UNITED STATES MARINE CORPS
Logistics Operations School
Marine Corps Combat Service Support Schools
Training Command
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FESCR 8204

STUDENT OUTLINE

REPAIR DETROIT FUEL INJECTORS

LEARNING OBJECTIVE

1. Terminal Learning Objective: Given a Detroit fuel injector, the required common and special tools, test equipment, repair parts, shop supplies, TM 9-2320-297-34, and appropriate Hartridge operating and servicing manuals, per information contained in the references, repair the fuel injector. (8.2.2)

2. Enabling Learning Objectives: Given a Detroit fuel injector, the required common and special tools, test equipment, repair parts, shop supplies, TM 9-2320-297-34, and appropriate Hartridge operating and servicing manuals, per information contained in the references:

a. disassemble the fuel injector, (8.2.2a)

b. inspect the disassembled components for serviceability, (8.2.2b)

c. repair or replace the unserviceable components, (8.2.2c)

d. assemble the fuel injector from serviceable components, and (8.2.2d)

e. test the fuel injector. (8.2.2e)

OUTLINE

1. COMPOSITION AND DESIGN CHARACTERISTICS OF THE FUEL INJECTOR

a. The fuel injector is a lightweight compact unit which enables quick, easy engine starting on diesel fuel only and permits the use of a simple, open type combustion chamber. The simplicity of design and operation provides for simplified controls and easy adjustment. No high pressure fuel lines or complicated air-fuel mixing or vaporizing devices are required.

b. The fuel injector performs four functions: timing, atomizing, metering, and pressurizing.

(1) It accurately times the moment of fuel injection.

(2) It atomizes the fuel for vaporization and mixing with the air in the combustion chamber.

(3) It meters and injects the correct amount of fuel required to maintain engine speed and to handle the load.

(4) It creates the high pressure required for proper fuel injection.

c. Combustion required for satisfactory engine operation is obtained by injecting, under pressure, a small quantity of accurately timed, metered, and finely atomized fuel oil into the combustion chamber.

d. Metering and timing during fuel injection is accomplished by an upper and lower helix machined in the lower end of the injector plunger.

e. The continuous fuel flow through the injector serves, in addition to preventing air pockets in the fuel system, as a coolant for those injector parts subjected to high combustion temperatures.

f. To vary the power output of the engine, injectors having different fuel output capacities are used. The fuel output of the various injectors is governed by the effective stroke of the plunger and the flow rate of the spray tip.

g. Since the helix angle and the plunger design determine the operating characteristics of a particular injector, it is imperative that the specified injectors are used for each engine. If injectors of different types are mixed in an engine, erratic operation will result and may cause serious damage to the engine or to the equipment which it powers.

h. Each injector has a circular disc pressed into a recess at the front side of the injector body for identification purposes. The injector we're using as a training aid is a model 9A90. That injector is used on the Detroit 8V92TA diesel engine employed in the MK48 vehicle. You will also find that the injector has a number stamped on the plunger, which represents the size of the plunger, and on the spray tip, which indicates the number of spray holes, hole size and hole angle. The training aid injector has "9-.0062-165A" stamped on the spray tip, which means it has nine holes, a hole size of .0062 inch and a hole angle of 165 degrees.

i. Each injector control rack is activated by a lever on the injector control tube which, in turn, is connected to the governor by means of a fuel rod. These levers can be adjusted independently on the control tube, thus permitting a uniform setting or fine tuning of all injector racks.

j. The fuel injector combines, in a single unit, all of the parts necessary to provide complete and independent fuel injection at each cylinder. Those parts are:

(1) The FOLLOWER provides a place for the rocker arm to activate the injector plunger.

(2) The STOP PIN prevents the injector follower from being pushed out of the body by the follower spring.

(3) The PLUNGER meters, times, and pressurizes the fuel so it can be injected into the engine.

(4) The GEAR is attached to the plunger and in mesh with the injector rack. It helps control the fuel output of the injector.

(5) The GEAR RETAINER holds the gear in place.

(6) The BUSHING is closely fitted (lapped) to the plunger. The bushing, along with the plunger, controls the amount of fuel injected.

(7) The SPILL DEFLECTOR is a stainless steel sleeve that prevents the high pressure, high velocity fuel from striking the injector body and eroding a hole in it.

(8) The CHECK VALVE is a flat valve that prevents exhaust gases from flowing back into the injector if a small piece of carbon or dirt holds the needle valve open.

(9) The VALVE SPRING holds the needle valve on its seat until pressure builds up to overcome the spring tension.

(10) The NEEDLE VALVE opens and closes the fuel flow to the spray tip orifices. The valve is raised by fuel pressure and held shut by the valve spring.

