SECTION 2

CYLINDER HEAD AND ACCESSORIES

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CYLINDER HEAD AND ACCESSORIES

CYLINDER HEAD

DESCRIPTION

The cylinder head, Fig. 2-1, is made of cast iron alloy with cast passages for water and exhaust gases. Drilled water holes at the bottom of the cylinder head match the water discharge holes in the liner. Cooling water is circulated through the head and is discharged through an elbow mounted on the side of the head mounting flange. Exhaust passages in the cylinder head line up with elbows in the crankcase, which conduct the exhaust gases through the water discharge manifold to the exhaust manifold.

A well is located in the center of the cylinder head for application of the unit fuel injector. To ensure correct positioning of the injector, a mating hole for the injector locating dowel is located in the head.

Fig. 2-2 shows the rocker arms, exhaust valves, valve bridges with springs, valve guides, overspeed trip pawl, fuel injector, and other related items making up a complete cylinder head assembly.

MAINTENANCE

NOTE: Procedures for disassembly, assembly, and qualification of cylinder head components are contained in this section. Procedures for removal and installation of a cylinder head or of a complete cylinder power assembly are contained in Section 5.

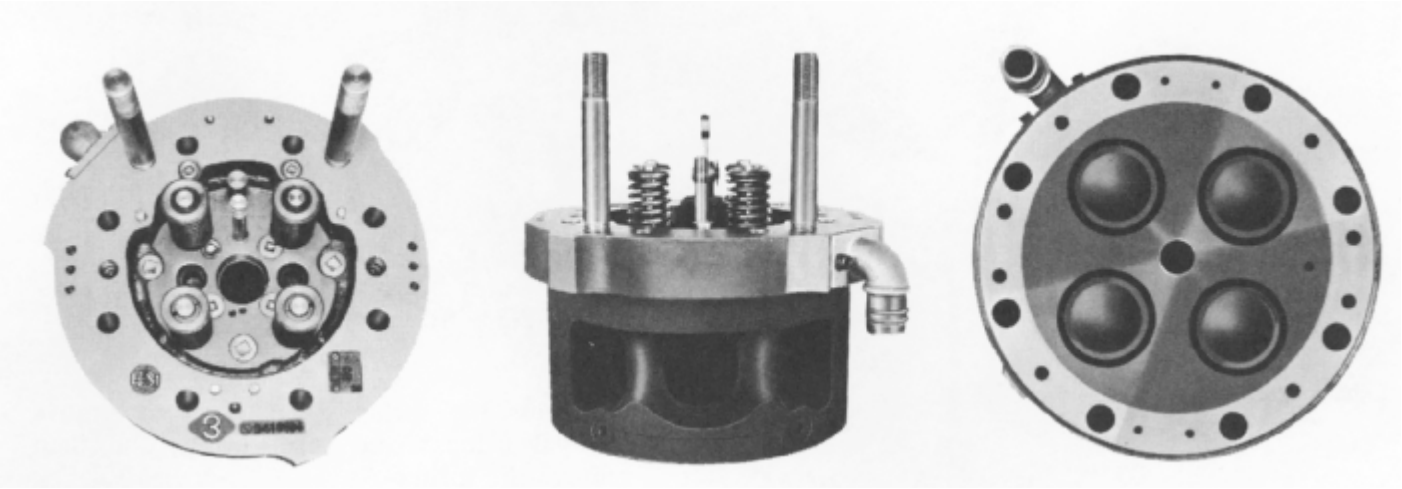


Fig. 2-1 - Cylinder Head With Valves

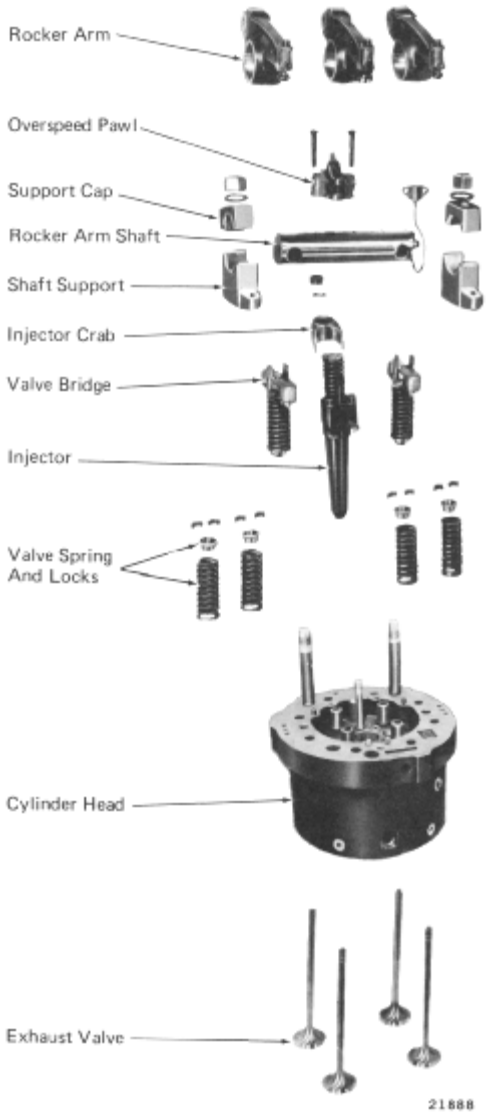
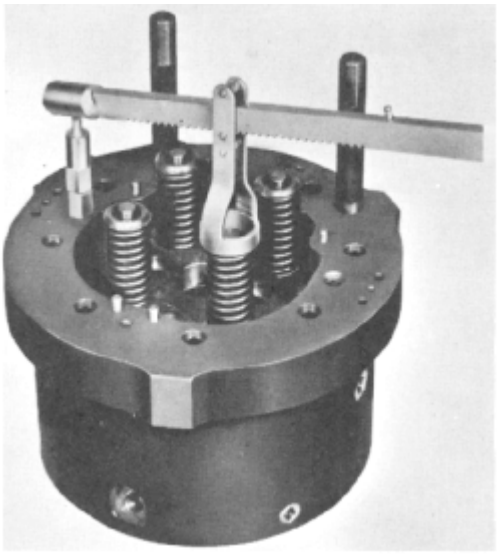


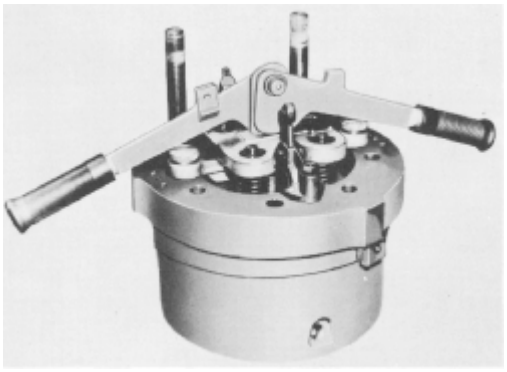
Fig. 2-2 - Complete Cylinder Head Assembly, Exploded View

EXHAUST VALVE AND SPRING REMOVAL

1. Remove exhaust valve springs using single valve spring compressor and adapter screwed into the head, or the multiple valve spring compressor, Fig. 2-3.



SINGLE



MULTIPLE

Fig. 2-3 - Compressing Valve Springs

2. Compress the springs sufficiently to remove the valve locks and spring seats, and then remove the springs.

3. After spring removal, the exhaust valves can be removed from the bottom of the head. NOTE: Valve springs can be removed and replaced without removing the cylinder head from the engine. If this is done, the piston must be at top center to prevent the valves from falling into the cylinder when the valve locks are removed.

VALVE GUIDES

Cast iron valve guides are press fit in the cylinder head and can be pressed in or out without damage by using a valve guide installing or removing tool. Although the valve guides generally do not require reaming after assembly, it is recommended that a plug gauge he inserted alter guide installation to ensure minimum diameter.

CLEANING CYLINDER HEAD

1. Clean cylinder head in a suitable solvent to remove surface oil and loosen baked-on carbon. Cleaning should be in accordance with accepted practice or as recommended by supplier of the cleaning material.

CAUTION: Do not use any form of blast cleaning (glass, sand, or shot) on the fireface of the head as blasting tends to remove sharp edges of the phonograph grooves of the gasket surface, reducing its sealing effectiveness.

