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Training Command
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AIM 5401

STUDENT OUTLINE

RECONDITION ENGINE VALVE TRAIN

GENERAL KNOWLEDGE: Initially, the lesson will impart the background knowledge that is required for a mechanic to perform intermediate maintenance level repairs on the engine valve assembly. The lesson content provides for the impartation of the following information.

LEARNING OBJECTIVES

Terminal Learning Objectives:

1. Given an unserviceable engine cylinder head assembly with valves, a valve refacing machine with required accessories, a valve seat grinding machine with required accessories, required tools, shop supplies, repair parts, TM 9-2320-297-34, and machine operation instructions, per information contained in the references, repair the engine valve train assembly. (5.4.1)

2. Given a valve refacing machine with required accessories, a valve seat grinding machine with required accessories, required tools, shop supplies, an unserviceable engine cylinder head assembly with valves, TM 9-2320-297-34, and machine operating instructions, per information contained in the references, use the reconditioning equipment in conjunction with cylinder head repair. (5.4.2)

Enabling Learning Objectives:

1. Given an unserviceable engine cylinder head assembly with valves, a valve refacing machine with required accessories, a valve seat grinding machine with required accessories, required tools, shop supplies, repair parts, TM 9-2320-297-34, and

machine operation instructions, per information contained in the references:

a. disassemble the cylinder head assembly, (5.4.1a)

b. inspect the disassembled components for serviceability, (5.4.1b)

c. repair, recondition, or replace the unserviceable components, (5.4.1c) and

d. assemble the cylinder head assembly from serviceable components. (5.4.1d)

2. Given a valve refacing machine with required accessories, a valve seat grinding machine with required accessories, required tools, shop supplies, a disassembled unserviceable engine cylinder head assembly, TM 9-2320-297-34, and machine operating instructions, per information contained in the references, prepare the reconditioning equipment for operation. (5.4.2a)

3. Given a valve refacing machine with required accessories, required tools, shop supplies, engine cylinder head valves, TM 9-2320-297-34, and machine operating instructions, per information contained in the references, use the valve refacing machine in conjunction with refacing the valves. (5.4.2b)

4. Given a valve seat grinding machine, with required accessories, required tools, shop supplies, a disassembled, unserviceable engine cylinder head assembly, TM 9-2320-297-34, and machine operating instructions, per information contained in the references, use the valve seat grinding machine in conjunction with grinding the valve seats. (5.4.2c)

OUTLINE

1. CYLINDER HEADS IN GENERAL

a. 6.2 Liter Diesel Engine Cylinder Head

(1) The DDA 6.2 liter diesel engine has two cylinder heads; one each on the right and left cylinder banks. The engine is used in the M998 Series vehicles.

(2) The cylinder head is a one-piece casting and will contain the following items that you will have to inspect, repair or replace when it is turned in for repair.

(a) Valves. The head contains eight valves per head; one intake valve and one exhaust valve per cylinder. Each valve has a valve spring which holds the valve on its seat.

(b) Precombustion chamber. Special alloy steel precombustion chamber inserts in the cylinder head are serviced separately from the head. With the cylinder head removed, they can be pushed out after removing the glow plugs and nozzles. To install a new precombustion chamber, use a socket the same size and tap it into the cylinder head.

(c) The 6.2 cylinder head has valve guide bores and valve seats that can be inspected and repaired. However, they are not replaceable.

1 When the valve guide bores fail inspection, they should be reamed and fitted with oversize valves.

2 The valve seats can be reconditioned. However, once they exceed the limits for reconditioning, the cylinder head will have to be replaced. We will cover the reconditioning procedures for the seats and valves later.

b. Cummins NHC Diesel Engine Cylinder Head

(1) The Cummins NHC 250 engines have three cylinder heads; one per every two cylinders. The engines are used in the M809 and M939 Series vehicles.

(2) The head is a one-piece casting with tapped fuel passages
incorporated in it. The cylinder head will also contain the following items that you will have to inspect, repair or replace when it is turned in for repair.

(a) Valves. You have two intake valves and two exhaust valves per cylinder, for a total of eight valves in each head. The valves are held on their seats by valve springs.

(b) Valve seats. You have replaceable valve seats which are used to extend the life of the head. Remember the 6.2 cylinder head; if the seats cannot be reconditioned, we have to

replace the cylinder head. Here we just replace the valve seats.

(c) Valve guides. You have a valve guide for each of the eight valves. The valve guides are also replaceable and extend the life of the cylinder head.

(d) Injector sleeves. You have one replaceable injector sleeve per cylinder; two per head.

(e) Crosshead guides. There are four replaceable crosshead guides per head; two per cylinder or one per every two valves.

c. Detroit 8V92TA Diesel Engine Cylinder Head

(1) The Detroit 8V92TA diesel engine that is employed in the LVS has two heads; one each on the right and left cylinder banks. Each bank contains four cylinders.

