SECTION II

CYLINDER HEAD ASSEMBLY

A. DESCRIPTION

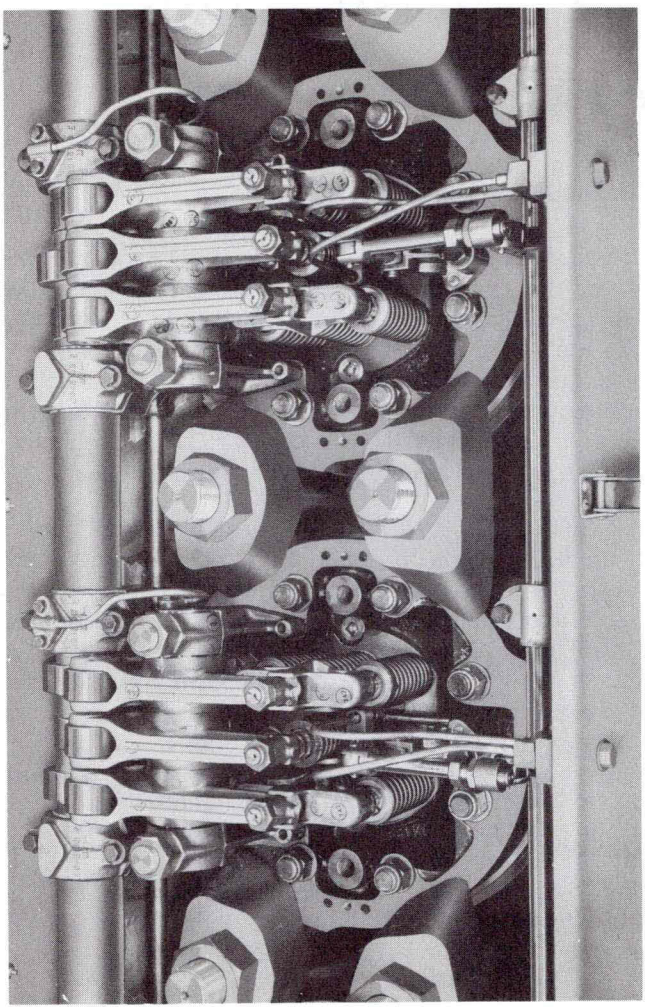
1. Cylinder Heads

Cylinder heads are made of alloy cast iron and are clamped in the crankcase by the cylinder head crabs, Fig. 2-1. A bronze cylinder head seat ring is used between the top of the retainer and cylinder head. The cylinder head is located by line-up of the discharge water outlet elbow, Fig 2-2, between the cylinder head and the crankcase. The 567C cylinder head is NOT interchangeable with earlier 567 series engine cylinder heads.

The head is cast with cored water passages having drilled openings at the bottom, Fig. 2-3, to match the water outlet holes on top of the cylinder liner on which it seats. Exhaust passages in the cylinder head line up with mating elbows in the retainer, which conduct 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. Injector locating dowel holes are provided for the standard and high output injectors. The standard injector dowel hole is on the cylinder head vertical centerline while the dowel hole for the high output injector is located off the vertical centerline. (For specific injector application, see Section XI.)

The cylinder head assembly includes three rocker arms, four exhaust valves and springs, valve bridges with springs, valve guides, overspeed trip pawl, fuel in-



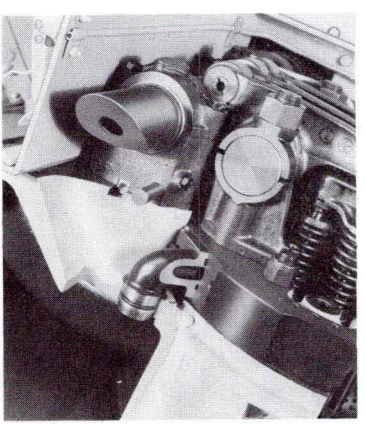
Top View Of Cylinder Heads
Fig. 2-1

jector and injector control lever, as shown in the exploded view, Fig. 2-4. It is secured to the liner by eight cylinder head to liner nuts; a hardened washer is used under each nut.

There are two designs of water discharge elbows, Fig. 2-5, used on 567C engine cylinder heads. Two elbows have long syphon tubes that extend down into the water discharge manifold with their end close to the bottom of the manifold. All other water discharge elbows used on the engine do not have the syphon tube. As their name implies, the long tube acts as a syphon, when the engine water is being drained, to empty water from the discharge manifold. It is important that the last cylinder head of the right bank and the first cylinder head of the left bank have a syphon tube discharge elbow. These cylinder heads position the syphon tube at the farthest ends of the manifold and provide for manifold drainage if the engine is not level.

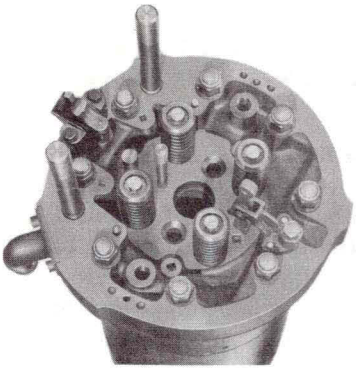
2. Exhaust Valves

The exhaust valves are the long stem type, having hardened and polished stem ends, held in the head by springs, tapered spring seats, valve keepers or locks tapered to fit the spring seat. The valve guides are precision type providing ample length for proper valve operation.

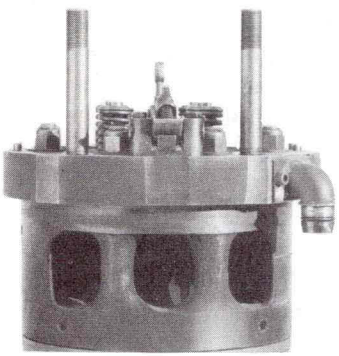


Water Discharge Elbow Location Fig. 2-2

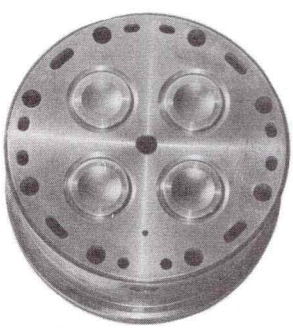
Exhaust valves used in the 567C series engines may be either a hard faced alloy valve 8206109 or what is termed a standard valve 8082254. The 8206109 valve is identical to the 8082254, except for the Stellite metal