2. Remove loose material from stud holes using stud hole cleaner and 115 volt or 230 volt drill, Fig. 2-4.

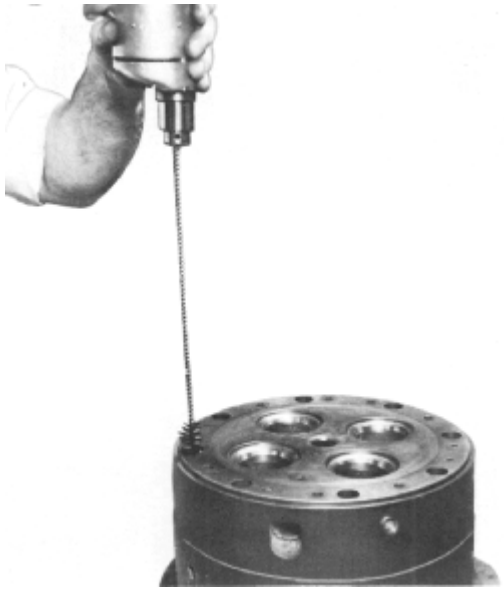


Fig. 2-4 - Cleaning Stud Holes

3. Clean the cylinder test valve threads using standard 1/2" pipe thread tap.

4. Using valve guide cleaner and a 115 volt or 230 volt drill, clean guide as shown in Fig. 2-5. Any evidence of galling inside of guide must be entirely removed by reaming, or the guide should be replaced. The I.D. of the guide should not exceed the limit when measured at the bottom and 12.7 rnm (1 /2") from top and bottom.

Fig. 2-5 - Cleaning Valve Guides

5. Clean phonograph finish of fireface using wire brush in a circular motion to remove dirt and carbon from phonograph grooves.

CYLINDER HEAD LEAK TEST

Seal all water passages in the head and apply 586 to 655 kPa (85 to 95 psi) air pressure to the passages. Immerse the head in water maintained at 71° C (160° F) for two minutes. Using this method, the leaks are easily detected and minor leaks are opened-up by the hot water for easy detection.

NOTE: When performing the cylinder head leak test, a scrap injector should be installed using an injector crab, spherical washer and nut. Torque nut to 81 ± 14 N-m (60 ± 10 ft-lbs) before immersion into the hot water.

Core plug leaks can usually be repaired by replacing the plug. Leaks caused by cracks, porosity, or dirt inclusion are cause for rejection.

INSPECTION

Inspect cylinder head for cracks using magnaflux procedures. Small magnaflux indications in the blend between the injector hole and the fireface may be removed by machining or grinding.

Scratches or nicks in the sealing areas for the head gasket or the grommet sealing areas require fireface refinishing. Small scratches or nicks in the phonograph finish area outside the sealing areas for the head gasket or grommets do not require refinishing.

Small scratches and nicks are permissible in the area inboard of the combustion gasket sealing area on the fireface of the head. If such small defects exist, there is no need to re-finish the face.

Inspect valve seats for pits and burned areas and perform dimensional checks. Seats not meeting visual or dimensional criteria must be resurfaced.

NOTE: Any head removed from an engine that has been overheated enough to "cook out" the head-to-liner grommets should be scrapped due to irreparable damage to the head.

CYLINDER HEAD REBUILD

A cylinder head with damaged valve seats, flange seating surface, fireface surface, or injector hole should be reworked in accordance with the following procedures.

INJECTOR HOLE REWORK

1. Blend chatter marks and gouges smooth at injector hole to fireface surface, leaving no sharp corners on injector seat side or fireface side of the blend.

2. Do not exceed maximum injector hole diameter or maximum allowable blend radius, Fig. 2-6.

FIREFACE AND FLANGE SEATING SURFACE REFINISHING

Refinishing of the cylinder head fireface and flange requires special tooling and procedures.

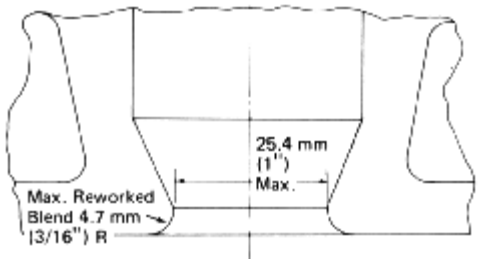


Fig. 2-6 - Injector Hole Rework

The following paragraphs contain recommendations for tooling and procedures to meet the required rework limits, Fig. 2-7.

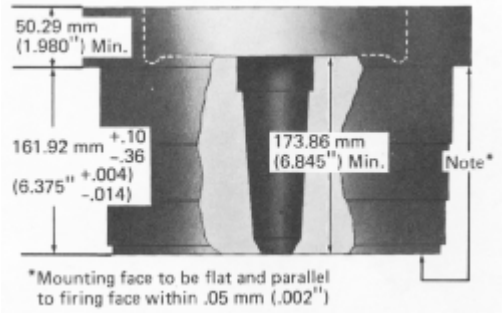


Fig. 2-7 - Rework Limits

1. A vertical lathe is recommended because of' ease of loading and unloading; although any machine capable of chucking and turning a head will do.

2. The following commercial tools are listed for reference:

   Insert-Valenite SPC-424 grade VC28 1/16" nose radius.

   Insert Holder-Valenite NVS-DN-12-C.

3. The depth of cut should be held to a minimum to extend the reconditioning life of the head. A cut of 0.152-0.203 mm (.006-.008") on the gasket surface and 0.254-0.406 mm (.010-.016") on the milled surface should be sufficient to clean up the fireface.

NOTE: To minimize the depth of cut, care should be taken to set up off the fireface rather than locating off the top of the flange.

4. Set feed at 0.61 mm (.024") per revolution and the rpm varied to maintain 76.2 smpm (250 sfpm). To achieve this constant cutting speed, the spindle speed will have to be increased as tile tool approaches the center of tile head to avoid tearing the surface of the head around tile injector hole.

5. The distance between the underside of the flange and the gasket surface of the fireface must be maintained, Fig. 2-7. To hold this dimension within specification, it will generally be necessary to machine the fireface and underside of the flange simultaneously because of the tight requirement on parrallelism between tile underside of the flange and the fireface, Fig. 2-8. However the cut on the underside of the flange should be held to a minimum within the allowable range of the fireface to flange dimension.

6. Sharp edges in the chamfer blend from the injector hole to the fireface must be blended smooth by hand using emery cloth. Deep scratches or gouges should be reworked in accordance with "INJECTOR HOLE REWORK".

VALVE SEAT GRINDING

To ensure uniform seat width and proper location of the seating area relative to the seat on the exhaust valve, while holding the specified concentricity to the valve guide bore, the valve seat I.D., O.D., and seating surface must be ground relative to the centerline of the valve guide bore.

Using any one of the valve seat reconditioning tool sets listed in service Data, perform the following procedures.

1. Mount each of the three grinding wheels on its own holder and dress the 45° wheel to 65°, the 30° wheel to 20°, and the 30° finishing wheel to 30°, Fig. 2-9.

NOTE: Use separate dressing tool for each wheel to maintain seat angle accuracy.

Original Finish

Reworked Finish

Fig. 2-8 - Fireface And Flange Refinishing

a. Lubricate dressing tool pilot with light film of oil.

b. Mount grinding wheel and holder on dressing tool pilot, Fig. 2-10.

c. Check that dressing tool is adjusted to proper angle for tool being dressed.

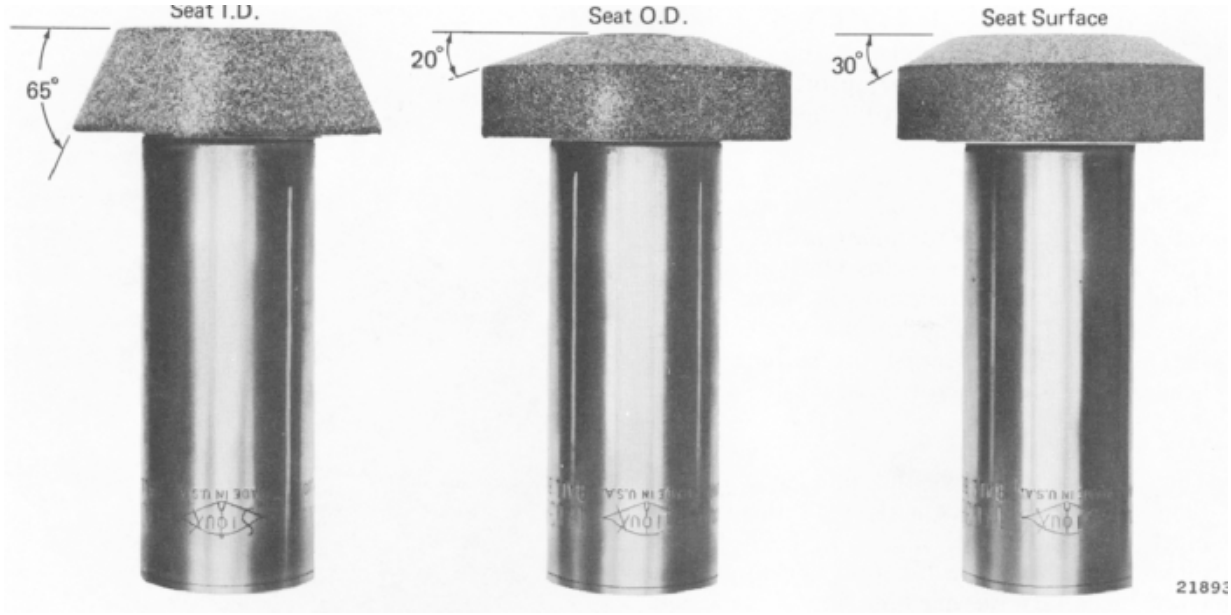


Fig. 2-9 - Valve Seat Grinding Wheels And Holders

Fig. 2-10 - Dressing Valve Seat Grinding Wheel

d. Apply driver to wheel holder and rotate wheel and holder at high speed, holding driver as straight as possible.

e. Move diamond steadily across wheel, taking light cuts until wheel face is smooth and at the proper angle.