(2) The cylinder head is a one-piece casting with tapped fuel passages incorporated in it. The cylinder head will also contain the following items when turned in for repair.

(a) Injector tubes. Each head contains four injector tubes; one per each cylinder. Each injector tube has a seal ring that forms a seal between the tube and head.

(b) Exhaust valves. This head has exhaust valves only. There are sixteen valves per head; four for each cylinder. The valves are held in place by valve springs, same as the other two heads.

(c) Valve guides. For each valve, you have a valve guide. The sixteen valve guides are replaceable, same as on the Cummins head.

(d) Exhaust valve bridge guides. On this head there is a valve bridge guide between every two exhaust valves. This makes a total of eight per head.

(e) Exhaust valve seat inserts. This head also has replaceable valve seat inserts. There are sixteen per head and they are used as seats for the valves and to extend the life of the cylinder head.

(f) Water nozzles. Detroit Diesel has incorporated eight water nozzles in the head to aid in cooling the hottest spots of the cylinder head. There are six double outlet nozzles and two single outlet nozzles. They too are replaceable.

2. REPAIR PROCEDURES FOR ENGINE CYLINDER HEADS

a. Remove the Valve Assemblies

(1) The first thing we want to do is tape the valve heads to the fire deck so the valves will not fall out when we rotate the head.

(2) We then number each valve by marking the number on the tape covering the valve head. The purpose of marking the valves is to make sure they are replaced in their original seat to avoid poor seating and loss of engine performance.

(3) Next, position the cylinder head so the valve springs are up and the bottom of the cylinder head is resting on a wooden table top, a wooden block large enough to cover all the valves, or two wooden blocks as we use here.

(4) Install the spring compressor adapter tool in one of the rocker arm bracket bolt holes. Now, place the compressor over the valve spring to be removed and, using caution, compress the spring. Remove the two-piece valve lock, slowly release the pressure on the spring and remove the spring cap, spring, and spring seat. You would remove all of the springs using the same procedures.

(5) Place the head on its side to remove the valves. Cut the tape around each valve and push the valves out.

b. Pressure Testing the Cylinder Head

(1) Before we actually pressure test the head, we should first perform a magnetic particle and fluorescent penetrant inspection. This inspection will locate any exterior cracks and could save you a lot of work for nothing. We do not spend time and money repairing a cylinder head that is cracked; we replace it.

(2) After we have checked the head for cracks, we are ready to prepare the cylinder head for the pressure test, by

removing all fuel and oil passage plugs and installing the cylinder head test fixture (J-28454).

(a) First, install a plug into the air compressor line hole on the rear of the cylinder head.

(b) Now, we install the test fixture on the cylinder head and torque the hold-down capscrews to 4 to 5 foot-pounds. Make sure you do not over tighten the capscrew because it could distort the rubber stoppers enough to seal off the outer diameter of the water nozzles. If that happens, you would not be able to detect a leak around the outer diameter of the nozzle.

(c) Next, install the air supply plate and the dummy injectors. Torque the injector clamp capscrews to 20 to 25 foot-pounds. You can make a set of dummy injectors from old injector nuts and bodies.

(3) Before starting the test, make sure that personnel are protected against pressurized water from a possible rupture or leak in a hose or fitting on the cylinder head. Once you are sure, install the air supply to the air supply plate and apply 40 pounds of air pressure. Then, before immersing the cylinder head into the water, check for air leaks around the eight water nozzles and the fire deck on the bottom of the cylinder head.

(4) After you are sure there is no air leak, carefully immerse the cylinder head into the tank of water. The water is preheated to 180 to 200 degrees Fahrenheit. Leave the cylinder head in the water for about twenty minutes. Check for leaks at the top and bottom of the injector tubes, oil galleys, exhaust ports, fuel manifolds, and at the top and bottom of the cylinder head.

(5) Once we are sure the cylinder head has passed the pressure test, remove it from the water tank and slowly relieve the air pressure and remove the air supply. Remove, dry, and store the cylinder head test fixture, air supply plate, dummy injectors, and the plug. Then, completely dry the cylinder head with the compressed air.

(6) Other cylinder heads are tested in a manner similar to that just described, using the appropriate test fixture for the cylinder head being tested. The Cummins NHC cylinder head also requires a fuel passage pressure test.

c. Inspect Cylinder Head for Flatness and Minimum Height

(1) To check the flatness of the cylinder head we need an accurate straightedge and feeler gage.

(2) We must check the cylinder head at eleven different points. In order for you to better understand the measuring points, open up volume 1 of TM 9-2320-297-34 to page 3-26. The top left illustration on that page shows you the different points at which the cylinder head must be checked. Just below that, you will see the maximum allowable warpage listed for each point.

