Tighten the attaching screws of the high-pressure turbocharger actuators.
e) Tighten the banjo bolts of the EGR actuator.

13. Install the boost pipes between the high-pressure turbochargers and the ICACs to the both sides.

NOTE: *Use a long 10 mm socket to make sure that the clamp tightens correctly.*

a) Install and tighten the clamp to the end of the ICAC.
b) Install and tighten the hose clip to the end of the high-pressure turbocharger.
c) Do the same procedure for the both sides.

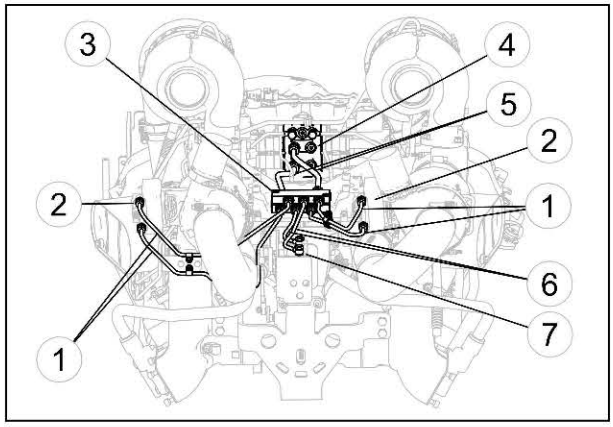


Fig. 880

(1) Coolant pipe for the actuator of the high-pressure turbocharger
(2) Actuator of the high-pressure turbocharger (wastegate actuator)
(3) Rear distribution unit of the coolant
(4) Front distribution unit of the coolant
(5) Coolant pipe between the front distribution unit and the rear distribution unit
(6) Coolant pipe for the EGR actuator
(7) EGR actuator

2.31.3.7 Install the engine wiring harness of the actuators

NOTE: ***Make sure that the wiring harness does not touch the hot areas of the engine.***

NOTE: ***Attach the wiring harness sufficiently with cable ties to prevent the vibration of the wiring harness.***

1. Start from the rear end of the engine.

2. Make sure that the wires do not make sharp turns and that sharp parts do not cause damage to the wires.

3. Connect the wire connector for the EGR actuator.

4. Connect the wire connectors for the actuators of the high-pressure turbochargers.

5. Attach the wire with the clips to the coolant pipes of the right side high-pressure turbocharger.

6. Pull the wires to the high-pressure turbocharger on the left side over the coolant pipes.

7. Do not pull the wires near the EGR coolers.

8. Pull the wire to the front end of the engine under the mounting bracket of the low-pressure turbochargers.

9. Attach the wiring harness with the cable tie to the coolant pipes of the ICACs.

10. Attach the wire clip to the front distribution unit of the coolant.

11. Connect the wire connectors for the engine wiring harness of the machine connection and the engine wiring harness.

12. Connect the wire connectors for the throttle valves.

13. Connect the wire connector for the MAF sensor (Mass Air Flow sensor)

14. Attach the engine wiring harness of the actuators with cable ties to the engine wiring harness on the front end of the engine.

15. Tighten the cable ties to the connectors of the engine wiring harness of the machine connection and to the engine wiring harness.
16. Cut the long ends of the cable ties.

2.31.3.8 Finalize the wiring harness replacement

See the instructions of the machine manufacturer for more information.

NOTE: *Do not start an engine without the protection covers.*

Procedure

1. Install the bracket of the DOC catalyst.
2. Install the DOC catalyst
3. Install the air-intake components of the machine.
4. Install the boost pipes.
5. Install the engine cover.
   a) Lift the engine cover carefully to its position.
   b) Install the gas springs of the engine cover.
   c) Install the attaching screws of the engine cover.
6. Install the other covers of the machine.
7. Fill in the coolant.
8. Use the service tool to do a check for the engine logs from the ECU.
9. Do the test run with the machine.
10. Do a check that there are no leakages from the engine.
11. Clean the machine.