2. Select a tapered pilot which will bring the shoulder on the pilot above the valve guide. Press pilot firmly into guide, using pin, Fig. 2-11. Wipe pilot with an oily cloth.

   A fixture, Fig. 2-12, is available for checking tapered pilots. To ensure satisfactory results, pilot runout should not exceed 0.013 mm (.0005 ").

3. Install lifter spring over tapered pilot, Fig. 2-13, and place 30° grinding wheel and holder over the pilot and spring.

4. Apply driver to wheel holder and grind the 30° seat angle until the width of the seat is at least 2.36 mm (.093") all the way around. The driving motor should be held as straight as possible, Fig. 2-14, and operated at top speed while grinding. Raise grinding motor off seat before stopping motor.

5. Remove 30° grinding wheel and apply 65° grinding wheel and holder over pilot and lifting spring.

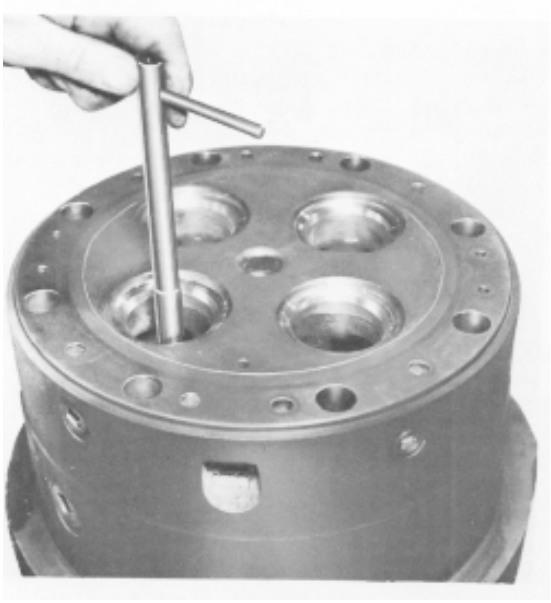


Fig. 2-11 - Tapered Pilot Installation

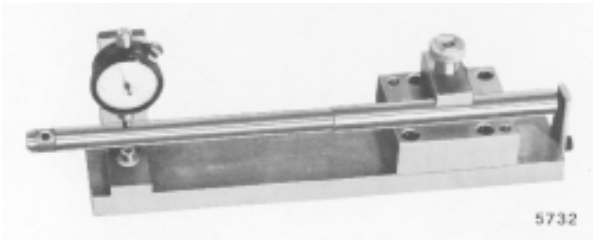


Fig. 2-12 - Tapered Pilot Checking Fixture

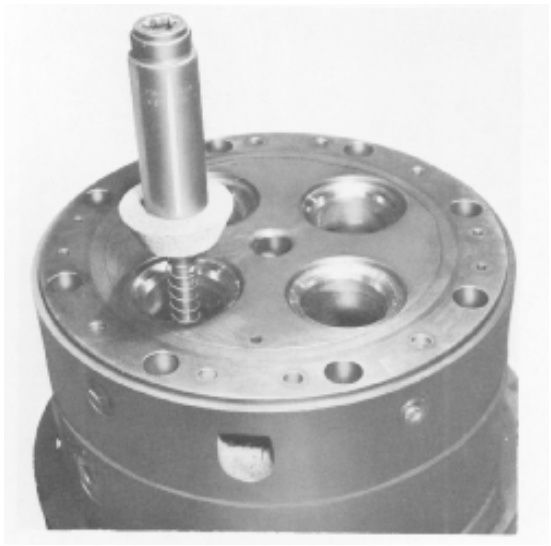
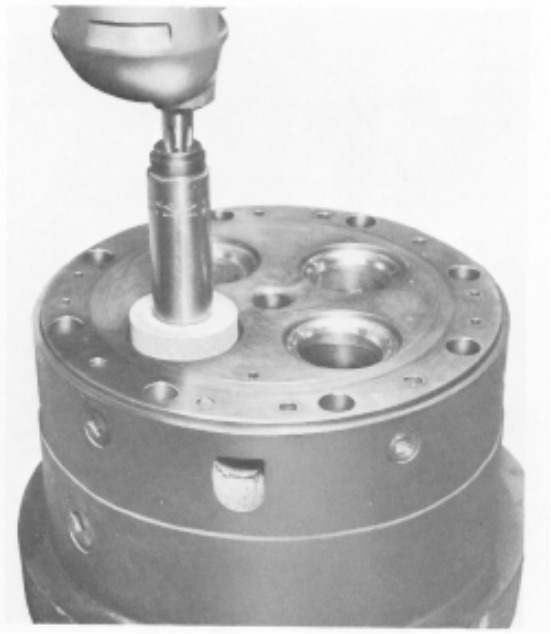


Fig. 2-13 - Lifting Spring Application



2-14 - Grinding Valve Seat

6. Grind 65° until the area adjacent to the 30° scat is smooth and clean.

NOTE: Grind away as little material as possible to maximiic the wear life of the scats.

7. Remove 65° grinding wheel and apply 20` grinding wheel and holder over pilot and lifting spring.

8. Grind 20° angle until the area adjacent to the 30° seat is clean and smooth. ('ontinue grinding until seat width is within the specified tolerance.

9. Check valve seat for proper dimensions, Fig. 2-15. If seat O.D. is too small, regrind seat with 30° grinder until O.D. is proper dimension. Then grind seat I.D. with 65° grinder until proper seat width is obtained.

   If seat O.D. is too large, regrind O.D. with 20° grinder until proper O.D. dimension is obtained. It' seat width is too small, grind seat with 30° grinder and O.D. with 20° grinder alternately until proper seat O.D. and scat width are obtained.

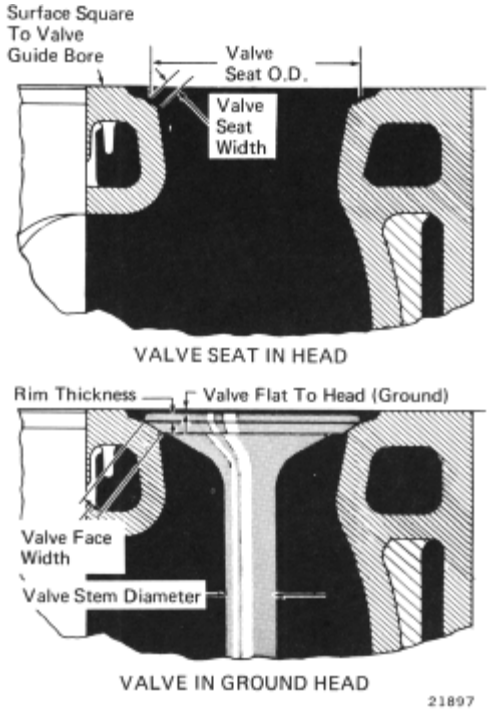


Fig. 2-15 - Valve Measurement Points

10. Reapply 30° wheel and grind seat lightly to remove burrs and improve the surface finish.

11. Use dial indicator included in the valve seat reconditioning set to measure trueness of valve seat. Place indicator over pilot, Fig. 2-16, and adjust so indicator is depressed slightly and

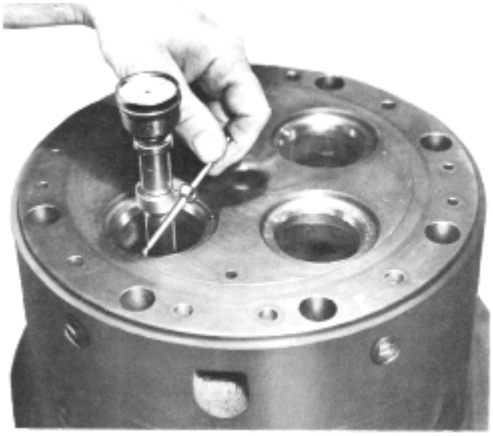


Fig. 2-16 - Checking Valve Seat Roundness

ball of valve seat rider is at the center of the valve seat. Rotate valve seat rider and observe indicator reading. Valve seat out-of-round will be indicated on the dial. Indicator reading must not exceed the limit.