(3) To make the check, lay the straightedge across the bottom of the cylinder head as illustrated in the manual. Then, using the feeler gage, measure the space between the straightedge and the cylinder head surface. If it exceeds the maximum allowable warpage listed in the manual, the head must be replaced.

(4) Measure the distance between the top and bottom faces of the cylinder head. The cylinder head height must be a minimum of 3.535 inches

(5) A Cummins cylinder head is also measured for warpage and thickness of the cylinder head.

d. Inspect the Injector Tubes

(1) When you inspect the injector tubes, look for a scored or cracked condition. If either condition exists or if leaks were found during the pressure test, the injector tube will have to be replaced.

(2) To remove the injector tube, install the injector tube installer tool into the injector tube. Then install the pilot through the bottom of the injector tube and into the injector tube installer tool. Now, tap on the pilot to loosen the injector tube. Once it is loose, remove the injector tube installer tool, injector tube and pilot from the cylinder head. Remove the O-ring seal and throw it and the injector tube away.

e. Inspect the Water Nozzles

(1) Inspect each water nozzle for any condition that would cause it not to direct the coolant as designed. Also

check them to make sure that they are not loose in the cylinder head.

(2) If any water nozzle is damaged, loose, or leaked during the pressure test, it will have to be replaced. To remove the water nozzle, use a slap hammer and sheet metal screw. It should come out easy.

f. Inspect the Valve Guides

(1) Inspect the valve guides for cracks, chipping, scoring, or excessive wear.

(2) After we inspect the valve guides, we need to measure their inside diameter and the outside diameter of the valve stems. The minimum and maximum limits for the valve guides are contained in the manual. You should already know how to make inside and outside measurements.

(3) Also, you will have to subtract the valve stem diameter from the inside diameter of the valve guide to get the valve-to-guide clearance. There should be no questions on how to do that either.

(4) If a valve guide fails the inspection or if any of the measurements were excessive, you will have to replace the valve guide.

(a) To remove the valve guide, you turn the cylinder head bottom side up on two, 3 inch high wooden blocks.

(b) Then, using the valve guide remover, drive the valve guides out.

g. Inspect the Valve Bridge Guides

(1) Inspect the valve bridge guides for cracks, chipping, scoring, or excessive wear. The valve bridge guides that fail the inspection will have to be replaced.

(2) To remove a valve bridge guide, we must first file or grind two notches 1/16 inch deep in opposite sides of the valve bridge guide. The two notches should be approximately 1.25 to 1.50 inches from the top of the valve bridge guide. This is normally done with a small cutting tool, such as a Dremel.

(3) Once we have the notches on the guide, place the spacer over the valve bridge guide. Then, slide the guide remover over the guide and aline the setscrews with the notches in the guide. Tighten the setscrews securely against the notches.

(4) Now, place the small spacer over the valve bridge guide and thread the nut onto the guide remover. Continue to turn the nut clockwise until the valve bridge guide is removed from the cylinder head.

h. Inspect the Valve Assemblies

(1) Visually inspect the valves for pitting, cracks, ridges on valve face, or a bent valve stem. If a valve head is warped or the stem is bent, the valve will have to be replaced. If a valve face is pitted or if it has ridges, we would reface the valve face.

(2) Next, inspect the spring for pit marks or cracks. If either condition exists, replace the spring. If the spring passes the visual inspection, place it in a valve spring tester and compress the spring to 1.80 inches. If it takes less than 25 pounds to compress the spring, replace the spring.

(3) After the spring, inspect the spring seat, spring cap, and the two-piece valve lock. If you find any signs of wear or damage, replace the defective part.

(4) The valve seat insert is a part of the valve assembly and should be inspected for excessive or uneven wear, pitting, or cracking. If the valve seat is unevenly worn or pitted, it can be refaced. If during the inspection you find a cracked or damaged valve seat insert, it must be replaced.

(a) To remove the valve seat insert, place the removing tool so the bottom of the collet is flush with the bottom of the valve seat insert.

(b) Now, press down on the handle and remove the valve seat insert from the cylinder head. We will cover installation of the valve seat insert later.

i. Inspect the Cam Follower Bores

(1) Inspect the cam follower bores for scoring or wear.

(a) If light score marks are present, they can be cleaned up with a crocus cloth moistened with fuel oil.

(b) Next, measure the inside diameter of each cam follower bore. The bore must be within the limits listed in the manual. The diameter must be between a minimum of 1.062 inches and a maximum of 1.063, with a limit of 1.065 inches on used parts. Are there any questions on how to make that measurement? Inspect and measure the cam follower bores in your cylinder head.