2.32 Terminal diagram

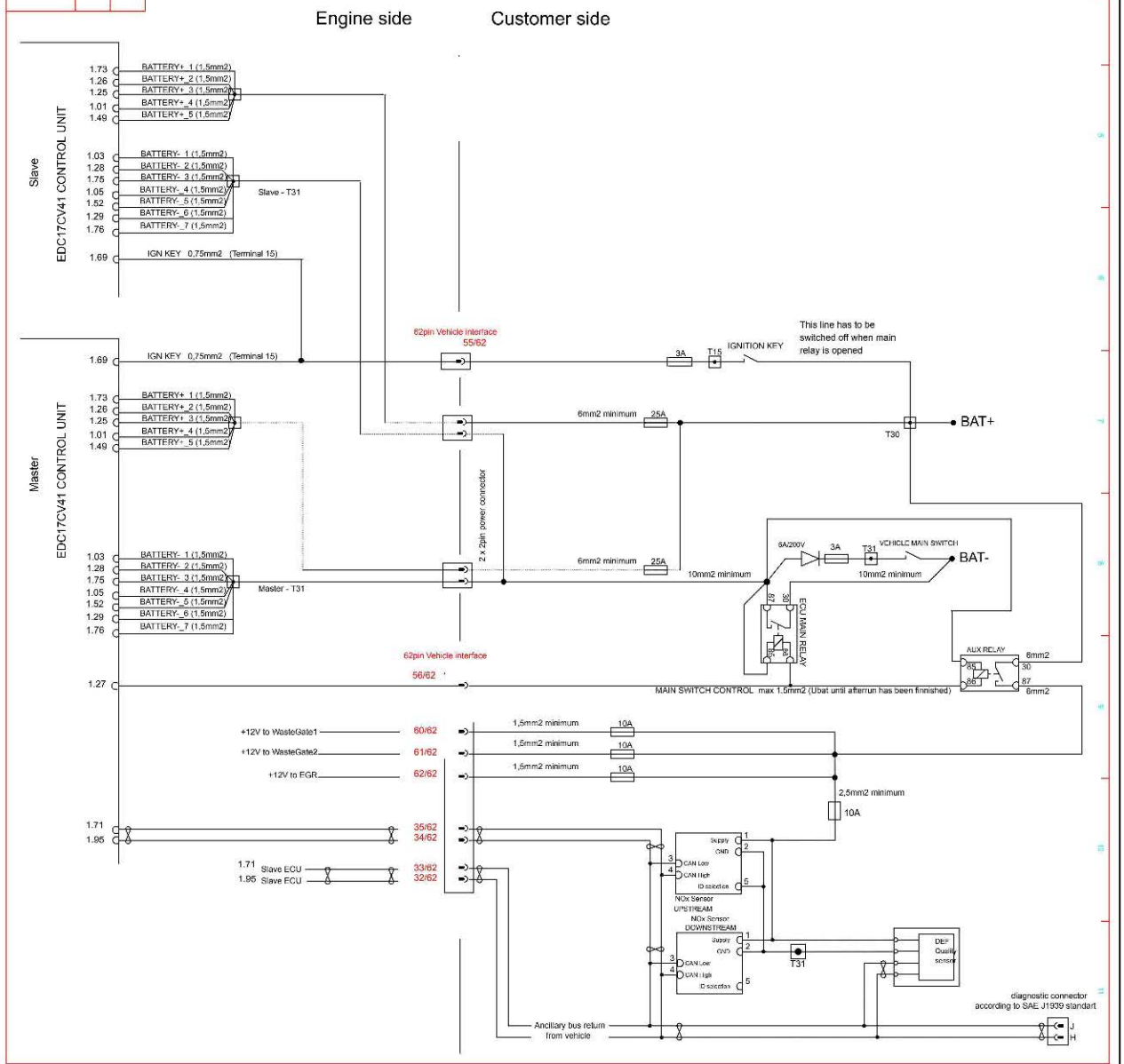
Requirement for the ECU supply:

The ECU and AUX relay must be powered at least 2 minutes after the iginition key (T15) has switched off.
This is required because of emptying of urea lines back to the tank and actuators calibration cycle in after run

ECU Main relay is required, if ECU supply power can be disconnected by vehicle Main switch. ECU Main relay and AUX relay can be replaced with timed relay or switch, if circuit is separated from the starter.

NOTE! This concept is an AGCO Power recommendation. ECU voltage feed can vary between different applications.