12. With the head positioned with the fircface up, install new valve in each position and measure the vertical distance from the fireface of the head to the rim of the exhaust valve, Fig. 2-15.

EXHAUST VALVES

DESCRIPTION

The long stein exhaust valves, Fig. 2-17, are fabricated from a forged nickel-chromium alloy steel head and a tip hardened steel stem by means of friction welding. Single bead valve locks hold the valve in a tapered spring seat. Precision valve guides ensure proper valve seating.

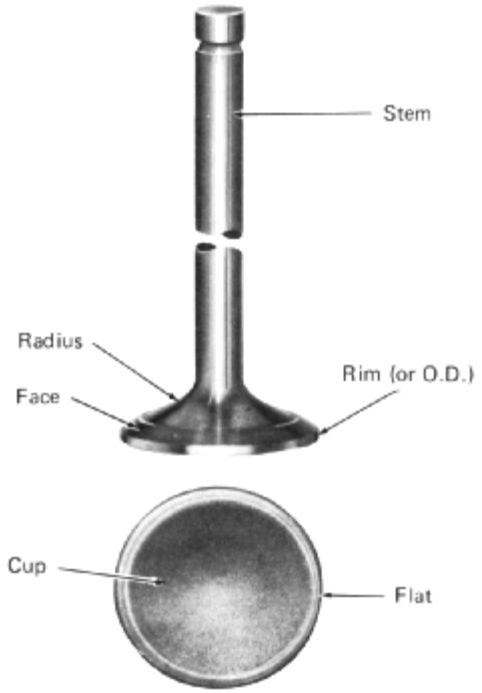


Fig. 2-17 - Exhaust Valve

MAINTENANCE

Handle valves carefully to avoid nicks and scuffs that might make the valve unfit for use. Piling valves on top of each other may cause nicks on the outside diameter or throat radius which can lead to valve failure. Before the valves can be reused, they must be reconditioned within the dimensional linlits listed in the Service Data at the end of this section.

CLEANING

Thoroughly clean the exhaust valves using a suitable solvent to remove surface oil and loose carbon. If necessary, use glass bead and vapor blasting to remove hard carbon deposits from the valves. Grit vapor blast must be maintained at a small enough size so the surface finish of the valve stems is not roughened beyond 0.635 µm (25 µ in.). If glass bead blasting is not available, wire brushing may be used as an alternative.

INSPECTION

Exhaust valves must be qualified by visual and Zyglo inspection prior to reconditioning. Acceptable conditions which allow valve reuse, and rejectable conditions which are cause for scrapping the valve are listed below. The valve surfaces referenced are identified in Fig. 2-17.

Acceptahlc Conditions:

1. Light pitting on the valve face that can be cleaned up within the maximum allowable valve face limit.

2. Protruding nicks and gouges in the valve stem must be removed before the valve face is ground in order to avoid scuffing of the valve guide and to ensure proper valve face runout. Belt sanding or buffing may be used to polish off protrusions, provided that the surface finish of the stem is maintained at or below 0.635 µm (25 µ in.) with a circumferential lay.

Rejectable Conditions:

1. Indications found in the cup area, Fig. 2-18, are defects which require rejection of a valve.

2. Any cracks found on the outside diameter of ring section of the valve, Fig. 2-19 are cause for rejection. Since rim cracks usually extend some distance into the valve face, they usually lead to failure.

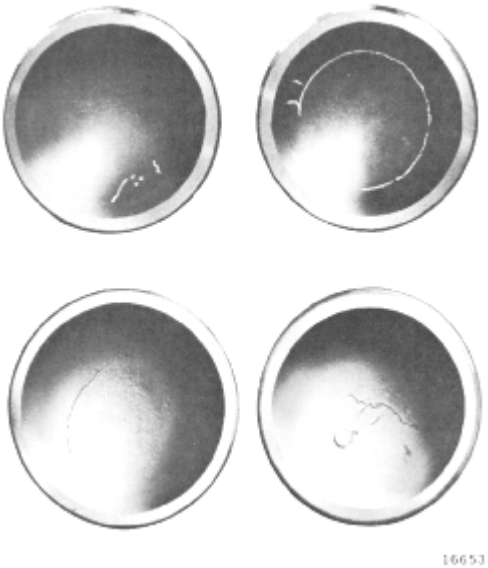


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Fig. 2-18 – Cup Defects

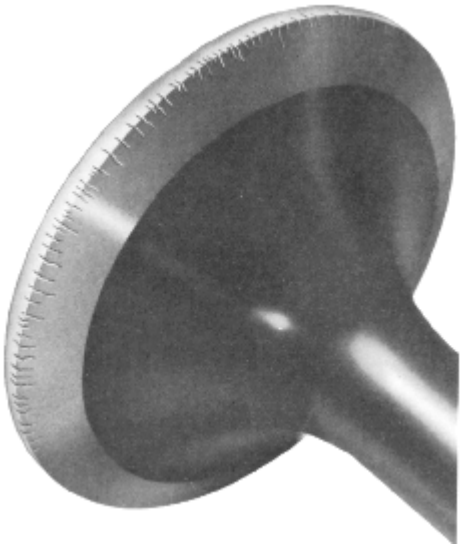


Fig. 2-19 - Face And Ring Defects

The face area, Fig. 2-19, is the critical area of the valve. Grinding cracks, channeling, and thermal cracks are cause for valve rejection.

3. Fretting or wear in the lock groove area of the stem is cause for rejection.

4. Reject valves that have been damaged to the extent that critical surfaces have been nicked or scuffed.

GRINDING VALVES

Follow instructions supplied with the 115 or 230 volt grinder for grinding valves. A complete listing of the eduiptrnent required for the machines is contained in the Service Tool Catalog.

VALVE SPRING, SEAT, AND LOCK

1. Inspect valve springs and valve bridge springs for any nicks or unusual wear. Valve springs should be cleaned with a suitable solvent and a soft wire brush. Do not hydro blast or grit blast. Valve springs should be protected to prevent rusting.

2. Perform dimensional and prcssurc checks to dualify valve springs.

3. Valve spring seats should be clean and smooth and the thickness of' the spring seating surface should not be less than the minimum limit.

4. Examine the valve locks, Fig. 2-20, for signs of excessive wear on the upper portion of' the bead and for evidence of' excessive fretting in the ground diameter which engages the valve stem. If these conditions exist, the locks should be replaced.

Fig. 2-20 - Valve Spring Seat Lock

EXHAUST VALVE INSTALLATION

After the exhaust valves have been reconditioned, they are applied to the reconditioned cylinder head. Position the head properly and complete the assembly of valve springs, spring seats, and valve locks.

VALVE STEM HEIGHT CHECK

1. Clean bottom of train feet, and that portion of the head on which the feet rest.

2. Apply tram firmly on cylinder head, Fig. 2-21.

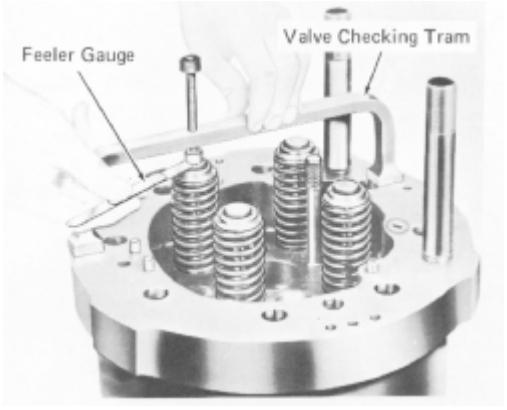


Fig. 2-21 - Checking Height Of Valve Sterns

3. Using feeler gauge and tram adjusting screw, determine difference in valve stern heights. The difference between valve stems under the same bridge should not vary more than 1.59 mm (1/16"). If the difference varies more than 1.59 mm (1/16"), the high valve should be replaced or the low valve ground in, provided this does not exceed the limit. Fnd of valve stem should not be ground off, as the tip is hardened.