Top



Exhaust Side



Bottom

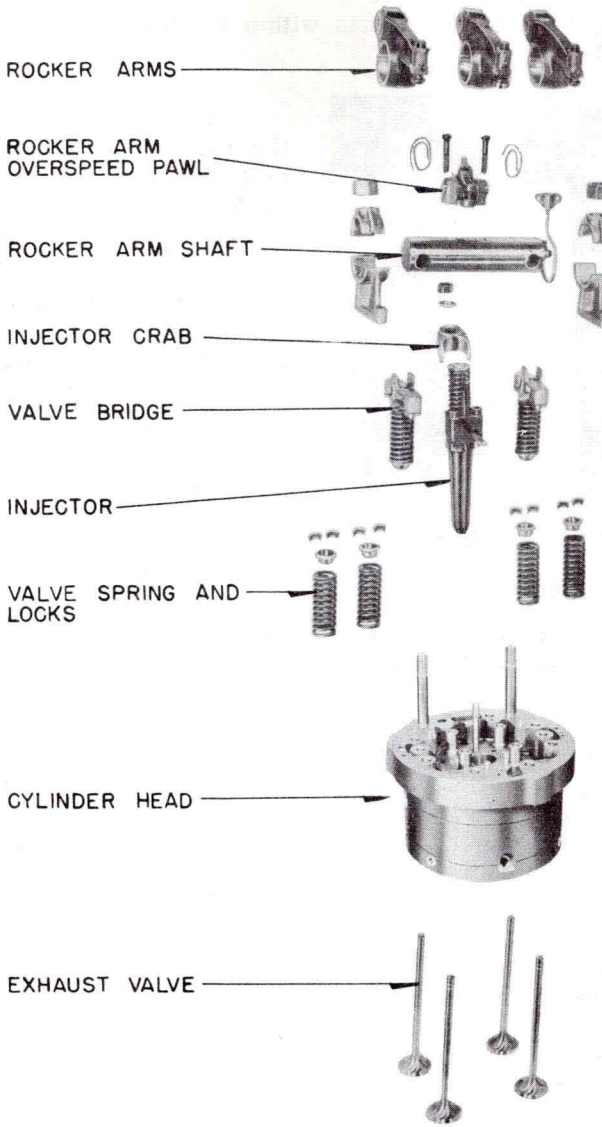
Cylinder Head Details
Fig. 2-3

in the valve face. Valve 8206109 can be identified by a 1/32" groove, 5/32" from top of valve, between the top of valve and first lock groove. (Some of the first Stellite faced valves used did not have the 1/32" groove and can only be identified by the part number 8206109.)

3. Valve Bridges and Hydraulic Lash Adjuster

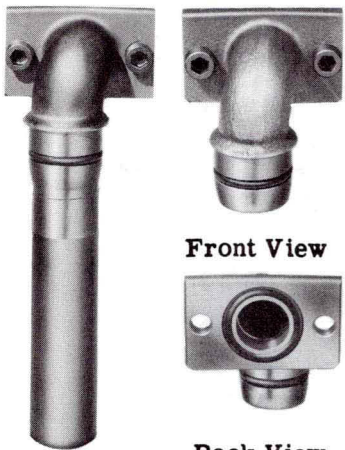
The valve bridge operates two exhaust valves from one rocker arm. A return spring and spring retainer having a ball seat are held on the valve bridge stem by a lock ring. The ball seat rests in a socket in the cylinder head and the spring applies pressure so that the valve bridges will stay in contact with the rocker arm.

The hydraulic lash adjuster used on the 567C engine is of the long travel type. It maintains zero lash between valve stem end and the valve bridge. The assembly consists of a body, plunger, spring, ball check and ball check retainer.



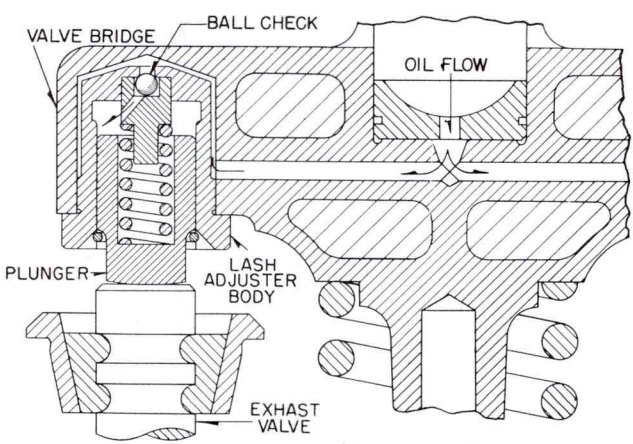
Cylinder Head Assembly
Fig. 2-4

A snap ring retains parts within the body as shown in Fig. 2-6.



Cylinder Head Water Discharge Elbows
Fig. 2-5

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 incompressible, further movement of the rocker arm causes the lash adjuster plunger to force open the exhaust valve. Proper hydraulic lash adjustment is very important because of its effect on the

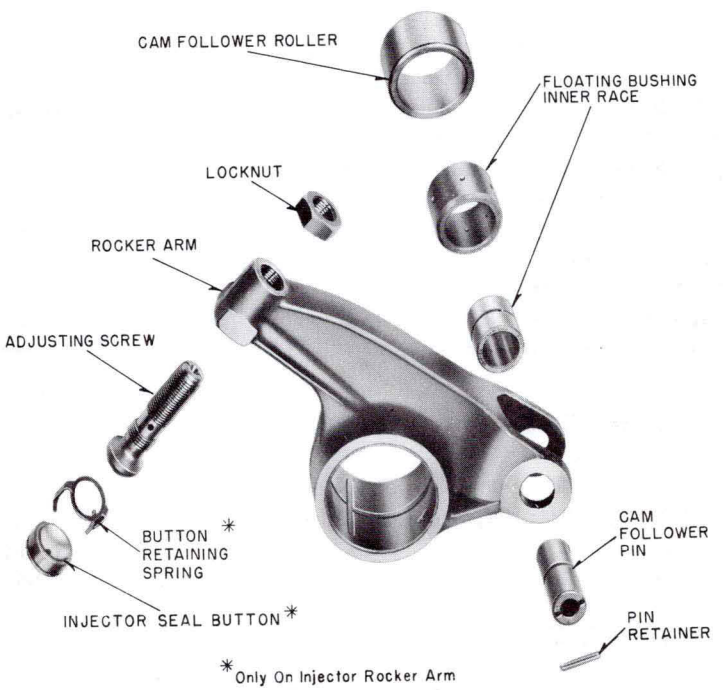


Hydraulic Lash Adjuster
Fig. 2-6

the valve operation. (See Item 8 under Maintenance "Adjusting Hydraulic Lash Adjusters.")

4. Rocker Arms

Three rocker arms, Fig. 2-7, 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 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.

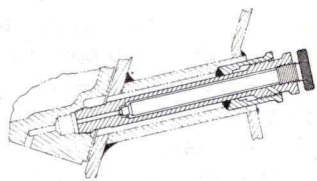


Exploded View of Rocker Arm Assembly
Fig. 2-7

An oil jumper line from the camshaft bearing carries oil to the rocker arm through drilled passages in the rocker arm shaft, Fig. 2-1. The rocker arm is drilled to supply oil to the valve bridge and lash adjusters and to the cam follower.