Main switch at the battery negative side



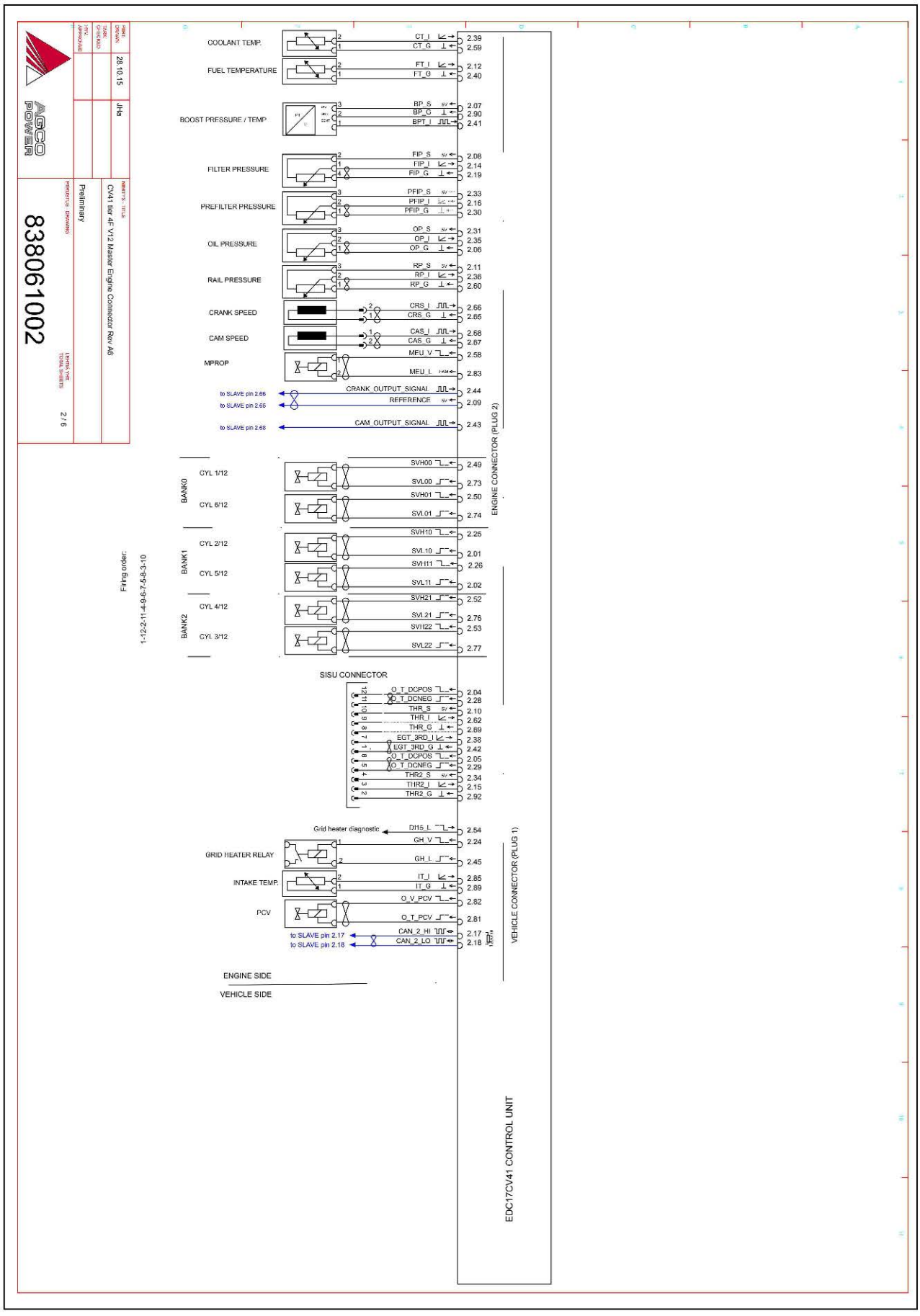

AGCO POWER
28.10.15
JHa
838061002
Preliminary
CV41 tier 4F V12 Master Engine Connector Rev A6
2 / 6
COOLANT TEMP.
FUEL TEMPERATURE
BOOST PRESSURE / TEMP
FILTER PRESSURE
PREFILTER PRESSURE
OIL PRESSURE
RAIL PRESSURE
CRANK SPEED
CAM SPEED
MPROP
to SLAVE pin 2.66
to SLAVE pin 2.65
to SLAVE pin 2.68
CRANK_OUTPUT_SIGNAL
REFERENCE
CAM_OUTPUT_SIGNAL
ENGINE CONNECTOR (PLUG 2)
BANK0
BANK1
BANK2
CYL 1/12
CYL 6/12
CYL 2/12
CYL 5/12
CYL 4/12
CYL 3/12
Firing order:
1-12-2-11-4-9-6-7-5-8-3-10
SISU CONNECTOR
Grid heater diagnostic
GRID HEATER RELAY
INTAKE TEMP.
PCV
CAN_2_HI
CAN_2_LO
to SLAVE pin 2.17
to SLAVE pin 2.18
VEHICLE CONNECTOR (PLUG 1)
EDC17CV41 CONTROL UNIT
ENGINE SIDE
VEHICLE SIDE