VALVE SEAT SEAL TEST

l. Place head in an angular position, resting on the rocker arm studs with valve seats in the up position.

2. Wipe bottom of head to remove dirt and dust.

3. Apply a light film of oil to the concave surface of the tester vacuum cup and attach tester to cylinder head with handle in six o'clock position, and covering one valve, Fig. 2-22.

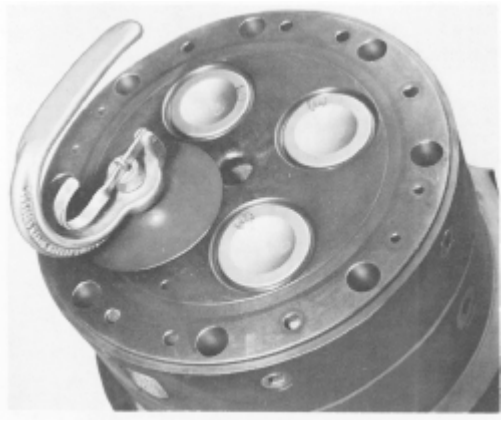


Fig. 2-22 - Testing Valve Seat Seal

Ensure that tester cup is finely seated on fireface and not on the head of the valve.

4. It' tester suction to fireface is depleted in less than two minutes, the valve seating is defective and the head seat and/or valve face must be reworked.

5. Open trigger valve to remove tester from head surface.

6. Check valve seat seal tester by applying it to a vertical piece of glass, as the release valve or rubber cup may be defective.

EXHAUST VALVE BRIDGE ASSEMBLY

DESCRIPTION

The valve bridge, Fig. 2-23, operates two exhaust valves from one rocker arm. A spring and spring seat are held on the valve bridge stem by a lock ring. The spring seat rests in a socket in the cylinder head and the spring applies pressure to maintain contact between the valve bridge and the rocker arm.

The hydraulic lash adjuster maintains zero lash between the end of the valve stem and the valve bridge. Lube oil flows from the rocker arm through a drilled passage in the valve bridge to the top of the lash adjuster, past the ball check, and into the body. When the rocker arm depresses the valve bridge, a slight movement of the plunger in the lash adjuster seats the ball check, trapping the oil. Since the oil is practically in-compressible, further movement of the rocker arm causes the lash adjuster plunger to force open the exhaust valve.

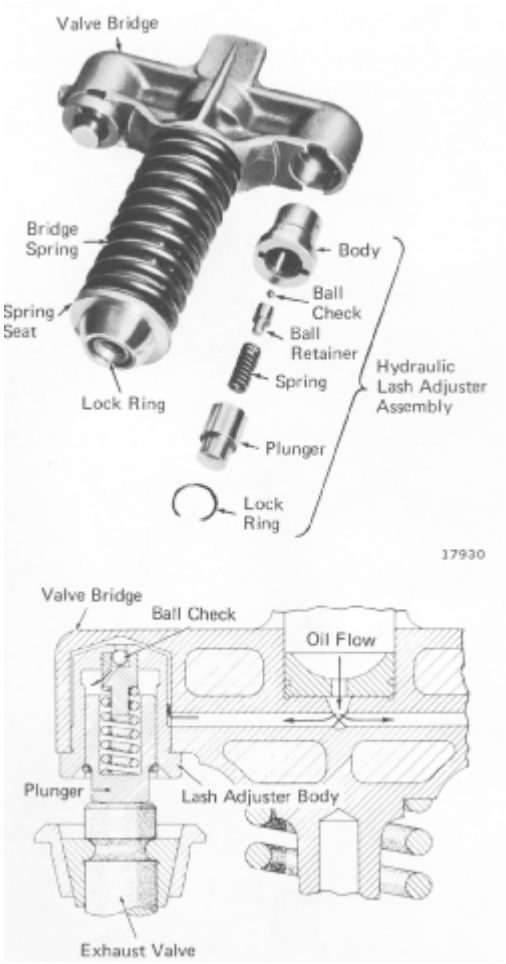


Fig. 2-23 - Valve Bridge Assembly

CLEANING

Prior to disassembly of the valve bridge, clean assembly with solvent. Do not use a caustic type cleaner, as the brass spring seat will be damaged.

DISASSEMBLY

1. Remove lash adjuster assembly from bridge, using adjuster puller, Fig. 2-24.

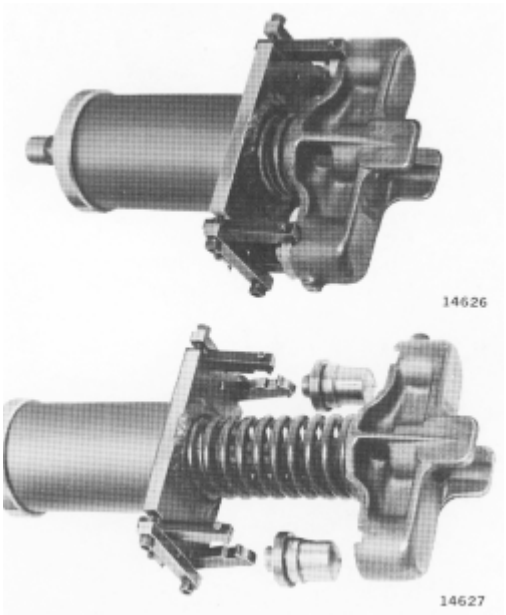


Fig. 2-24 - Removing Hydraulic Lash Adjuster

2. Mount valve bridge spring compressor in vise, Fig. 2-25. Install valve bridge in compressor, compress spring, remove lock ring, and remove spring seat and spring.

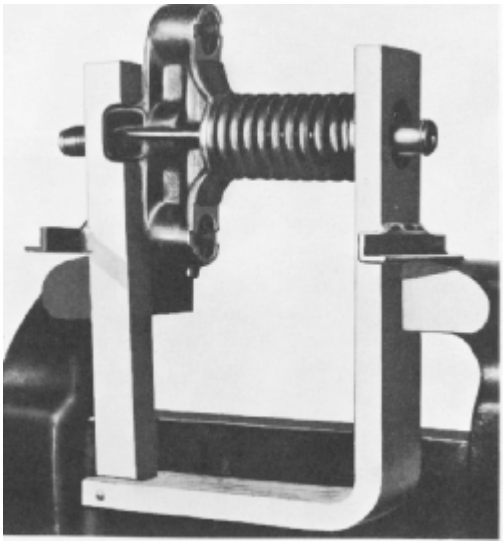
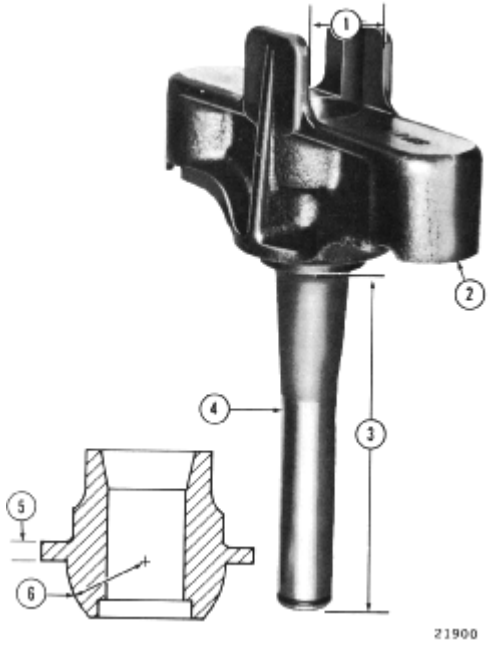


Fig. 2-25 - Compressing Valve Bridge Spring

INSPECTION

Visually inspect valve bridge parts and replace those that are damaged beyond repair. Check the pin in the end of the valve bridge to see that it is tight. Also check the valve bridge for a bent shank. If the shank is slightly bent, it may be straightened and re-used.

Inspect the valve bridge and spring seat at the points shown in Fig. 2-26, and refer to dimensions in the Service Data at the end of this section.



Refer to Service Data for applicable dimensions.

1. Distance between rocker arm guide ears.
2. Lash adjuster socket diameter.
3. Valve bridge shank length.
4. Shank diameter from shank end to 63.5 mm (2.50") above shank end.
5. Spring seat rim thickness.
6. Spring seat spherical radius.

Fig. 2-26 - Valve Bridge Measurement Points

Refer to "LASH ADJUSTER" portion of this section for maintenance and qualification of lash adjuster assemblies.