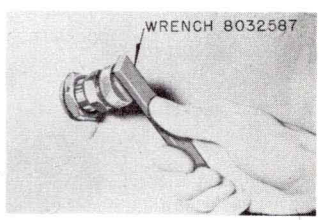
5. Cylinder Test Valves

The cylinder test valve consists of a body, valve stem, packing nut and seal ring. This assembly is inserted in a housing within the crankcase and screwed in the cylinder head, Fig. 2-8.



Cylinder Test Valve
Fig. 2-8

Cylinder test valves are provided on the engine at each cylinder to facilitate maintenance. At intervals at which maintenance or inspection is required, the valves are opened to relieve compression, thus reducing the effort required to rotate the crankshaft. A cylinder test valve wrench, Fig. 2-9, is used to open the valves 3 turns before rotation and to close the valves after inspection.



Test Valve Wrench
Fig. 2-9

B. MAINTENANCE

The following maintenance procedures consists of removing, cleaning, reconditioning, and installing the cylinder head and its component parts. For cylinder head Magnaflux inspection, see Maintenance Instruction 1754.

1. Cylinder Test Valves

If the cylinder test valves leak with normal tightening, the valve seat should be reamed, using reamer #8064804, Fig. 2-10. Valve seat diameter at top should not exceed 1/4". If valve stem face is scored or damaged, it should be reground and rehardened to a case

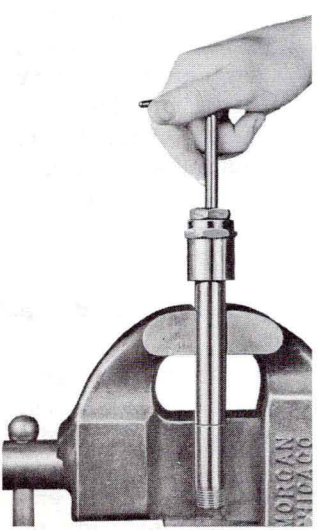
depth of .005"-.010". Minimum length of seat protrusion from stem is 1/4".

When installing a cylinder test valve, apply a small amount of white lead or pipe thread compound to the threads. This will alleviate rusting and binding, to make removal easier. To remove test valves, loosen packing nut and remove assembly from cylinder head by unscrewing body nut.

2. Removing Cylinder Head

The cylinder test valve must be removed and engine cooling water system drained before attempting to remove the cylinder head. If the cylinder liner is to be removed, remove piston cooling "pee" pipe assembly and water jumper line before starting to remove cylinder head.

a. Remove rocker arms, rocker arm shaft, and valve bridges.
   (1) Disconnect camshaft bearing to rocker arm oil line.
   (2) Remove rocker arm shaft cap nuts and remove caps.
   (3) Remove rocker arm assembly, being careful not to let shaft fall from rocker arms.
   (4) Remove valve bridges.



Reaming Test Valve Seat
Fig. 2-10

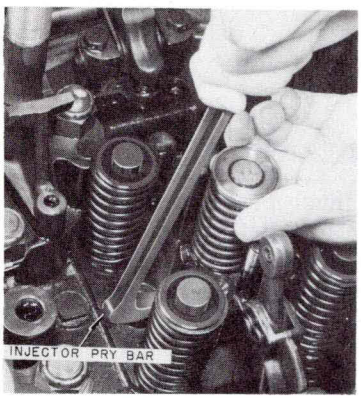
b. Remove injector.
   (1) Disconnect fuel oil lines from injector and fuel oil manifold.
   (2) Remove adjustable injector link.
   (3) Remove injector crab.
   (4) Remove injector, using prybar #8041183, Fig. 2-11. Protect injector from dirt and damage

by using holding rack #8159228, or shipping container.

c. Remove cylinder liner stud nuts and washers.

d. Remove crab nuts and crabs.

(1) Place crab stud protector tubes #8034600 over studs to protect threads.

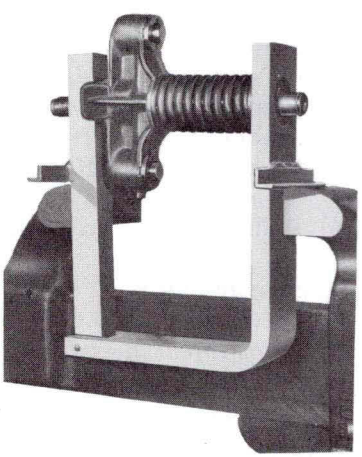


Removing Injector
Fig. 2-11

e. Remove cylinder head with use of head removing tool #8075894. Protect water outlet elbow. Place head into cylinder carrying basket #8060247, to protect machined gasket seat surface from damage.

f. Remove cylinder head seat ring and check for wear.

NOTE: Maintenance File 232 giving construction details on equipment for handling the cylinder head, liner, piston and rod assembly is available upon request.



Compressing Valve
Bridge Spring
Fig. 2-12

3. Rocker Arms and Shaft

Inspect rocker arm bushings, cam followers, and rocker arm shaft, Fig. 2-7. Look for evidence of discoloration, excessive wear, shelling or scuffing due to lack of

lubrication. Inspect for fatigue cracks. For wear limits, see specifications.

4. Valve Bridges and Lash Adjusters

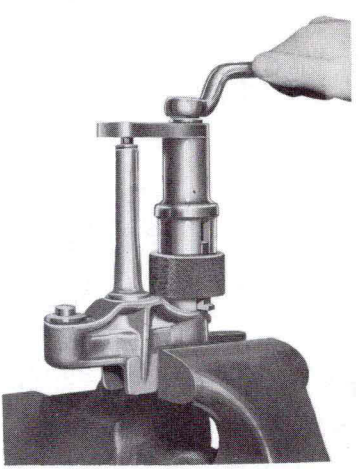
Clean valve bridges using a solvent, inspect for wear or damage. Rework as in following paragraphs.

a. Removing and installing valve bridge springs or spring seats, Fig. 2-12.
   (1) Mount valve bridge spring compressing tool #8070883 in vise.
   (2) Install valve bridge in compressing tool, compress spring, remove snap ring and remove spring.
   (3) Install new spring or valve spring spherical seat as required, and replace snap ring using snap ring tool #8070903.

b. Removing and installing hydraulic lash adjuster.

NOTE: Inoperative lash adjusters are noisy and can be located while engine is running at idle by their sharp tapping. (This may be noticed at times with good adjusters when first starting an engine, caused by cold oil). To correct this condition, remove lash adjuster and clean or replace parts, as necessary.

(1) To remove lash adjuster assembly



Removing Hydraulic Lash Adjuster
Fig. 2-13

clamp valve bridge in vise removing lash adjuster, as shown in Fig. 2-13, using lash adjuster removing tool #8070866. Puller arm #8154408 is used with this tool for removing long travel lash adjuster.