(c) If the cam follower bores are excessively worn or scored, you will have to replace the cylinder head.

j. Install New Valve Guide

(1) The manual directs us to use an arbor press and press the valve guide into the cylinder head. However, there is an easier way to install the valve guide without using a press and you will not damage a thing.

(2) First, insert the internally threaded end of the valve guide into the guide installer tool. Then, position the valve guide squarely on the valve guide bore. Take a hammer and gently tap the valve guide straight into its bore until the guide installer tool contacts the bottom of the counterbore in the cylinder head.

(3) This method is not only a lot easier than using a press, it requires only one individual whereas if you use a press, you will need another person to help lift the cylinder head.

k. Install New Valve Bridge Guide

(1) After you apply the non-hardening sealant to the undercut end of the valve bridge guide, start that same end into the cylinder head.

(2) Now, place the bridge guide installer tool over the valve bridge guide. Take your hammer and gently tap the valve bridge guide straight into the cylinder head until the bridge guide installer tool contacts the cylinder head.

l. Install Valve Seat Insert

(1) Measure the diameter of the valve seat insert counterbore. The diameter should be between 1.440 and 1.441 inches. If required, the valve seat insert is available .010 inch oversize.

(2) To install the valve seat inserts, you have to immerse the cylinder head in the water tank for at least thirty minutes, with the water preheated to 180 to 200 degrees. The reason for this is to expand the valve seat insert counterbores to make it easier to install the inserts and to cause the counterbores to form a better seal as they cool down.

(3) While the cylinder head is in the water, get the insert installer and the inserts ready to be installed, so that you will be able to install the inserts before the head cools down.

(4) After the cylinder head has been in the water for thirty minutes, remove it from the hot water and place it on wooden blocks, with the bottom side up. Place the inserts in their counterbores and using the insert installer, drive each insert into its counterbore until seated against the bottom of the bore.

(5) When you replace the inserts on the job, make sure you use the hot water to ensure a good seal between the insert and counterbore.

m. Check Contact Surface of Valve and valve Seat Insert

(1) First, put a light coat of Prussian blue dye on the face of the valve. Then, lower the valve stem into the valve guide and let the valve drop against the valve seat insert.

(2) Now, push on the valve stem until the valve face is about one inch above the valve seat insert. Without rotating the valve, release the valve stem and, at the same time, apply pressure against the valve head until the valve face makes contact with the valve seat insert. You should repeat the procedure several times to get a good imprint in the Prussian blue dye. Always make sure you do not rotate the valve.

(3) Being careful not to smear the Prussian blue dye, remove the valve from the cylinder head and check the imprint. The imprint in the Prussian blue dye should have an even seat mark all the way around the center of the valve face. If the

imprint is uneven, the valve and valve seat insert must be refaced.

n. Introduction to the K. O. Lee Model K403CM Valve Refacer

(1) The valve refacer is a model K403CM made by K. O. Lee Company. It has its own light so you can see your work better.

(2) The item that holds the valve at the correct angle and also turns it during the valve grinding operation is called the valve chucking workhead.

(a) The machine has a self-lubricating, flexible shaft that causes rotation of the valve during the grinding operation.

(b) The workhead hand nut is used to apply pressure on the inner cone sleeve to close the collet down on the valve to secure it in the workhead.

(c) Inserted inside of the hand nut is the valve stop gauge. It provides a stop to determine how far the valve is placed into the workhead for chucking purposes. It is also used as a wrench to loosen and tighten the slotted nuts securing the attachments.

(d) On the backside of the workhead and located on the top table is the workhead stop pin. This tapered pin is used to position the workhead in the desired degree setting. The degrees are marked near their respective holes. Do not forget that the flat surface is minus one degree.

(3) The lever arm is used to move what we call the top table. Moving the lever back and forth sideways causes the table to move towards and away from the grinding wheel, thus the workhead holding the valve moves with it. An adjusting screw allows adjusting the maximum movement of the table to the left during valve grinding. Also, you can position the table lever arm in whatever position is more convenient for you by rotating the control knob on its end.

(4) The hand wheel is for the feed screw assembly. Rotation of the hand wheel clockwise advances the subtable, top table and workhead, towards the grinding wheel.

(5) The item on the left side of the machine is called the micrometer butt grinding attachment. As its name indicates, it is used for grinding the valve butt.

(6) The machine is equipped with a coolant nozzle used to direct coolant on the work during grinding operations. It will rotate and is
adjustable in length to allow it to be used on either the face grinding wheel or the butt grinding wheel. A control knob controls the flow of coolant from the nozzle.