LASH ADJUSTER

DISASSEMBLY

1. Depress lash adjuster plunger and remove locking ring, Fig. 2-23.

2. Carefully disassemble lash adjuster to avoid damaging the machined surfaces on the inside diameter of the body or the outside diameter of the plunger.

3. Replace spring and ball check with new parts prior to assembly of lash adjuster.

CLEANING

1. Lash adjuster parts may be cleaned using fuel oil. Lacquer deposits can be removed with alcohol, lacquer thinner, or other suitable solvent. Completely remove any dirt, lacquer, or metal particles.

2. Do not buff the outside or inside diameter of the body, the outside diameter of the plunger, or the spherical radius on the tip of the plunger.

INSPECTION

1. Inspect the body for scores, scratches, or galled areas on the machined outside diameter, and replace if any are found.

2. Inspect the plunger for scores, scratches, or galling on the outside diameter, and replace if evidenced. Also, inspect the plunger tip, and if the contact point is worn flat more than 6.35 mm (.250") in diameter, the plunger should be replaced.

3. Inspect the ball retainer 4.22 mm (.166") diameter counterbore depth at the center of' the ball depression. Replace the ball retainer if the depth is greater than 3.63 mm (.143").

ASSEMBLY

Assemble lash adjuster in an area free of dirt. lint, and metal particles.

QUALIFYING LASH ADJUSTERS

It is recommended that lash adjuster test stand, Fig. 2-27, be used to qualify the lash adjusters for use in the engine. This test stand automatically measures the time required for the lash adjuster plunger to travel through 1.52 mm (.060") while it is subjected to a 13.6 kg (30 lbs) ram load, and rotated about 10 RPM relative to the lash adjuster body.

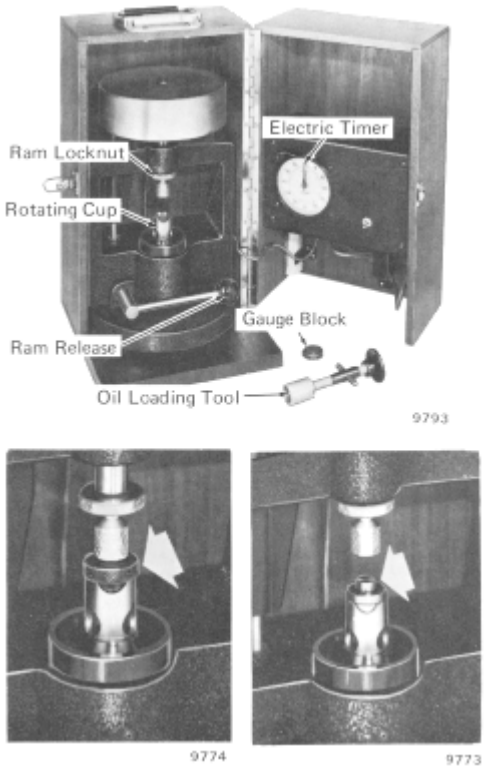


Fig. 2-27 - Lash Adjuster Test Stand

A gauge block and oil loading tool, Fig. 2-27, are supplied with the stand. The gauge block is used to check and adjust the tripping point of the microswitches, if necessary, to ensure that the leak down time is measured over exactly 1.52 mm (.060") travel of the lash adjuster plunger. The oil loading tool is used to charge the lash adjuster with oil and bleed off any air which might cause incorrect leak down time intervals. It is essential that only Electro-Motive hydraulic lash adjuster test oil be used in conjunction with this test stand since the operation of' the test and limits governing the lash adjuster are based on the use of this oil.

TEST STAND OPERATION

The 1.52 mm (.060") travel of the ram starts when the tip of the ram is 9.52 mm (.375") from the top of the rotating cup. This starting point should be checked with the 9.52 mm (.375") gauge block supplied with the test stand, and it should be checked often enough to be sure it has not changed. This check is to be made by placing

the gauge block on top of the rotating cup with the step facing up, and then lowering the ram by turning the ram release. The time clock on the test stand should start the very moment the ram load contacts the gauge block. If the timer does not start, or starts too soon, the ram should be readjusted. This is done by loosening the ram locknut, turning the ram tip up or down to the proper adjustment, and retightening the locknut. The time clock start and stop microswitches are permanently set so that the time for the 1.52 mm (.060") travel is automatically recorded on the time clock. (If a microswitch has to be replaced, the 1.52 mm (.060") between the microswitch positions should be set by inverting the gauge block which has a 1.52 mm (.060") step on it.)

TEST PROCEDURE

1. Place the lash adjuster assembly in oil loading tool and immerse it into a container of lash adjuster test oil that is deep enough for the hole in the lash adjuster to be well below the oil level.

2. Completely depress the lash adjuster plunger at least 10 times to ensure that any air trapped inside is pumped out.

3. Retract the spring-loaded plunger in the oil loading tool and allow the ball check to seat in the lash adjuster. Try to depress the lash adjuster plunger two or three more times to ensure that the ball check is seating. The assembly should feel firm, without any "give" to it.

4. Take the lash adjuster out of the test oil and remove the oil loading tool being careful that the spring-loaded plunger does not unseat the ball check. Wipe the excess oil off the lash adjuster and place it in the rotating cup on the test stand.

5. Turn the switch on to rotate the cup. Lower the ram until it rests on the lash adjuster plunger and release handle so that the plunger carries the full 13.6 kg (30 lbs) load.

NOTE: Be sure the lash adjuster body is rotating around the plunger.

6. The time for 1.52 mm (.060") travel (leak down time) will be automatically recorded on the time clock. The "leak down time" should be within limits of ten seconds minimum and 40 seconds maximum, based on a normal temperature of 24° C (75° F) for the oil and lash adjuster. If the temperature of the oil and lash adjuster is other than 24° C (75° F), the limits should be detennined by the following:

Oil And Lash Adjusters Temp.		Min. Leak Down Time Seconds	Max. Leak Down Time Seconds
°C	°F		
16	60	15.8	70.6
18	65	13.2	54.8
21	70	11.4	45.2
24	75 (Base)	10.0	40.0
27	80	9.0	36.0
29	85	8.0	32.6
32	90	7.2	30.2
35	95	6.6	28.4
38	100	6.2	27.8

The temperature of the test oil and lash adjuster should be allowed to become stable before leak down checks are made. If a lash adjuster fails to pass the minimum "leak down time," it should be refilled and retested to be sure that the failure was not due to air trapped in the lash adjuster.

ASSEMBLY OF VALVE BRIDGE

1. Using the valve bridge spring compressor, Fig. 2-25, assemble a qualified spring, spring seat and lock ring to the valve bridge.

2. Install the lash adjuster assembly in the valve bridge, using the installer tool, Fig. 2-28.

Fig. 2-28 - Installing Lash Adjuster

ROCKER ARM ASSEMBLY

DESCRIPTION

Three rocker arms, Fig. 2-29, are mounted on the cylinder head. Two rocker arms actuate the four exhaust valves, the third operates the injector. The rocker arms are operated directly by the camshaft through a cam follower roller mounted at the fork end of each rocker arm. The opposite end of each rocker arm has an adjusting screw and locknut for setting the injector timing and adjusting the hydraulic lash adjusters. The injector rocker arm, although similar in appearance to the exhaust rocker arm, is stronger than the exhaust rocker arm, and can be identified by the yoke at the cam follower end which is square-shaped on the injector rocker arm, but V-shaped on the exhaust rocker arm. Also, only the injector rocker arm has the machined notch for the overspeed trip. Injector and exhaust rocker arms are not interchangeable.

Lubricating oil is supplied to the cam follower assembly and the adjusting screw end through drilled passages in the rocker arm.

MAINTENANCE

Remove adjusting screw and cam follower races, bushings, and pin and thoroughly clean all parts in fuel oil or similar solvent. Do not clean inner and outer races and bushings in a caustic solution. Handle parts with care to avoid nicking the bearing surfaces.

1. Inspect the rocker arm bushings, cam follower rollers, inner race, Fig. 2-30, and rocker arm shaft for evidence of heat discoloration, excessive wear, shelling or scuffing due to lack of lubrication and for fatique cracks.