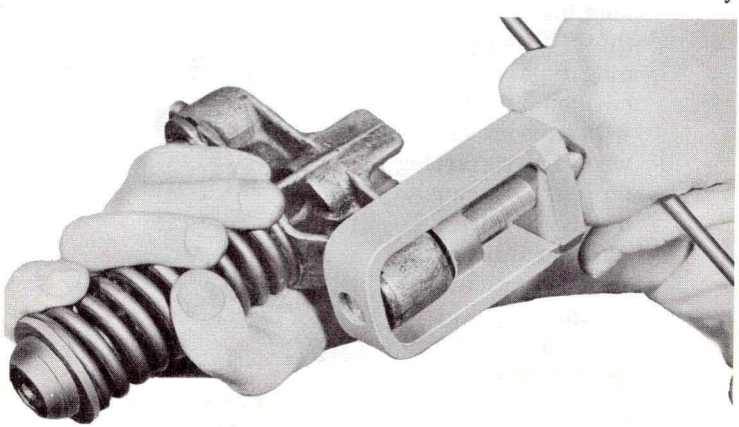
(2) To install lash adjuster assembly, use installing tool #8072927 shown in Fig. 2-14.

(3) Internal parts of the lash adjuster can be removed for cleaning or replacement and reinstalled without removing lash adjuster body from valve bridge. Use tool #8072927 with plug, to compress the lash adjuster plunger for removing the snap ring as shown on Fig. 2-15, using snap ring removing tool #8080632.

c. Cleaning And Qualifying Lash Adjusters

Lash adjuster parts may be cleaned using fuel oil and lacquer deposits removed using alcohol or lacquer thinner or other suitable solvent.

After cleaning and reassembly, the lash adjuster should be qualified for use. It is recommended that the lash adjuster test stand 8267432 be used, since it assures both accuracy



Installing Lash Adjuster
Fig. 2-14

Removing Snap Ring
Fig. 2-15

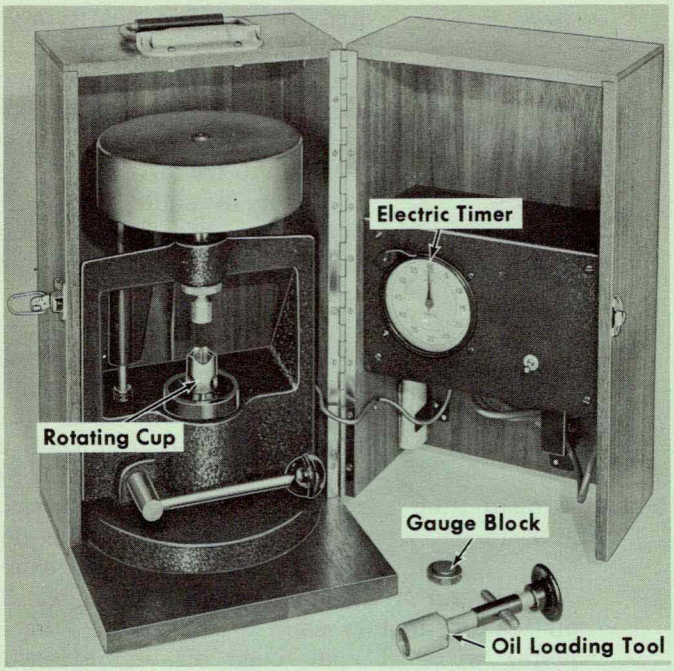
and speed when qualifying the lash adjusters for use in the engine. This test stand automatically measures the time required for the lash adjuster plunger to travel through .060" while it is subjected to a 30 pound ram load, and rotated about 10 RPM relative to the lash adjuster body.

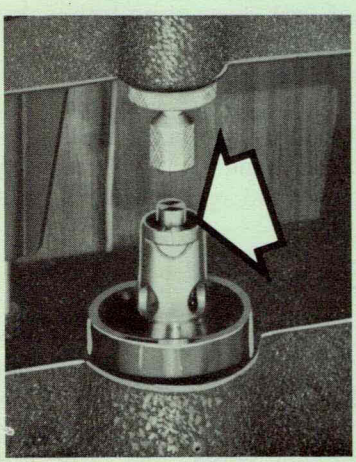
A gauge block and oil loading tool, Fig. 2-15a, are supplied with the stand. This gauge block is used to check and adjust the tripping point of the microswitches, if necessary, to insure that the leak down time is measured over exactly .060" travel of the lash adjuster plunger. The oil loading tool is 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 8276528 (5 gal.) be used in conjunction with this test stand since the operation of the test stand and limits governing the lash adjuster are based on the use of this oil.

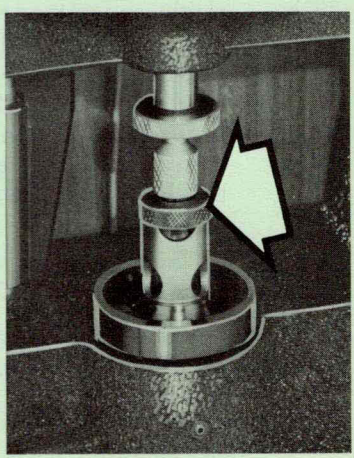
(1) Test Stand Operation

The .060" travel of the ram starts when the tip of the ram is .375" from the top of the rotating cup. This starting point should be checked with .375" gauge block 8267434, 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





Lash Adjuster In Position



Gauge Block Application

Fig. 2-15a — Lash Adjuster Test Stand

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 instant the ram load is released on to 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 lock nut, turning the ram tip up or down to the proper adjustment, and retighting the lock nut. The time clock start and stop microswitches are permanently set so that the time for the .060" travel is automatically recorded on the time clock. (If a microswitch has to be replaced, the .060" between microswitch positions should be set by inverting the gauge block which has a .060" step on it.)

(2) Test Procedure

(a) Place the lash adjuster assembly in oil loading tool 8267435, and immerse it into a container of hydraulic lash adjuster test and storage oil that is deep enough for the hole in the lash adjuster to be well below the oil level.

(b) Completely depress the lash adjuster plunger at least ten (10) times to insure that any air trapped inside is pumped out.

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

(d) Remove the lash adjuster from the oil and the 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.

(e) Turn the switch on to start the cup rotating. Lower the ram until it rests on the lash adjuster plunger and release the handle so that the plunger carries the full 30 pound load.

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

(f) The time for .060" travel (leak down time) will be automatically recorded on the time clock. The "leak down time" should be within the limits of seven (7) seconds minimum and forty (40) seconds maximum, based on a normal temperature of 75° F., for the oil and the lash adjuster. If the temperature of the oil and the lash adjuster is other than 75° F., the limits should be determined by the following Table A.