(11) The SPRAY TIP has the orifices through which the fuel is atomized and injected into the combustion chamber.

(12) The NUT retains the injector valve and spray tip on the body.

(13) The SPRING SEAT provides a place for the valve spring to seat.

(14) The SPRING CAGE provides a place for the needle valve spring and spring seat.

(15) The CHECK VALVE CAGE provides a place for the check valve to be installed.

(16) The SEAL forms the seal between the injector body and the injector tip nut.

(17) The CONTROL RACK, as stated earlier, is in mesh with the gear. The control rack connects the injector to the control tube and the governor. (18

(19) The FILTER keeps any small particles from entering the injector.

(20) The FILTER CAP GASKET forms the seal between the cap and body.

(21) The FILTER CAP FITTING holds the inlet filter in place and provides a place to connect the inlet and return jumpers.

(22) The FOLLOWER SPRING returns the follower and the plunger that is connected to the follower to the raised position.

2. PRINCIPLES OF OPERATION OF THE FUEL INJECTOR

a. Fuel, under low pressure, enters the injector at the inlet side through the filter cap and filter. From the filter, the fuel passes through a drilled passage into the supply chamber, that area between the plunger bushing and the spill deflector, in addition to that area under the injector plunger within the bushing. The plunger operates up and down in the bushing, and is supplied fuel through the two, funnel-shaped ports in the bushing wall.

b. The motion of the injector rocker arm is transmitted to the plunger by the follower which bears against the follower spring. In addition to the reciprocating motion, the plunger can be rotated around its axis by the gear, which meshes with the control rack. To accomplish fuel metering, as stated earlier, an upper and lower helix are machined in the lower part of the plunger. The helix relationship to the ports changes with the rotation of the plunger.

c. As the plunger moves downward under pressure of the injector rocker arm, some of the fuel under the plunger moves into the supply chamber through the lower port until the port is covered by the lower end of the plunger.

The fuel below the plunger continues to move up through a central passage in the plunger into the fuel metering recess and into the supply chamber through the upper port until that port is covered by the upper helix of the plunger. With the upper and lower ports both covered, the remaining fuel trapped under the plunger is subjected to increased pressure by the continued downward movement of the plunger.

d. When sufficient pressure is built up, it opens the flat check valve. The fuel in the check valve cage, spring cage, tip passages and tip fuel cavity is compressed until the pressure force acting upward on the needle valve is sufficient to open the valve against the downward force of the valve spring. As soon as the needle valve lifts off its seat, the fuel is forced through the small orifices in the spray tip and atomized into the combustion chamber.

e. When the lower helix of the plunger uncovers the lower port in the bushing, the fuel pressure below the plunger is relieved and the valve spring closes the needle valve, ending injection.

f. A pressure relief passage has been provided in the spring cage to permit bleed-off of fuel leaking past the needle pilot in the tip assembly.

g. As stated earlier, the check valve prevents leakage from the combustion chamber into the fuel injector in case the valve is held open by a small particle of dirt. The injector plunger is then returned to its original position by the injector follower spring.

h. On the return upward movement of the plunger, the high pressure cylinder within the bushing is again filled with fuel oil through the ports. The constant circulation of fresh, cool fuel through the injector renews the fuel supply in the chamber, helps cool the injector, and also effectively removes all traces of air which might otherwise accumulate in the system and interfere with accurate metering of the fuel.

i. The fuel injector outlet opening, through which the excess fuel oil returns to the fuel return manifold and then back to the tank, is directly adjacent to the inlet opening.

j. Changing the position of the helixes, by rotating the plunger, retards or advances the closing of the ports and beginning and ending of the injection period. At the same time, it increases or decreases the amount of fuel that is injected into the cylinder.

(1) With the control rack pulled out all the way (no injection), the upper port is not closed by the helix until after the lower port is

uncovered. Consequently, with the rack in this position, all of the fuel is forced back into the supply chamber and no injection of fuel takes place.

(2) With the control rack pushed all the way in (full injection), the upper port is closed shortly after the lower port has been covered, thus producing a maximum effective stroke and maximum injection.

(3) From the no injection position to full injection position (full rack movement), the contour of the upper helix advances the closing of the ports and the beginning of injection.

3. REPAIR AND TESTING PROCEDURES FOR THE FUEL INJECTOR

a. Instructions

(1) Detailed instructions for repairing the fuel injector are contained in the manual that was issued to you at the beginning of this block of instruction. Follow those instructions carefully to effect those repair procedures on the training aid fuel injector to which you have been assigned.

(2) Have the instructor assigned to your station check your work at each point designated in this student outline.

(3) Refer to TM 9-2320-297-34 for the procedures used to perform the repair steps listed. Use the index to locate the instructions in the manual and read the instructions carefully before performing each task.

b. Disassemble Fuel Injector

(1) Install the injector in the holding fixture.