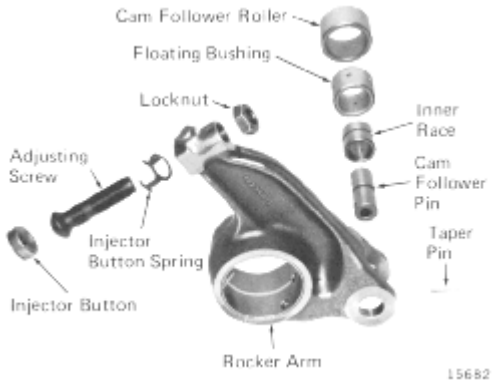


Fig. 2-30 - Injector Rocker Ann, Exploded View

2. Check that all oil holes and passages are clean.

3. All adjusting screws should be checked for hand-free operation and any galling on the ball end.

4. All adjusting screw buttons should be visually checked for galling or cracking.

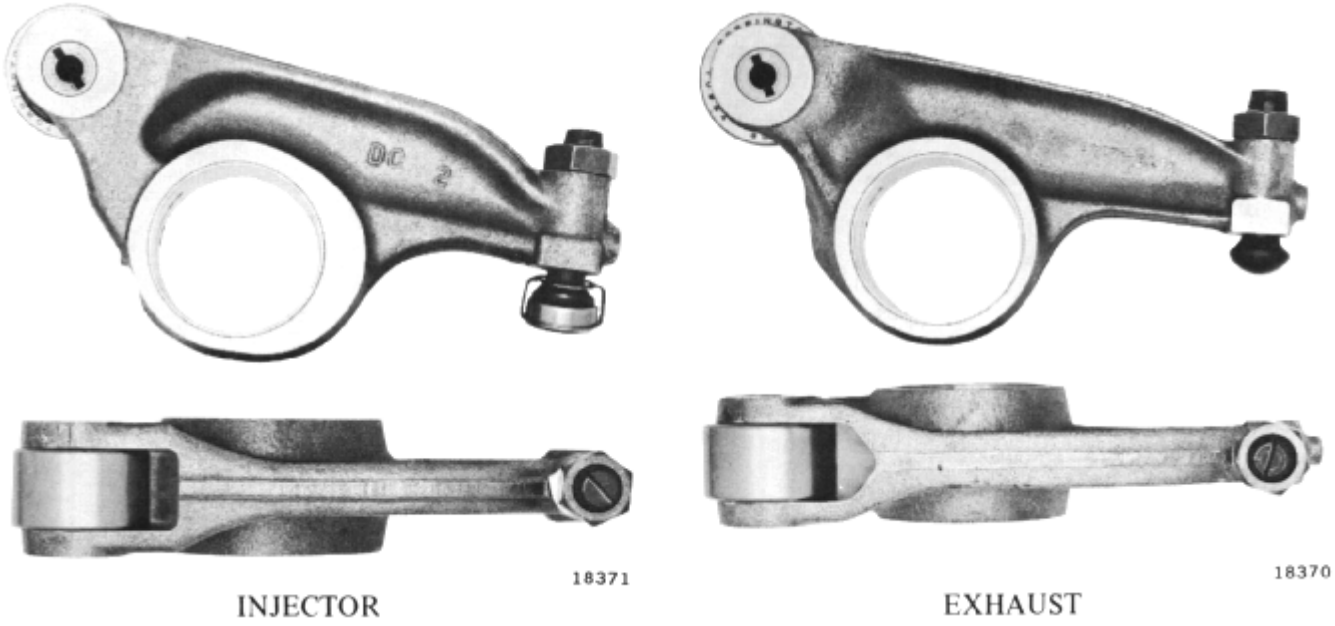


Fig. 2-29 - Rocker Arms

ROCKER ARM SUPPORT ASSEMBLY

DESCRIPTION

The rocker arms are mounted on rocker arm shaft which is held at each end between a shaft support and shaft cap, Fig. 2-31. Lubricating oil is supplied to the rocker arms through drilled passages in the rocker arm shaft and an oil supply line from the cam shaft bearing bracket.

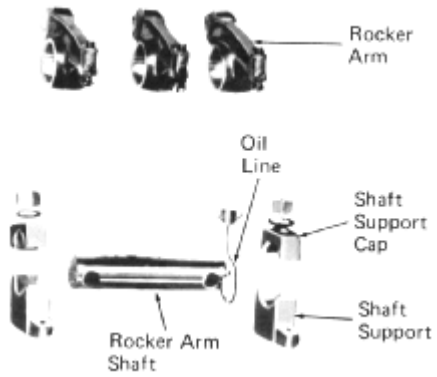


Fig. 2-31 - Rocker Arm Support Assembly

MAINTENANCE

Thorougly clean shaft, support caps, and support in suitable solvent. Check that oil passages in shaft and oil line are clean and free from obstructions.

Check shaft diameter at wear step for proper dimensions, and check for cracks, scratches, or galling in the bearing areas.

Check the shaft support for the correct height dimension between the base and bottom of the bore. Holding this dimension with the limits will ensure that the height mismatch between supports for any one cylinder will be 0.15 mm (.006") or less. Mismatch greater than 0.15mm (.006") can lead to camshaft lobe distress and broken rocker arm studs.

A flat and true nut seating surface must be provided on the support cap or broken washers and studs can result. If a seating surface is damaged, it may be remachined until a minimum dimension of 12.70 mm (I 2") is obtained between the seating surface and top of bore.

The surface must be machined square with the stud hole and parallel with the centerline of the rocker rocker arm shaft within 0.25 mm (.010") total indicator reading. Cracks in the cap or shaft support are cause for rejection.

CYLINDER TEST VALVE

DESCRIPTION

Cylinder test valves, Fig. 2-32, are provided on the engine at each cylinder. Any time maintenance or inspection if performed, the valves are opened to relieve compression, reducing the effort required to rotate the crankshaft. With the test valves open, fuel and coolant leaks can be detected by fluid discharge at the valves while the engine is being barred over. The cylinder test valve is inserted in a housing within the crankcase and screwed into the cylinder head. A cylinder test valve wrench, Fig. 2-33, is used to open and close the valves.

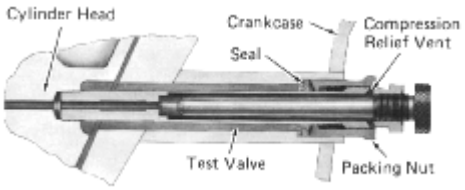


Fig. 2-32 - Cylinder Test Valve

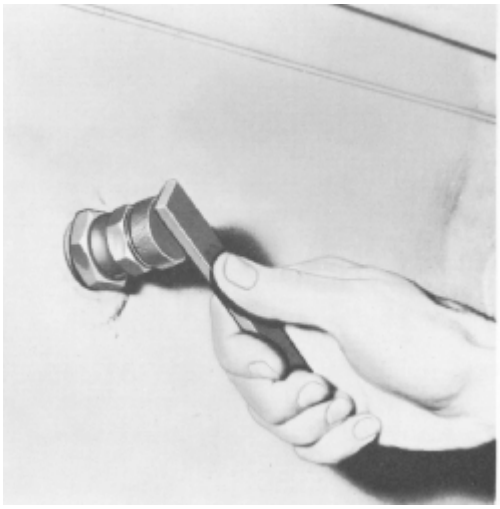


Fig. 2-33 - Test Valve Wrench

MAINTENANCE

1. If a cylinder test valve is leaking, check that packing nut, Fig. 2-32, has been torqued to 81-88 N-m (60-65 ft-lbs). If nut has been overtightened, change seal, Fig. 2-32, and correctly torque packing nut. Should valve continue to leak, remove the valve from the engine and ream the valve seat as shown in Fig. 2-34.

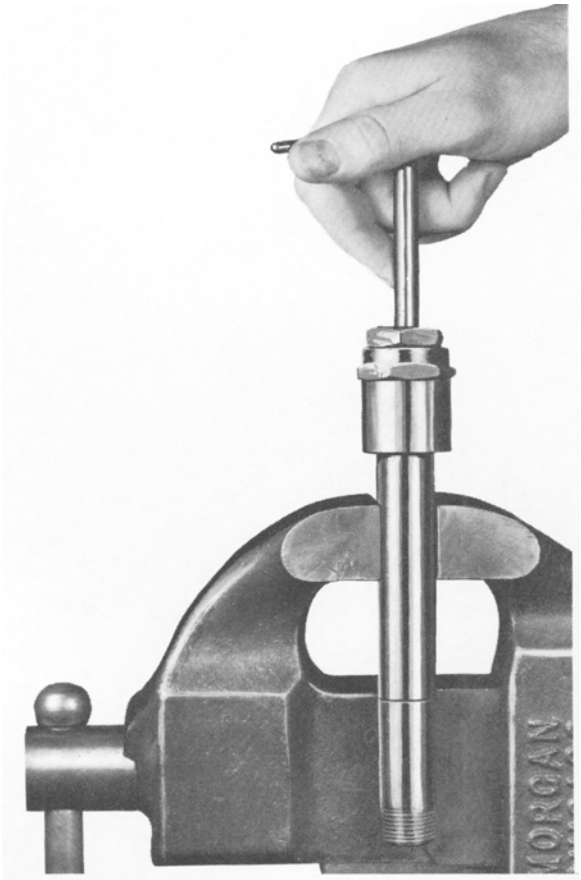


Fig. 2-34 - Reaming Test Valve Seat

2. If reaming will not correct the leaking due to a scored or damaged valve stem face, it should be reconditioned within the limits shown in Fig. 2-35. Reharden the tip to a depth of 0.13-0.25 mm (.005"-.010").