TABLE A

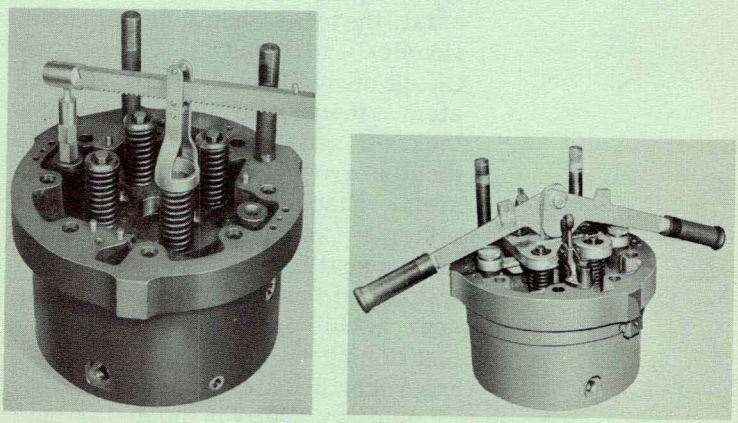
Oil and Lash Adjuster Temp. °F.	Min. Leak Down Time Seconds	Max. Leak Down Time Seconds
60	12.8	70.6
65	10.2	54.8
70	8.4	45.2
75 (Base)	7	40.0
80	6	36.0
85	5	32.6
90	4.2	30.2
95	3.6	28.4
100	3.2	27.8

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 in order to be sure that the failure was not due to air trapped in the lash adjuster.

5. Exhaust Valves and Guides

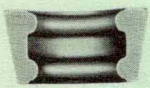
a. Removing valve springs.

Compress spring using compressor tool 8033783 and adapter 8034054 screwed to head, or use type of compressor tool that compresses all four springs 8239430, Fig. 2-16. Valve springs can be removed and replaced without removing the cylinder head from the engine, by using a special short adapter with tool 8033783. 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 and valve bridge springs should be inspected for nicks or unusual



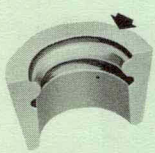
Compressing Valve Springs
Fig. 2-16

Single Bead



Double Bead

Grooved Top



Smooth Top

Valve Lock Details Fig. 2-16a

wear when removed. Do not clean springs using hydro blasting or grit blasting. Minimum free length of the spring is 3-31/32". The spring seats should be inspected for unusual wear or damage. Minimum thickness of the spring seating surface is .145".

b. Mating locks and valve stems.
Valve spring seat locks are single bead, replacing prior double bead locks, Fig. 2-16a. Valve locks should be used as follows: (1) Install single bead locks in valve top groove; (2) Do not use single and double bead halves together on the same valve; (3) Both halves of lock on valve must be same type, either smooth top or grooved top.

(1) Single bead locks
Examine single bead locks at overhaul periods for signs of excessive wear on upper portion of 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.

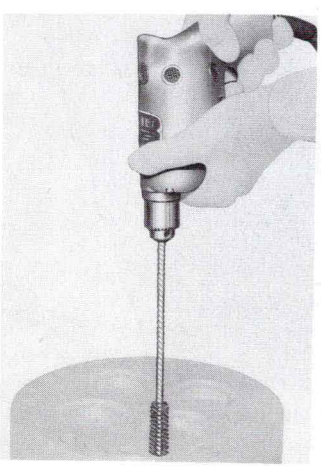
(2) Double bead locks
Check double bead lock fit to valve stem. If lock fits loosely, try new lock. If new lock is loose, it indicates grooves are worn in valve stem. Discard valves or locks if either is worn. Check locks and spring seat together. Match to obtain a rigid assembly, so no spring seat wobble is felt.

c. Reconditioning valves.
Before reconditioning exhaust valves, they should be visually inspected as outlined in Maintenance Instruction 1755, and dimensionally inspected as shown in Fig. 2-18 and given under Specifications.

For refacing valves follow instructions supplied with valve refacing machine 8137779, 110-volt, 8137780, 220-volt. Special grinding wheels are used for refacing Stellite faced exhaust valves, 8215388 is used with Black and Decker Grinder Universal #6, and 8035729 with Albertson Co. Sioux Model 663. See Tool Catalog for complete description of valve tools.

d. Valve Guides

The valve guides are a press fit in the cylinder head and can be pressed in or out using valve guide installing or removing tool 8224241, to prevent damage to the guide. Although the valve guides are precision guides and generally do not require reaming after assembly, it is recommended a .626" reamer or plug gauge be inserted after guide installation to assure a .626" minimum diameter. For precision valve guide limits, refer to Specifications under Valve Guides at the end of this Section.

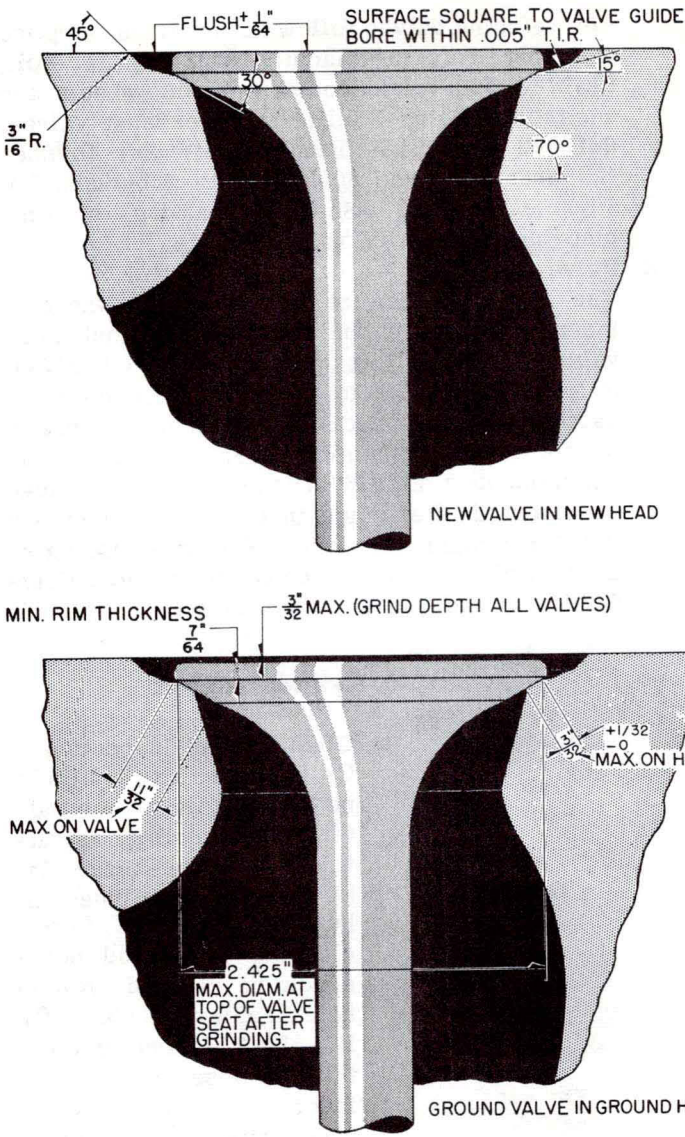


Stud Hole Cleaning Tool
Fig. 2-17

6. Cylinder Heads

a. Cleaning and inspection

Cylinder heads should be thoroughly cleaned after disassembling, as outlined in Maintenance Instruction 1706. When the head is removed from cleaning tank, stud holes should be cleaned. A stud hole cleaning tool #8211907, Fig. 2-17, is available for this purpose. Clean cylinder test valve threads in head with 1/2" standard pipe tap. When head is clean, inspect for cracks and damage (See Mainte-