Fig. 882

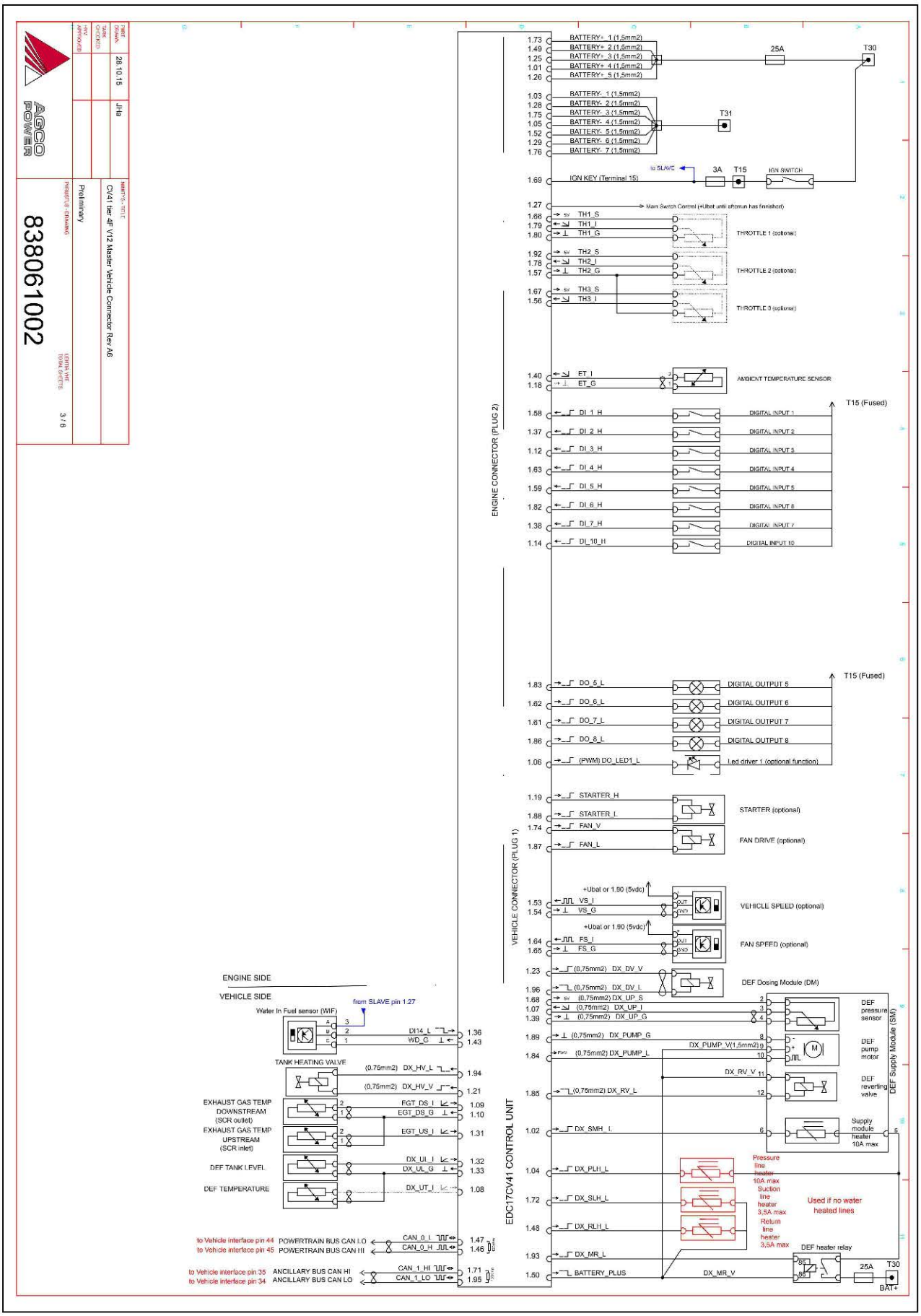

AGCO POWER
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Preliminary
CV41 tier 4F V12 Master Vehicle Connector Rev A6
28.10.15
JHa
3 / 6
ENGINE CONNECTOR (PLUG 2)
VEHICLE CONNECTOR (PLUG 1)
EDC17CV41 CONTROL UNIT
BATTERY+ 1 (1,5mm2)
BATTERY+ 2 (1,5mm2)
BATTERY+ 3 (1,5mm2)
BATTERY+ 4 (1,5mm2)
BATTERY+ 5 (1,5mm2)
25A
T30
BATTERY- 1 (1,5mm2)
BATTERY- 2 (1,5mm2)
BATTERY- 3 (1,5mm2)
BATTERY- 4 (1,5mm2)
BATTERY- 5 (1,5mm2)
BATTERY- 6 (1,5mm2)
BATTERY- 7 (1,5mm2)
T31
to SLAVE
3A
T15
IGN SWITCH
IGN KEY (Terminal 15)
Main Switch Control (+Ubat until afterrun has finnished)
TH1_S
TH1_I
TH1_G
THROTTLE 1 (optional)
TH2_S
TH2_I
TH2_G
THROTTLE 2 (optional)
TH3_S
TH3_I
THROTTLE 3 (optional)
ET_I
ET_G
AMBIENT TEMPERATURE SENSOR
T15 (Fused)
DI_1_H
DI_2_H
DI_3_H
DI_4_H
DI_5_H
DI_6_H
DI_7_H
DI_10_H
DIGITAL INPUT 1
DIGITAL INPUT 2
DIGITAL INPUT 3
DIGITAL INPUT 4
DIGITAL INPUT 5
DIGITAL INPUT 6
DIGITAL INPUT 7
DIGITAL INPUT 10
DO_5_L
DO_6_L
DO_7_L
DO_8_L
(PWM) DO_LED1_L
DIGITAL OUTPUT 5
DIGITAL OUTPUT 6
DIGITAL OUTPUT 7
DIGITAL OUTPUT 8
Led driver 1 (optional function)
STARTER_H
STARTER_L
FAN_V