3. The cylinder test valve body may be reworked to the dimensions shown in Fig. 2-35. Use reamer to recondition the valve seat. If necessary to exceed the 6.35 mm (1/4") maximum diameter of valve seat, Fig. 2-35, recut bottom of 12.7 mm (1/2") diameter counterbore and reface hexagon end to hold the 153.99 mm (6-1/6") nominal dimension.

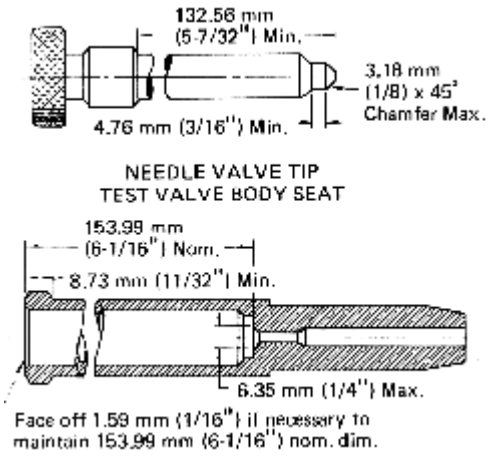


Fig. 2-35 - Test Valve Reconditioning Limits

4. After reconditioning, air test the valve assembly at 620 kPa (90 psi) air pressure.

CYLINDER HEAD SEAT RING

DESCRIPTION

The cylinder head seat ring is a brass ring used between the crankcase head seat and the cylinder head to provide a seating surface for the cylinder head and to maintain proper piston to head clearance.

MAINTENANCE

Inspect head seat ring for proper dimensions. If ring does not meet required specifications, it should be replaced with a new ring.

SERVICE DATA

CYLINDER HEAD AND ACCESSORIES

SPECIFICATIONS

Clearance and dimensional limits listed below are defined as follows:

1. New limits are those to which new parts are manufactured. (Drawing tolerances.)

2. Minimum, maximum, and tolerance measurements are provided as service limits. At time of rebuild or any time unscheduled maintenance is performed, the service limits should not be exceeded. Engine components within these limits may be reused with the assurance that they will perform satisfactorily until the next scheduled overhaul.

Cylinder Head

Valve seat angle	30°00'-30°15'
Valve seat width	2.36-3.18 mm (.093"-.125")
Variation of seat width on a given seat-Max.	0.38 mm (.015")
Diameter at top of valve seat (ground)	
Max.	61.90 mm (2.437")
Min.	60.33 mm (2.375")
Valve seat runout max. (measured at center of seat)	0.10 mm (.004")
Valve flat to head	
New	0.38 mm (.015")
Max.	2.36 mm (.093")
Valve lift	17.48 mm (.688")
Fireface surface (refinished - circumferential lay)	2 µm-3 µm (80 µ in.-120 µ in.)

Exhaust Valves

Stem diameter (measured within 12.7 mm (1/2") of weld and 12.7 mm (1/2") below P/N stencil on stem)	
New	15.786-15.812 mm (.6215"-.6225")
Min.	15.761 mm (.6205")
Diameter of head	63.50 mm (2.500")
Valve face angle	30°00'-29°45'
Valve seat runout - Max.	0.05 mm (.002")
Valve rim thickness-Min. (measured at O.D.)	2.77 mm (.109")
Valve face width-Max.	8.71 mm (.343")

Valve Springs

Free length (approximately)	
New	104.78 mm (4.125")
Min.	100.79 mm (3.968")
Length - valve open	68.28 mm (2.688")
Length - valve closed	85.72 mm (3.375")
Pressure to compress spring to 68.25 mm (2.687") length.	
New	96.6-102.1 kg (213-225 lbs)
Min.	79.4 kg (175 lbs)
Valve bridges spring - same as valve spring. Spring must not show any set after being compressed with coils touching:	
Valve spring seat thickness - Min.	3.68 mm (.145")

Rocker Arm

Rocker arm shaft diameter - Min.	57.05 mm (2.246")
Rocker arm bushing inside diameter - Max.	57.25 mm (2.254")
Press bushing to rocker arm	0.05-0.10 mm (.002"-.004")
Inner race outside diameter - Min.	26.62 mm (1.048")
Floating bushing inside diameter - Max.	26.80 mm (1.055")
Floating bushing outside diameter - Min.	36.665 mm (1.443511)
Cam follower roller inside diameter - Max.	36.843 mm (1.4505")

Rocker Arm Shaft Support Assembly

Shaft support - support base to bottom of bore	55.47-55.63 mm (2.184"-2.190")
Shaft support cap - nut seating surface to top of bore - Min.	12.70 mm (.500")
Shaft diameter - Min. (measured at wear step)	57.05 mm (2.246")

Valve Guide

Inside diameter (not installed) - New	15.938-16.015 mm (.6275"-.6305")
(Installed in head) - Min.	15.900 mm (.6260")
Max. limit - 12.70 mm (1/2") from bottom and top	16.08 mm (.633")
Valve stem to guide clearance - Max.	0.25 mm (.010")
Press fit in head	0.013-0.051 mm (.0005"-.0020")

Cylinder Head Seat Ring

Thickness standard - New	4.83-4.93 mm (.190"-.194")
Minimum thickness	4.67 mm (.184")
Uniform thickness within	0.06 mm (.0025")
Maximum wear step	0.08 mm (.003")

Valve Bridge

Refer to Fig, 2-26

Distance between rocker arm guide ears -	
Min.	23.75 mm (.935")
Max.	23.88 mm (.940")
Lash adjuster socket diameter -	
Min.	22.212 mm (.8745")
Max.	22.225 mm (.8750")
Valve bridge shank length -	
Min.	103.18 mm (4.062")
Max.	103.96 mm (4.093")
Shank diameter from shank end to 63.5 mm (2.50") above the shank end -	
Min.	15.799 mm (.6220")
Max.	15.837 mm (.6235")
Spring seat rim thickness -	
Min.	2.36 mm (.093")
Max.	3.18 mm (.125")
Spring seat spherical radius	
New	15.82 mm (.623")
Max. wear step on radius	0.79 mm (.031 ")

EQUIPMENT LIST

	Part No.
Test valve wrench	8032587
Valve spring compressor (single)	8033783
Adapter (use with 8033783)	8034054
Crab stud protector tubes	8034600
Valve seat reconditioning tool set (115 volt)	8035775
Valve seat reconditioning tool set (220 volt)	8041445
Valve checking tram	8042773
Electric drill, 1/4" (115 volt)	8045450
Electric drill, 1/4" (230 volt)	8062140
Cylinder test valve seat reamer	8064804
Valve bridge spring compressor	8070883
Valve bridge lock ring guide	8070903
Lash adjuster installer	8072927
Lock ring remover - lash adjuster	8080632
Valve guide cleaner	8141439
Tapered pilot checking fixture	8173996

SERVICE DATA

CYLINDER HEAD AND ACCESSORIES

Cylinder head stud hole cleaner	8211907
Valve seat seal tester	8213518
Vacuum cup (spare for 8213518)	8213519
Valve spring compressor (multiple-crank type)	8215081
Valve guide installer - remover	8224241
Valve spring compressor (multiple)	8239430
Lash adjuster test stand	8267432
Lash adjuster test oil (18.93 litres [5 gal.])	8276528
Lash adjuster test stand (220 V 60 Hz)	8299249
Valve seat reconditioning tool set (air motor)	8332668
Lash adjuster puller	8394719
Lash adjuster pulling arm	8395481
Grinder-valve and tool-230 volts 60 Hz single phase	9310355
Grinder-valve and tool-230 volts 60 Hz three phase	9310356
Grinder-valve and tool-115 volts 50 Hz single phase	9310357
Grinder-valve and tool-230 volts 50 Hz single phase	9310358
Grinder-valve and tool-230 volts 50 Hz three phase	9310359
Grinder-valve and tool-115 volts 60 Hz single phase	9310360
Drive belt for valve grinders	9310380
Valve stem end grinding wheel	9310381
Valve face grinding wheel with hub	9310382