Exhaust Valve Clearance
Fig. 2-18

Dressing Valve Seat Grinder
Fig. 2-19

nance Instruction 2127 for cylinder head Magnaflux inspection), and if satisfactory, proceed with following service operation.

b. Grinding valve seats
Use valve seat reconditioning set 8035775, 115-volt or 8041445, 220-volt. Do not use grinding compound. See Fig. 2-18, for valve and valve seat dimensions. Proceed as follows:

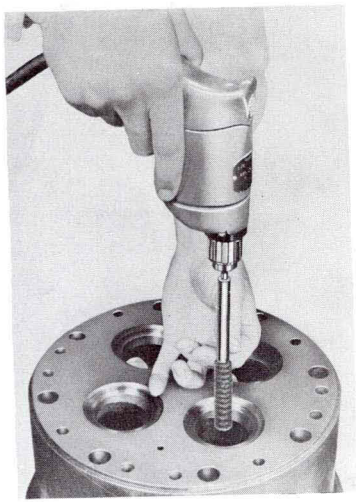
(1) Dress grinding wheel before using on each cylinder head. Mount as in Fig. 2-19. Wipe pilot with oil-soaked cloth for lubrication. Do not get oil on the grinding wheel. Adjust the spiral sleeve on the dressing tool until the wheel touches the diamond. Make final adjustment with diamond adjusting screw. Holder and grinding wheel are then revolved with the high speed drive. Hold the driver as straight as possible. Move the diamond steadily across the wheel, taking light cuts. Keep grinding wheel properly dressed to obtain the best results for fast grinding, accuracy, and a smooth finish.

(2) Clean valve guides with cleaning tool 8141439 drill 8062140, 220-volt, or 8045450, 110 volt, shown in Fig. 2-20. Any evidence of galling inside of guide must be entirely removed

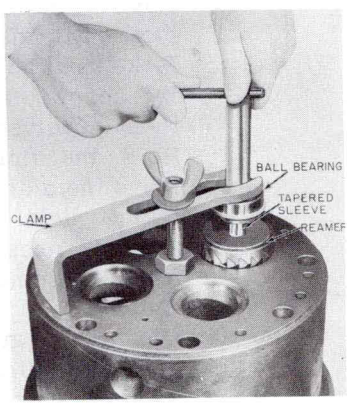
by reaming or the guide replaced. See Specifications for condemning limits.

(3) Select a tapered pilot which will bring the shoulder on the pilot above the valve guide. Press pilot firmly into guide, using pin. Wipe pilot with an oily cloth.

(4) Ream inside and outside of valve seat to conform to dimensions given on Fig. 2-18. Use reamer clamp 8194884 with adapter 8192140 to apply an even, adjustable pressure to the reamer, Fig. 2-21. First, use reamer 8192191 to ream clearance inside of seat. (Cutting angle of this reamer has been changed from 75° to 70° to conform to current design cylinder heads.) The top outside of the valve seat is narrowed to proper width of 3/32" + 1/32" - 0", using one of the following reamers. Cylinder heads serial 55A-2267 and after have a 3/16" radius at edge of valve recess to bottom of head; on these heads use reamer 8227358. Use reamer 8192190 on all cylinder heads prior to serial 55A-2267. After completion of reaming operations, blow out cuttings with air hose and wipe parts clean.

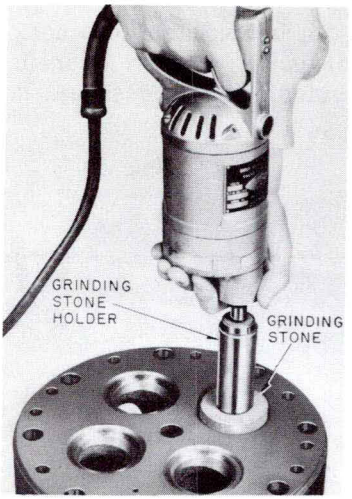


Cleaning Valve Guide
Fig. 2-20



Reaming Valve Seat
Fig. 2-21

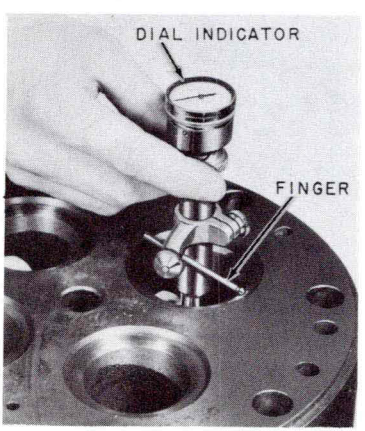
(5) Place holder with wheel over pilot. Insert abrasive cloth between grinding wheel and valve seat, and clean seat by turning holder by hand. Remove abrasive cloth and proceed to grind with driving motor, as shown in Fig. 2-22. No pressure is required when grinding. Permit the driving motor to run at top speed. Hold driving motor as straight as possible. Grind until valve seat is true. Raise grinding wheel off seat before stopping motor.



Grinding Valve Seat
Fig. 2-22

(6) Check valve seat width. If over 1/8", ream with outside reamer, then grind lightly to remove any raised edge caused by reamer.

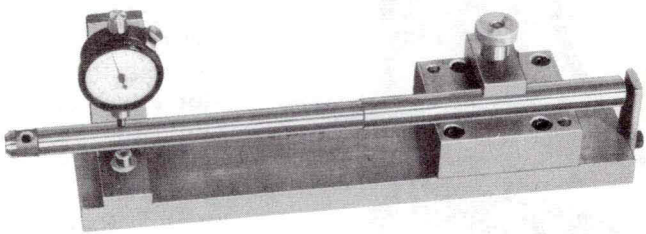
(7) Use indicator 8073108 included in the valve grinding set to measure trueness of valve seat. Place indicator over pilot, Fig. 2-23, and adjust so indicator is depressed slightly and ball of valve seat rider is at the center of the valve seat. Rotate valve seat rider and observe indicator reading. Valve seat out of round will be indicated on dial. Indicator reading must not exceed



Checking Valve Seat Roundness
Fig. 2-23

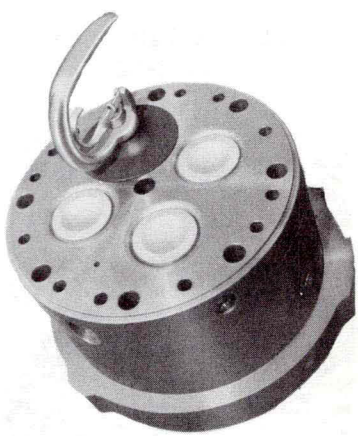
.002". An attempt should be made to obtain a perfect valve seat, since it is a very important factor in valve life.