FAN_L
STARTER (optional)
FAN DRIVE (optional)
+Ubat or 1.90 (5vdc)
VS_I
VS_G
VEHICLE SPEED (optional)
FS_I
FS_G
FAN SPEED (optional)
(0,75mm2) DX_DV_V
(0,75mm2) DX_DV_I
DEF Dosing Module (DM)
(0,75mm2) DX_UP_S
(0,75mm2) DX_UP_I
(0,75mm2) DX_UP_G
DEF pressure sensor
(0,75mm2) DX_PUMP_G
DX_PUMP_V(1,5mm2)
(0,75mm2) DX_PUMP_L
DEF pump motor
DX_RV_V
DEF reverting valve
(0,75mm2) DX_RV_L
Supply module heater 10A max
DEF Supply Module (SM)
DX_SMH_I
DX_PLH_L
DX_SLH_L
DX_RLH_L
Pressure line heater 10A max
Suction line heater 3,5A max
Return line heater 3,5A max
Used if no water heated lines
DEF heater relay
DX_MR_L
DX_MR_V
BATTERY_PLUS
BAT+
ENGINE SIDE
VEHICLE SIDE
Water In Fuel sensor (WIF)
from SLAVE pin 1.27
DI14_L
WD_G
TANK HEATING VALVE
DX_HV_L
DX_HV_V
EXHAUST GAS TEMP DOWNSTREAM (SCR outlet)
EGT_DS_I
EGT_DS_G
EXHAUST GAS TEMP UPSTREAM (SCR inlet)
EGT_US_I
DEF TANK LEVEL
DX_UL_I
DX_UL_G
DEF TEMPERATURE
DX_UT_I
to Vehicle interface pin 44 POWERTRAIN BUS CAN LO
to Vehicle interface pin 45 POWERTRAIN BUS CAN HI
CAN_0_I
CAN_0_H
to Vehicle interface pin 35 ANCILLARY BUS CAN HI
to Vehicle interface pin 34 ANCILLARY BUS CAN LO
CAN_1_HI
CAN_1_LO