(7) The drawer at the bottom is the coolant tank. We use honing oil for coolant in the coolant tank. Always make sure that the right amount of honing oil is in the tank before operation.

o. Lubrication Checks and Services

(1) First, we have the oil in the workhead. The oil level is easy to check. You just make sure it is up to the level line in the window. It uses universal gear lubricant or S.A.E. 50 motor oil or the equivalent. To add oil, you remove the fill plug and the small head screw used for a breather hole. Check the oil level before every operation.

(2) The next oil points are the oil caps on the top table. Once a week, put a few drops of oil in the caps and traverse the top table back and forth with the lever arm. Also move the subtable in and out by complete rotation of the hand wheel in both directions.

(3) About every six months you need to put a few drops of S.A.E. 10 motor oil in the oil hole located at each end of the motor. This will keep the motor bearings lubricated.

(4) The feed screw assembly has ball-type oil cups located above the feed screw shaft; one at the front to lubricate the front bearing and one at the rear to lubricate the rear bearing. To expose the oil hole in the front, move the table all the way to the rear and move the table all the way to the front to expose the oil hole in the rear. Fill these oil points with S.A.E 10 oil about once a month. Also, about once a month, put a few drops of oil directly on the feed screw, it is easily accessible when the coolant tank is removed.

(5) The fluid pump is filled with 60 weight transmission oil and should be checked every three months or more often depending on use. To refill, detach the flexible drive shaft and remove the cover by loosening the screw.

p. Procedures for Reconditioning Valves

(1) The first thing we want to do is to dress the grinding wheel. Always wear safety goggles or glasses during all dressing and grinding operations.

(a) Position the rocker arm attachment on the front table stud and lock it in place with the slotted nut. Now, remove the upper cone, slide the diamond holder on the attachment pin and tighten the thumb lockscrew. Adjust the holder so that the diamond screw is at a right angle to the face of the wheel.

(b) Turn on the machine, and by use of the feed screw, feed the diamond slowly up to the grinding wheel. Rough dress the wheel by passing the diamond rapidly back and forth across the wheel, using light feed, until you are certain the wheel is true. Finish dressing the wheel by passing the diamond slowly across the wheel several times, without feed until the cutting action ceases. Then, back the diamond off from the wheel when the dressing operation is completed and remove the rocker arm attachment with diamond holder.

(c) Strict adherence to the wheel dressing procedures will result in a smooth wheel capable of producing the finest possible valve face finish. You should dress the wheel often enough to keep it balanced, or vibration and improper face grinding will result. Also, rotate the diamond screw 1/2 turn after initial contact with the wheel and before each subsequent dressing.

(2) The next thing is to install the correct collet and the valve into the workhead. It is important to make sure the collet, sleeve, valve stem, and the inside of the spindle are free from dirt, grit or carbon by cleaning with solvent. Tiny particles can easily throw the valve off center, causing an incorrectly ground valve face.

(a) Select the proper size collet for the valve you want to recondition and make sure it is clean. Insert the

collet into the workhead housing and insert the sleeve behind the collet with the tapered opening toward the collet.

(b) Next, make sure the valve stem is clear and free from carbon and dirt that could cause inaccurate chucking. Pull the valve stop gauge back to allow the valve stem to enter the collet freely. Then, insert the valve into the workhead so that one end of the double-end collet grabs the stem as close to the head as possible, still remaining on the ground surface of the stem. Now, tighten the workhead hand nut so the collet will grip the valve stem and hold the valve in position while grinding the valve face.

(c) After you have set the first valve in the workhead, push the stop gauge against the valve stem. By keeping the stop gauge in this fixed position, it becomes a positioner for all valves in that series, which saves you time in doing the job.

(d) If you have valves with recessed stems, the collet should grip the stem below the recessed portion, not on the recess.

(3) Now, we need to get the workhead to the proper angle for the valve to be reconditioned. In our case, the technical manual for the cylinder head says we need to grind the face of the valve at a thirty degree angle. So, we just position the angle stop pin in the hole marked thirty degrees on the workhead track. Then, move the workhead against the angle stop pin and tighten the slotted nut. Always keep the small tapered pins in the angle stop holes not being used, as this will keep out grinding debris.

(4) With the workhead secured at the proper grinding angle, the wheel properly dressed, and the valve carefully chucked, we are ready to grind the valve face.

(a) First, feed the valve up close to the wheel to adjust the traverse handle and table stop.

1 To adjust the traverse lever, twist the ball to the left to loosen, move the handle into position and twist the ball to the right to tighten.

2 We begin grinding in the same manner as when dressing

the wheel, but we do not want the valve to pass off the wheel. So, to prevent the valve from running off the left side of the wheel, the table stop, located at the right side of the table should be adjusted to keep the valve face about 1/16 to 1/8 inch from the edge of the wheel.

(b) After the traverse lever and table stop are adjusted, start the machine and direct the coolant flow over the head of the valve.