A fixture 8173996, Fig. 2-24, is available for checking valve grinding and seat testing arbors. To insure satisfactory results, the grinding arbors should not exceed .0005" run out.



Pilot Checking Fixture
Fig. 2-24

c. Testing valve seats
To check seal of valves, assemble valves and springs to cylinder head and place head in an angular position resting on the rocker arm studs, with the valve seats up. Be sure that the bottom of the head is clean.



Vacuum Cup Lifter
Fig. 2-25

Vacuum cup lifter (4") 8213518, Fig. 2-25, is used to test the valve seal. Apply soap or a suitable lubricant to the concave surface of the vacuum cup, and apply to the cylinder head, carefully covering one valve. Be sure seal is not formed on the head of the valve, thereby testing the cup portion of the valve instead of the seat. Place

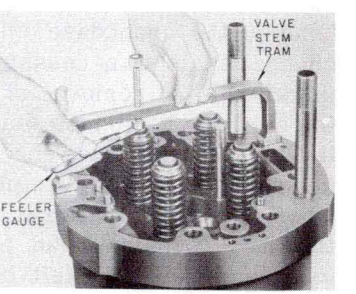
the valve tester with its handle in the 6 o'clock position, so tester will fall off readily when vacuum is depleted. If the tester falls off in less than three (3) minutes, the valve seating is defective and the head seat and/or valve face must be reworked. To remove the tester, open the trigger valve. Check the valve seat tester occasionally by applying it to a vertical piece of glass, because the release valve or rubber cup may become defective. New vacuum cups 8213519 are available.

d. Checking the height of valve stems
After reconditioning valves and valve seats, the height of the valve stem above the cylinder head must be checked. This is done with the use of the valve stem tram 8042773, as shown in Fig. 2-26. Clean off bottom feet of tram, and portion of cylinder head on which tram rests. Hold tram down firmly on cylinder head and with use of feeler gauge and screw, determine the difference of valve stem height. The difference of this height between valve stems under the same bridge should not vary more than 1/16". If the difference varies more than 1/16", the high valve would have to be replaced or the low valve ground in, provided this does not exceed the limits given on Fig. 2-18. End of valve should not be ground off as tip is hardened.

7. Installing Cylinder Head

Before installing cylinder head be sure the retainer inner surface and exhaust is cleaned of loose carbon and oil.

Examine the cylinder head that it is clean internally and in particular that the bottom surface is clean, free of dirt, nicks



Checking Height Of Valve Stems
Fig. 2-26

or scratches which would cause water seal or gasket leakage. Clean the liner stud holes using tool 8211907, Fig. 2-17. If this tool is not available, a wire brush can be used to remove rust, scale or dirt from these holes. It is recommended that just prior to installation of any cylinder head that a small quantity of green soap be applied to the bottom of all water and stud holes to help prevent possibility of dirt dropping on the water seals or cylinder head gasket surface during installation of the head.

Liner stud nuts should be examined and discarded when bottom of nut or threads are galled, or insert area cracked, torn, or frayed. Inspect cylinder head nut washers for damaged surface or warped condition, and replace if required.

Copper clad steel shim liner to head gasket should be installed with notched holes on liner pilot stud and left adjacent stud. Examine counterbore in liner water holes to be sure these areas are free of dirt and nicks that would break the seal grommets.

Install new seal rings in clean grooves of water discharge elbow. Clean flange surface on cylinder head for the elbow and apply elbow to head. Torque value of elbow to head capscrews is 30 foot-pounds. The discharge water elbow also serves to position the cylinder head in the crankcase. The elbow may be removed to change seals if necessary and reapplied with the head installed after removal of the crab above it, otherwise the cylinder head installation need not be disturbed. A thin shim used between the elbow flange and cylinder head, to hold the seal in place, aids in elbow application when the cylinder head is in place. It is important that the last cylinder head of the right bank and the first cylinder head of the left bank have a syphon tube water discharge elbow to permit water drainage from the discharge manifold when draining the engine cooling water. This arrangement assures drainage in the event the engine is not level when drained.

When this preliminary work is completed, proceed with the installation of the cylinder head, as follows:

a. Apply cylinder head seat ring to top of retainer. (See specifications for seat ring limits.) Lower head into position slowly. Line up water discharge elbow with mating hole in crankcase.

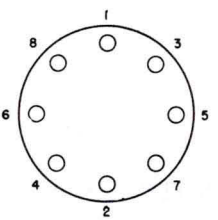


Fig. 2-27

b. Apply cylinder liner stud nuts and tighten snugly. Use lube oil or a lubricant having specifications similar to Texaco Stud Lube #921 on threads and bottom of nuts. At this initial tightening, apply only 75 foot-pounds torque.
c. Apply crabs and crab nuts. Use a lubricant similar to "b" above on the threads. Pull crab nuts down snugly.
d. Tighten liner stud nuts to proper torque of 200 foot-pounds, as indicated in the sketch, Fig. 2-27, making several rounds.
e. Tighten crab nuts. Crab nuts should be tightened alternately, forming the letter "X," and in two passes, half torque each pass. Powerench #8211089 may be used, which has a mechanical ratio of 12-1. Socket #8065580, box wrench #8034085, used with 60" extension, can also be used. Torque value for the crab nuts is 1800 $\pm$ 5% foot-pounds.
f. Install injector. Connect fuel oil lines and adjustable link. Injector crab nut torque value is 40-50 foot-pounds. (Time, as given in Section X).
g. Install valve bridges (with protruding boss toward camshaft for uniform assembly) rocker arms and lube oil lines. Set valves per item 8 below.
h. Install cylinder test valves.
i. Apply liner water inlet line and piston cooling oil pipe if these items were removed. Before

applying "pee" pipe, clean it with cleaning tool #8087086; after applying, check alignment in piston carrier with tool #8071720.

j. After assembly is installed and everything tightened properly, adjustments set and engine is ready to run, start engine and raise water temperature to 170° F. Recheck torque on crabs and liner stud nuts. Inspect assemblies for condition after running.

NOTE: When liner and crab nuts are being retightened, those which move at LESS than the specified torque values, should be tightened to the proper torque value. Those nuts which do not move below or up to the proper values, should be CHECKED by pulling up to a value not exceeding 10% more than the recommended torque values. Special offset box socket wrenches #8166890 and #8166891 used with a standard torque wrench are available to tighten inaccessible cylinder head nuts under installed rocker arms.

8. Adjusting Hydraulic Lash Adjusters

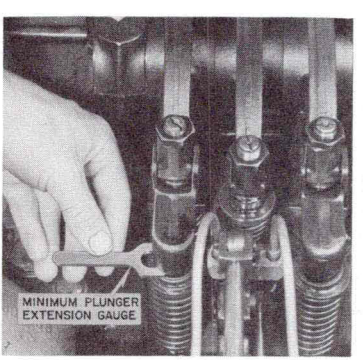
Application of properly operating lash adjusters, correct setting and subsequent inspection at regular maintenance intervals is very important in valve operation. Improperly set or defective lash adjusters cause the valve to be subjected to increased stress which leads to ultimate failure with resulting damage to the engine.