Fig. 883

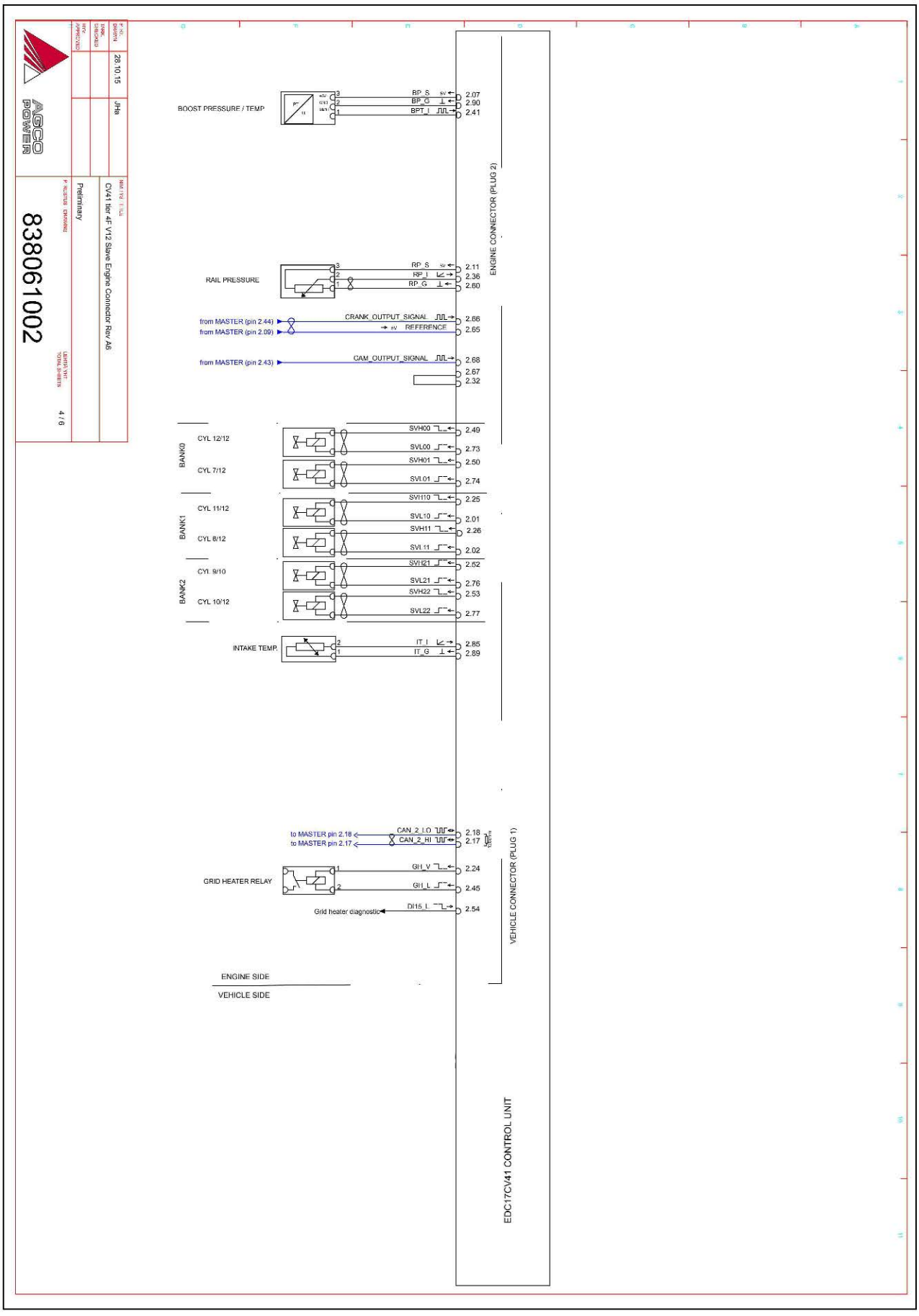

AGCO POWER
28.10.15
JHa
838061002
Preliminary
CV41 tier 4F V12 Slave Engine Connector Rev A6
4 / 6
BOOST PRESSURE / TEMP
BP_S
BP_G
BPT_I
2.07
2.90
2.41
ENGINE CONNECTOR (PLUG 2)
RAIL PRESSURE
RP_S
RP_I
RP_G
2.11
2.36
2.60
from MASTER (pin 2.44)
from MASTER (pin 2.09)
CRANK_OUTPUT_SIGNAL
REFERENCE
2.66
2.65
from MASTER (pin 2.43)
CAM_OUTPUT_SIGNAL
2.68
2.67
2.32
BANK0
CYL 12/12
CYL 7/12
SVH00
SVL00
SVH01
SVL01
2.49
2.73
2.50
2.74
BANK1
CYL 11/12
CYL 8/12
SVH10
SVL10
SVH11
SVL11
2.25
2.01
2.26
2.02
BANK2
CYL 9/10
CYL 10/12
SVH21
SVL21
SVH22
SVL22
2.52
2.76
2.53
2.77
INTAKE TEMP.
IT_I
IT_G
2.85
2.89
to MASTER pin 2.18
to MASTER pin 2.17
CAN_2_LO
CAN_2_HI
2.18
2.17
GRID HEATER RELAY
GH_V
GH_L
2.24
2.45
Grid heater diagnostic
DI15_L
2.54
VEHICLE CONNECTOR (PLUG 1)
ENGINE SIDE
VEHICLE SIDE
EDC17CV41 CONTROL UNIT