(c) Using the feed screw wheel, slowly start the actual grinding. Make sure you use light feed each time and traverse the valve across the wheel and back again. Repeat the process until the valve face is cleaned up. Then, traverse the valve back and forth slowly across the wheel without feed until no sparks are visible.

(d) Once no more sparks are visible, back the valve off the wheel and turn off the motor. Remove the valve from the workhead and you should now be able to observe a quality finish on the valve face.

(e) If only part of the valve face touches the grinding wheel, when you start the grinding operation, stop and check the valve stem for straightness. You cannot recondition a valve with a bent stem.

(5) To dress the butt grinding wheel, remove the diamond dresser from the rocker arm attachment and slip it over the stop pin on the front side of the "V" block assembly. Line up the diamond so it is perpendicular with the wheel and tighten it with the thumb screw.

(6) Then, using the micrometer feed, move the diamond in until it almost touches the wheel. Turn on the motor and continue to feed the diamond up to the wheel slowly, as too deep a cut may cause damage to the diamond. Once the cutting action starts, pass the diamond back and forth across the wheel several times by means of the "V" block assembly, while taking cuts not to exceed .001 inch. You do not have to use the slow finishing passes on this wheel, because the butt does not require the smooth finish of a valve face.

(7) Remove the diamond dresser and position the valve stem in the "V" holder, with the butt just touching the grinding wheel. Adjust the fork back so that the valve face fits against

the beveled sides of the fork, and lock it in place with the thumb screw, as a steadying support. Hold the valve in position by pushing the clamp firmly down on the valve stem. If additional tension is required, the thumb screw on top of the clamp can be turned slightly. To release the clamp, hold down on the front while pulling up on the back of the clamp.

(8) Now, back the valve away from the grinding wheel a known distance on the micrometer, using the micrometer feed. Then adjust the coolant nozzle so the flow of coolant will be on the valve butt.

(9) Turn on the motor and feed the butt of the valve up to the wheel. The entire holder block swings at the point of the feed control, allowing you to pass the butt of the valve stem back and forth across the wheel and through the stream of coolant. Feed the valve butt in and pass it back and forth across the wheel until cleaned up.

(10) After you have cleaned up the butt end of the valve, hold the butt grinding wheel in one position near the outer portion of the wheel, loosen the thumb screw slightly and rotate the valve a few times with your fingers while holding its position in the "V" guide. This will put the finishing touches on the valve butt. Then, remove the valve from the holder.

q. Procedures for Reconditioning Valve Seat Inserts

(1) The first thing we want to do is make sure the valve guide is clean. Also, the valve seat insert must be clean to prevent carbon from clogging the grinding wheel as this will slow up the grinding and require unnecessary dressing of the grinding wheel.

(2) After the cleaning is done, select the correct size pilot for the guide hole. Place a drop of oil on the lower portion of the pilot and insert it into the guide hole. The top of the pilot should be long enough to allow a minimum of 2 1/2 inches to fit into the holder.

(3) Next, we select the correct grinding wheel. In our case here we want to use a 31 degree angle grinding wheel first. Now, screw the wheel on the holder and install on the driver.

(4) Before you start grinding the valve seat insert, make sure the grinding wheel is properly dressed. To dress the

grinding wheel, we use the dressing tool you see here, which it comes with the seat grinding set.

(a) First, set the desired angle on the dressing tool.

(b) Now, put a little light oil on the pilot of the dressing tool and position the wheel holder and driver on the pilot.

(c) Adjust the pilot, which raises and lowers the grinding wheel, until the wheel just touches the diamond.

(d) You are now ready to turn on the driver and dress the wheel. Take light cuts with the diamond and move the diamond steadily across the wheel. The diamond holder is threaded so you can make the light cut adjustments until you have the wheel trued. Then, remove from the dressing tool.

(5) Now that you have the grinding wheel ready, place the lifting spring over the pilot that we installed in the valve guide. The purpose of this spring is to relieve the weight of the wheel holder and driver.

(6) Be sure you put a drop of oil on the top section of the pilot to eliminate friction and place the wheel, holder and driver over the pilot and on the lifting spring.

(7) We are now ready to start grinding the valve seat insert. Support the weight of the driver and let it run at high speed. As you are grinding, sway the top of the driver gently from side to side about 1/4 inch off center to each side, and note the dual action cutting ability, grinding speed, and finish. Do not use pressure when grinding, let the wheel do the cutting.

(8) After you have the seating surface of the valve seat reconditioned with the 31 degree wheel, use a 60 degree grinding wheel to open the throat of the valve seat insert.

(9) Once you have the throat of the valve seat insert ground, change to a 15 degree wheel and grind the contact surface of the valve seat insert to narrow the width of the seat to 3/64 inch.