After complete cylinder head assembly has been installed, the lash adjusters must be set.

a. Rotate crankshaft so that piston is at or near top center of the cylinder being set.
b. Loosen rocker arm adjusting screw locknuts.
c. Turn rocker arm adjusting screw down until the last valve touches the hydraulic lash adjuster plunger, and then turn one and one-half (1-1/2) turns further down.

d. Check valve bridge spherical seat to be sure that it is spring loaded against the cylinder head spherical seat. If the bridge spring spherical seat is not spring loaded against the cylinder head spherical seat (any looseness evident), turn down the rocker arm adjusting screw until no looseness is felt, and then turn it one-quarter (1/4) turn further down.
e. Tighten rocker arm adjusting screw locknut.
f. After running the engine for two or three minutes, or after pumping oil out of lash adjuster by forcing down the rocker arm, check the clearance between lash adjuster bodies and the end of the valve stems with piston near top center. If the clearance is less than one-sixteenth (1/16") the cylinder head should be removed for reconditioning or rejection. Use minimum extension gauge #8107788, as shown in Fig. 2-28, to gauge lash adjuster plunger minimum extension. This gauge is 1/16" thick and it should fit between lash adjuster body and valve stem top, to assure the 1/16" clearance.

9. Tracing A Defective or Noisy Cylinder



Minimum Plunger Check
Fig. 2-28

A cylinder that is not firing properly will have a cooler exhaust stack, compared to one that is firing properly (engine at idle). This is caused by:

a. Badly leaking exhaust valves.
b. Defective injector.
c. Improper injector timing or control rack setting.
d. Dirty injector filter.
e. Air bound injector.

f. Excessive ring blow-by.
g. Cracked piston.

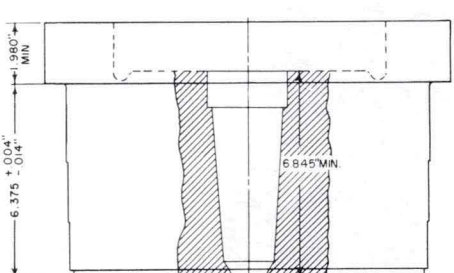
To determine if injector is at fault, disconnect injector adjustment link on the suspected cylinder and, with engine running at idle, push control rack open slowly and return to idle position as soon as observation has been made. If injector is operating properly a pronounced laboring of the cylinder will have been detected.

An exhaust valve leak can be detected when standing outside of locomotive by a pronounced blow at the exhaust stack, with engine idling.

To locate the leaking cylinder (engine shut down) install cylinder test adapter #8070872 in place of cylinder test valve, connect air hose to adapter, rotate engine until piston of cylinder to be tested is at top center and turn on air pressure. If valves are leaking, blow will be heard at exhaust stack. This method can also be used for checking excessive ring blow-by. In this case, blow will be heard in air box. If piston is cracked, blow will be detected at oil pan.

10. Repair of Damaged Seating Surfaces

It is permissible to rework cylinder heads which have damaged seating surfaces to the limits shown on Fig. 2-29.



Cylinder Head Dimensions
Fig. 2-29

C. SPECIFICATIONS

Exhaust Valves	
Diameter of stem (new)	.6215" - .6225"
Valve stem diameter	Min. .620"
Diameter of head	2-1/2"
Valve seat angle	30°
Lift	.686"
Number per cylinder	4
Valve Springs	
Free length (approximately) (new)	4-1/8"
Free length	Min. 3-31/32"
Length - valve open	2-11/16"
Length - valve closed	3-3/8"
Pressure with valve open	213 lbs. to 225 lbs. (new)
2-11/16" length	175 lbs. low limit

Valve bridge spring - same as valve spring. Spring must not show any set after being compressed with coils touching.

Valve spring seat thickness	Min. .145"
Rocker Arm	
Rocker arm shaft diameter	Min. 2.246"
Rocker arm lever bushing inside diameter	Max. 2.254"
Press-bushing to rocker arm	.002" - .004"
Inner race outside diameter	Min. 1.048"
Floating bushing inside diameter	Max. 1.055"
Floating bushing outside diameter	Min. 1.4435"
Cam follower inside diameter	Max. 1.4505"
Valve Guide	
Inside diameter (New-not installed)	.627" - .629"
(installed in head)	Min. .626"
Limit (at bottom)	.632"
Limit (1/2" from bottom and top)	.630"

C. SPECIFICATIONS (Cont'd)

Valve stem to guide clearance	Limit .010"
Press fit in head	.0005" - .0020"
Cylinder Head Seat Ring	
Thickness (new) standard	.192" ± .002"
Minimum thickness	.184"
Uniform thickness within	.002"
Maximum wear step	.003"

D. EQUIPMENT LIST

	Part No.
Valve Seal Tester	8213518
Vacuum Cup (spare for 8213518)	8213519
Test Valve Wrench	8032587
Snap Ring Removing Tool - Lash Adjuster	8080632
Cylinder Head Removing Tool	8075894
Cylinder Head Carrying Basket	8060247
Valve Bridge Spring Compressing Tool	8070883
Valve Bridge Snap Ring Installing Tool	8070903
Hydraulic Lash Adjuster Puller	8070866
Lash Adjuster Installing Tool	8072927
Exhaust Valve Spring Compressing Tool	8033783
Adapter (for above)	8034054
4-Spring Compressing Tool	8239430
Valve Refacing Machine 110 Volt	8137779
Valve Refacing Machine 220 Volt	8137780
Valve Seat Reconditioning Set 115 Volt	8035775
Driver (for above) 115 Volt	8200893
Valve Seat Reconditioning Set 220 Volt	8041445
Driver (for above) 220 Volt	8200894
Valve Guide Cleaning Tool	8141439
Guide Installing and Removing Tool	8224241
Valve Seat Reamer (inside)	8192191
Valve Seat Reamer (outside) see text	8192190
Valve Seat Reamer (outside) see text	8227358
Pressure Arm - Valve Seat Reamer	8194884
Taper Pilot Checking Fixture	8173996
Cylinder Test Valve Seat Reamer	8064804
Valve Stem Tram	8042773

D. EQUIPMENT LIST

Cylinder Head Stud Hole Cleaning Tool	8211907
Crab Nut Socket	8065580
Box Socket Wrench	8034085
Crab Nut Box Wrench Handle - 60"	8084091
Lash Adjuster Minimum Plunger Extension Gauge	8107788
Cylinder Test Valve Adapter (air test)	8070872
Crab Nut Powerench Set	8250885
"Pee" Pipe Cleaning Tool	8087086
Exhaust Valve Guide Installer	8224241
Cylinder Assembly Lift (eccentric type) (8212009 is for 567C engines only)	8212009