Fig. 884

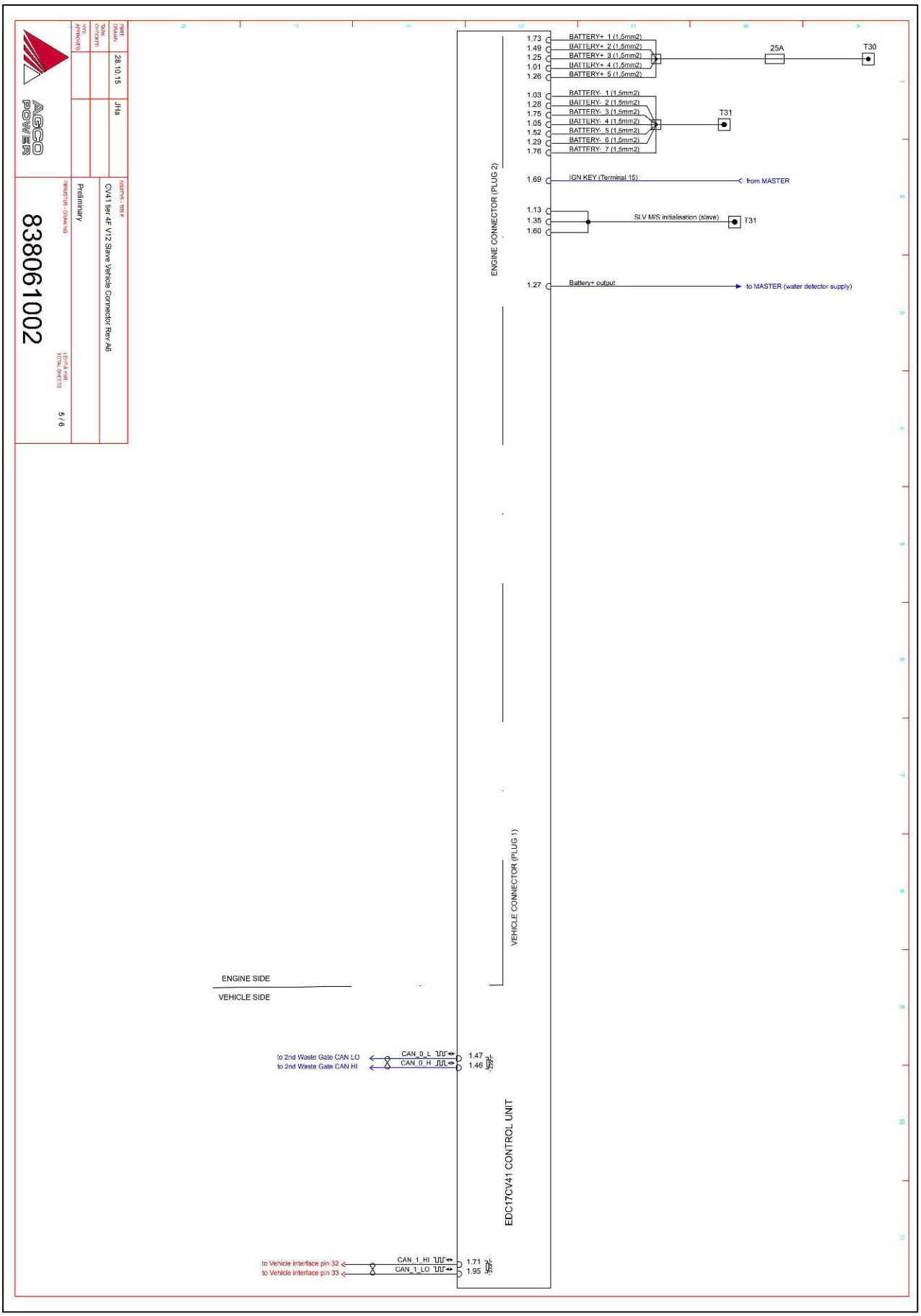

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Preliminary
CV41 tier 4F V12 Slave Vehicle Connector Rev A6
28.10.15
JHa
ENGINE CONNECTOR (PLUG 2)
VEHICLE CONNECTOR (PLUG 1)
EDC17CV41 CONTROL UNIT
1.73 BATTERY+ 1 (1,5mm2)
1.49 BATTERY+ 2 (1,5mm2)
1.25 BATTERY+ 3 (1,5mm2)
1.01 BATTERY+ 4 (1,5mm2)
1.26 BATTERY+ 5 (1,5mm2)
25A
T30
1.03 BATTERY- 1 (1,5mm2)
1.28 BATTERY- 2 (1,5mm2)
1.75 BATTERY- 3 (1,5mm2)
1.05 BATTERY- 4 (1,5mm2)
1.52 BATTERY- 5 (1,5mm2)
1.29 BATTERY- 6 (1,5mm2)
1.76 BATTERY- 7 (1,5mm2)
T31
1.69 IGN KEY (Terminal 15)
from MASTER
1.13
1.35
1.60
SLV M/S initialisation (slave)
T31
1.27 Battery+ output
to MASTER (water detector supply)
ENGINE SIDE
VEHICLE SIDE
to 2nd Waste Gate CAN LO
to 2nd Waste Gate CAN HI
CAN_0_L 1.47
CAN_0_H 1.46
to Vehicle Interface pin 32
to Vehicle Interface pin 33
CAN_1_HI 1.71
CAN_1_LO 1.95