(2) Remove the filter caps.

(3) Remove the follower spring.

(4) Remove the injector nut.

(5) Remove the spray tip assembly.

(6) Remove the bushing.
(7) Remove the control rack.

STOP! Have instructor initial.

c. Clean and Inspect Injector Components

(1) Clean the injector components.

(2) Measure the distance between the cam follower face and the plunger slot.

(3) Check the spring tension.

(4) Inspect the plunger and bushing.

(5) Inspect the check valve assembly.

(6) Inspect the sealing surfaces for nicks, burrs, and cracks.

(7) Inspect the spray tip.

STOP! Have instructor initial.

d. Recondition Needle Valve and Spray Tip

(1) Instructions.

(a) Detailed instructions for setting up the nozzle reconditioner and grinding of the test piece and needle valve are located in the Hartridge Nozzle Reconditioner Operating and Service Manual.

(b) Refer to the reconditioner manual for the procedures used to perform the reconditioning steps listed.

(2) Grind the needle valve.

(a) Perform needle valve lift test

(b) Install the needle valve onto the grinder.

(c) Adjust the machine to obtain proper grinding angle.

(d) Grind the needle valve.

(e) Remove the needle valve from the grinder.

STOP! Have instructor initial.

(3) Refer to the Hartridge Injectomatic One Operating and Servicing Manual for the procedures used to recondition the Detroit injector tip.

(a) Dress the stone using the nozzle reconditioner.

(b) Install the tip on the machine.

(c) Set the timer.

(d) Lapp the injector tip.

(e) Remove the injector tip from the machine.

STOP! Have instructor initial.

(4) Refer to the Hartridge Nozzle Multiclean Manual for the procedures used to clean the injector tip.

(a) Install the injector tip.

(b) Clean the injector tip.

(c) Remove the injector tip from the multiclean machine.

STOP! Have instructor initial.

(5) Refer to the Hartridge Nozzle Testmaster Operating and Servicing Manual for the procedures used to test the injector needle valve and tip.

(a) Perform the needle valve lift test.

(b) Install the needle valve and tip assembly on the Nozzle Testmaster.

(c) Flush the needle valve and tip assembly.

(d) Check the spray pattern and atomization from all nine spray holes.

(e) Perform leakage test.

(f) Perform opening pressure test.

(g) Remove the needle valve and tip assembly from the tester.

STOP! Have instructor initial.

e. Assemble Fuel Injector

(1) Install the filter caps.

(2) Install the control rack.

STOP! Have instructor initial.

(3) Install the bushing.
(4) Install the check valve assembly.

(5) Install the spray tip.

(6) Install the injector nut.

(7) Install the cam follower.

(8) Check the runout.

(9) Perform the control rack and plunger movement test. Use the holding fixture to perform this test.

STOP! Have instructor initial.

f. Test the Injector

(1) Install the injector on the test stand.

WARNING: The fuel spray from an injector can penetrate the skin. Fuel oil which enters the blood stream can cause a serious infection. Follow instructions and use the proper equipment to test an injector.

(2) Perform the body pressure test.

(3) Remove the injector from the test stand.

STOP! Have instructor initial.

(4) Perform the fuel output test. Refer to the Hartridge H.A. 255 Detroit diesel injector Calibrator Operating and Servicing Manual and perform the following procedures:

(a) Turn the main power switch to "ON."

(b) Turn the isolator switch to "1" and allow the calibration fluid to warm up until the temperature meter displays a reading.

(c) Release the locking screw on the cam selector and position it to the 92 series while turning the handwheel. Tighten the locking screw.

(d) Install the injector into the clamping lever and pull down the lever to lock the injector into place.

(e) Turn the handwheel to make sure the machine turns.

(f) Push and hold the control rack in the FULL FUEL position throughout the remainder of the flow test.

(g) Press the motor start button and start the motor running until fluid appears in the drain pipe.

(h) Press the meter output button. The dial indicator will zero and then an initial output from the injection will purge the air. If the dial falls to zero, reset the meter output button.

(i) Press the meter output button and at the end of metering observe the reading on the dial indicator. The fuel output must be a minimum of 85cc and a maximum of 91cc.

STOP! Have instructor initial.

f. An injector that fails any of these tests must be disassembled and repaired. All tests must then be performed again.

STUDENT REFERENCES:

TM 9-2320-297-34
H.A. 225 Detroit Diesel Injector Calibrator Operating and Servicing Manual
Nozzle Testmaster Operating and Servicing Manual
Nozzle Multiclean Operating Manual
Injectomatic One Operating and Servicing Manual
Nozzle Reconditioner Operating and Servicing Manual