(10) Always narrow the seat as narrow as you can and still be within specifications because the seat widens as it wears.

If you don't narrow the seat to begin with, it will soon widen to the point that it is no longer within specifications.

(11) While grinding the valve seat inserts, do not permit the grinding wheel to contact the cylinder head. When an insert has been ground to the extent that the grinding wheel contacts the cylinder head, install a new insert.

r. Measure the Valve and Valve Seat Insert

(1) First, measure the valve head thickness from the valve face to the bottom of the valve head. It must not be less than the limit listed in the manual. If it is less, you must replace the valve.

(2) Next, measure valve recess with the valve seated against the valve seat insert. The measurement must be within the limits listed in the manual. If it is not you will have to replace the valve seat insert.

(3) The next thing we are going to do is check the valve seat insert concentricity with relation to the valve guide. In other words, we are going to make sure that the valve seat insert is directly centered with the valve guide.

(a) First, we install the gauge block and dial indicator into the valve bore.

(b) Now, rotate the dial indicator and note the reading. If the reading (runout) on the dial indicator had exceeded .002 inch, we would first check for a bent valve guide. If the guide was bent, we would replace it and recheck the concentricity. If the valve guide was not, bent then we would regrind the valve seat insert and recheck the concentricity.

(4) Once the measurements are correct, we would then recheck the contact between the valve face and the valve seat insert, using the Prussian blue dye. After all this is done, we would then clean the cylinder head and valves.

s. Install New Water Nozzle

(1) If you will look at the drawing on page 3-33 of your manual, you will see that they use arrows to show which direction the orifices should be facing.

(2) Position the water nozzle in the opening with the orifices facing in the direction of the arrows.

(3) Tap the water nozzle into the cylinder head making sure it is flush to .004 inch below the surface of the cylinder head. Also make sure the water nozzle fits tightly.

t. Install New Injector Tube

(1) First, we install a new O-ring into the counterbore of the cylinder head. Then, insert the injector tube installer tool into the injector tube and install the pilot into the bottom of the injector and injector tube installer tool.

(2) Now, drive the injector tube into its bore. The injector tube flange, at the seal ring end, should not protrude more than .120 inch above the cylinder head casting. The seal is formed when the O-ring is pressed between the head counterbore and the outside diameter of the injector tube. The injector tube flange is merely used to retain the seal ring in the head counterbore.

(3) Remove the pilot and install the upsetting die into the bottom of the injector tube installer tool. Then, using a torque wrench, torque the upsetting die to thirty foot-pounds to flare the lower end of the injector tube. Once the injector tube is flared, remove the upsetting die and the injector tube installer.

u. Ream New Injector Tube

(1) The reamers used in the following operations are hand reamers, and should not be used in conjunction with any fixture or clamp, or in shop drill presses. Reaming must be done carefully and without undue force or speed so as to provide a smooth surface and to avoid cutting through the thin wall of the injector tube. The reamer should be turned only in a clockwise direction when inserting, reaming, or withdrawing the reamer. Turning the reamer in the opposite direction will dull the cutting edges of the flutes. Use a suitable lubricant, preferably a light cutting oil, on the reamer flutes when reaming.

(2) Using the first reamer, ream the inside diameters of the injector tube to receive the injector nut and spray tip.

This operation also provides a guiding surface for the tube tip refinisher and for the second reaming operation.

(a) During the reaming operation, remove the reamer frequently, turning in a clockwise direction, and clean chips from the reamer flutes.

(b) Ream the injector tube until the lower shoulder of the reamer contacts the injector tube; then remove the reamer.

(3) Now, finish excess material off the tube tip, using the tube tip refinisher and a socket wrench with a speed handle. When the tube tip refinisher contacts the bottom of the cylinder head, the operation is completed. The tube tip will then be flush to .005 inch below the surface of the head. Clean out the inside of the injector tube to remove the reaming chips.

(4) The tapered lower end of the injector tube must provide a smooth and true seat for the lower end of the injector nut to effectively seal the cylinder pressures and properly position the injector tip into the combustion chamber.

(a) Therefore, to determine the amount of stock that must be reamed from the seat of the injector tube, install the injector gauge in the injector tube and zero the gauge block on the finished surface of the cylinder head. Now, hold the injector gauge in the injector tube and move the gauge block onto the injector gage. It should be flush to $\pm$ .014 inch with the fire deck of the cylinder head.

(b) If it is not within these specifications, place a few drops of cutting oil on the bevel seat of the injector tube and carefully install the second reamer into the injector tube until it contacts the bevel seat.

(c) Make a trial cut by turning the reamer steadily without applying any downward force on the reamer. Remove the reamer, blow out the chips, and look at the level seat to see what portion of the seat has been cut. Proceed carefully with the reaming operation, withdrawing the reamer occasionally to observe the reaming progress.