Fig. 885

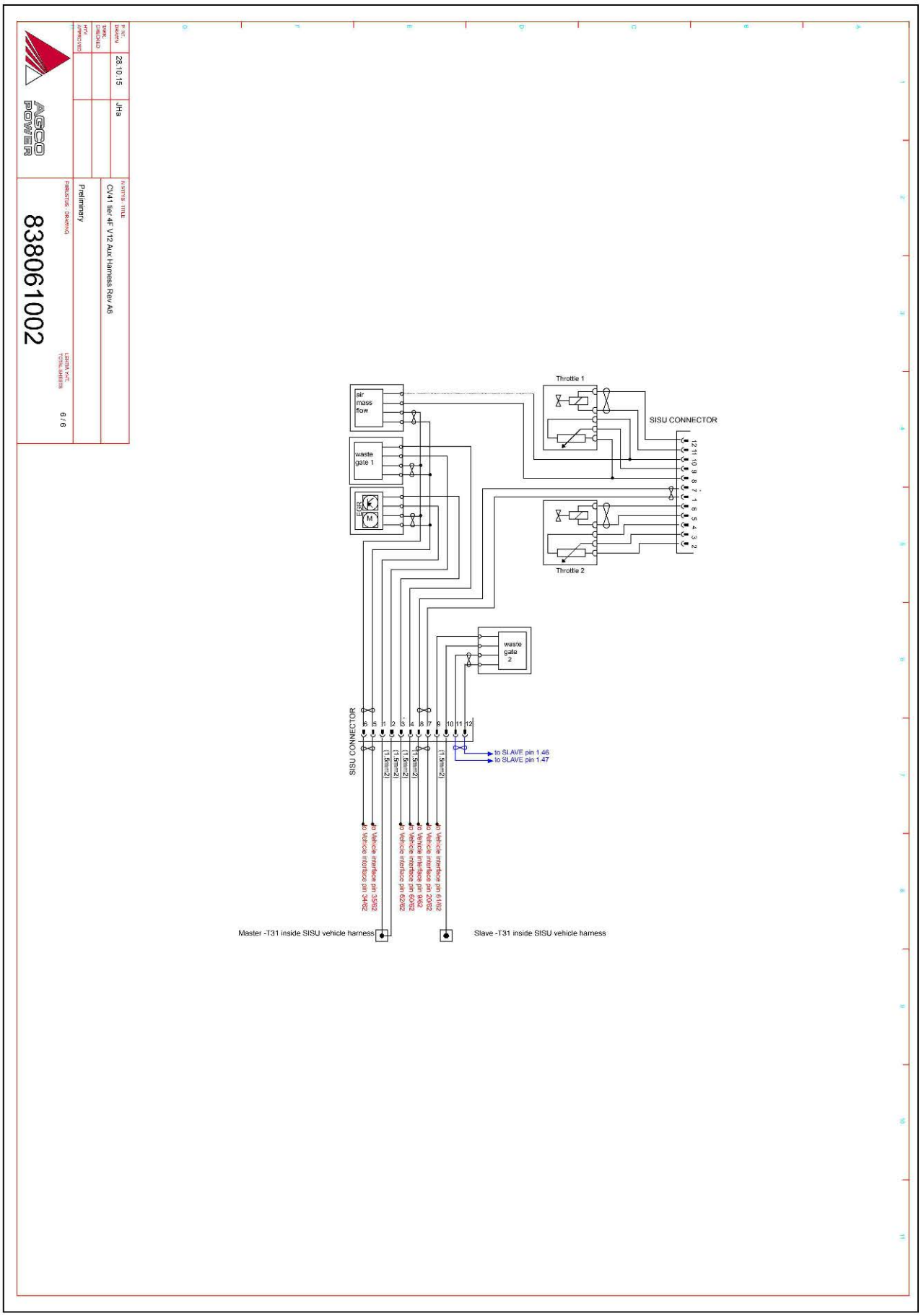

AGCO POWER
28.10.15
JHa
838061002
Preliminary
6 / 6
CV41 tier 4F V12 Aux Harness Rev A6
Throttle 1
Throttle 2
SISU CONNECTOR
air mass flow
waste gate 1
waste gate 2
to SLAVE pin 1.46
to SLAVE pin 1.47
Master -T31 inside SISU vehicle harness
Slave -T31 inside SISU vehicle harness

Fig. 886