(d) When you think it is right, remove the chips from the injector tube and use the injector gauge and gauge block to check that the dimension is flush to $\pm$ .014 inch with the fire deck of the cylinder head.

v. Install Valve Assemblies

(1) First, position the valves in their proper valve bores. Then, wrap a strip of tape around the end of the valve stem to keep the valve from falling out when you turn the cylinder head over.

(2) Now, turn the cylinder head over so the valve stems are facing up. If you are not working on a wooden top work bench, use wooden blocks to position the cylinder head on, making sure the blocks cover all valves to keep them from falling out when the tape is removed.

(3) After removing the tape from the valve stems, position the spring seat, spring, and spring cap over the valve stem.

(4) Install the spring compressor tool into the rocker shaft bolt hole and position the compressor over the valve spring cap.

(5) Now, apply just enough pressure on the spring with the compressor tool to permit the installation of the two-piece valve lock. Once the spring is compressed enough, install the two-piece valve lock in the groove of the valve stem, and slowly release the pressure on the spring, making sure the two-piece valve lock is in place.

(6) Once you have all the valves installed, turn the cylinder head on its side, take a plastic hammer and tap each valve stem. This will help seat the two-piece valve lock and reduce the chance of failure.

w. After the valves are installed you would install any plugs, connectors or elbows that were removed. Also replace any of the fused plugs located above the exhaust ports, if they leaked during the pressure test or if damaged. In our case we did not remove any of these items because they passed our inspection. So, our cylinder head is ready to be installed on an engine.

3. PERFORM REPAIR PROCEDURES

a. Detailed instructions for performing each procedure are explained in the references provided to you at the beginning of this class. Find the procedures in the appropriate reference

and read them completely to become familiar with the total task. Then, follow those instructions carefully to effect those repair procedures on the training aid cylinder head to which you have been assigned.

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

c. Remove the valve assemblies. (TM 9-2320-297-34)

d. Inspect the cylinder head for flatness. (TM 9-2320-297-34)

e. Measure cylinder head for height. (TM 9-2320-297-34)

f. Inspect the injector tubes. (TM 9-2320-297-34)

g. Remove injector tube. (TM 9-2320-297-34)

h. Inspect the water nozzles. (TM 9-2320-297-34)

i. Remove a water nozzle. (TM 9-2320-297-34)

j. Inspect the valve guides. (TM 9-2320-297-34)

(1) Record outside diameter of valve stem.

(2) Record inside diameter of valve guide. _____

(3) Record valve-to-guide clearance.

k. Remove a valve guide. (TM 9-2320-297-34)

l. Inspect the valve bridge guide. (TM 9-2320-297-34)

m. Remove a valve bridge guide. (TM 9-2320-297-34)

n. Inspect the valve assemblies. (TM 9-2320-297-34)

(1) Inspect the valves.

(2) Inspect the valve springs. Record spring test results.

(3) Inspect the valve spring seats, spring caps, and two-piece valve locks.

(4) Inspect the valve seat inserts.

(5) Remove a valve seat insert.

o. Inspect the cam follower bores. (TM 9-2320-297-34) Record diameter of cam follower bore.

STOP: Have Instructor Initial.

p. Install a new valve guide. (TM 9-2320-297-34)

q. Install a new valve bridge guide. (TM 9-2320-297-34)

r. Measure the diameter of the valve seat insert counterbore. Record diameter of counterbore.

s. Install a new valve seat insert. (TM 9-2320-297-34)

t. Check the contact surface of the valve and valve seat insert. (TM 9-2320-297-34)

STOP: Have Instructor Initial.

u. Recondition the valve face. (K. O. Lee Instructions Form VR78)

(1) Prepare the refacer for operation.

(2) Recondition the valve face.

v. Recondition the valve seat insert. (Sioux Instructions Form 194)

(1) Prepare the seat grinding equipment for operation.

(2) Recondition the valve seat insert.

w. Measure the valve and valve seat insert. (TM 9-2320-297-34)

(1) Record thickness of valve head.

(2) Record valve recess.

(3) Recheck contact surface of valve and valve seat insert.

STOP: Have Instructor Initial.

x. Install a new water nozzle. (TM 9-2320-297-34)

y. Install a new injector tube. (TM 9-2320-297-34)

z. Ream the new injector tube. (Kent-Moore Instructions Form No. DDA66-5B)

STOP: Have Instructor Initial.

aa. Install the valve assemblies. (TM 9-2320-297-34)

STOP: Have Instructor Initial.

REFERENCES:

TM 9-2320-297-34
Sioux Instructions Form 194
Kent-Moore Instructions Form No. DDA66-5B
K.O. Lee Instructions Form VR78