

## Diagnosis and Treatment of a Sticking Valve (Oct 2007)

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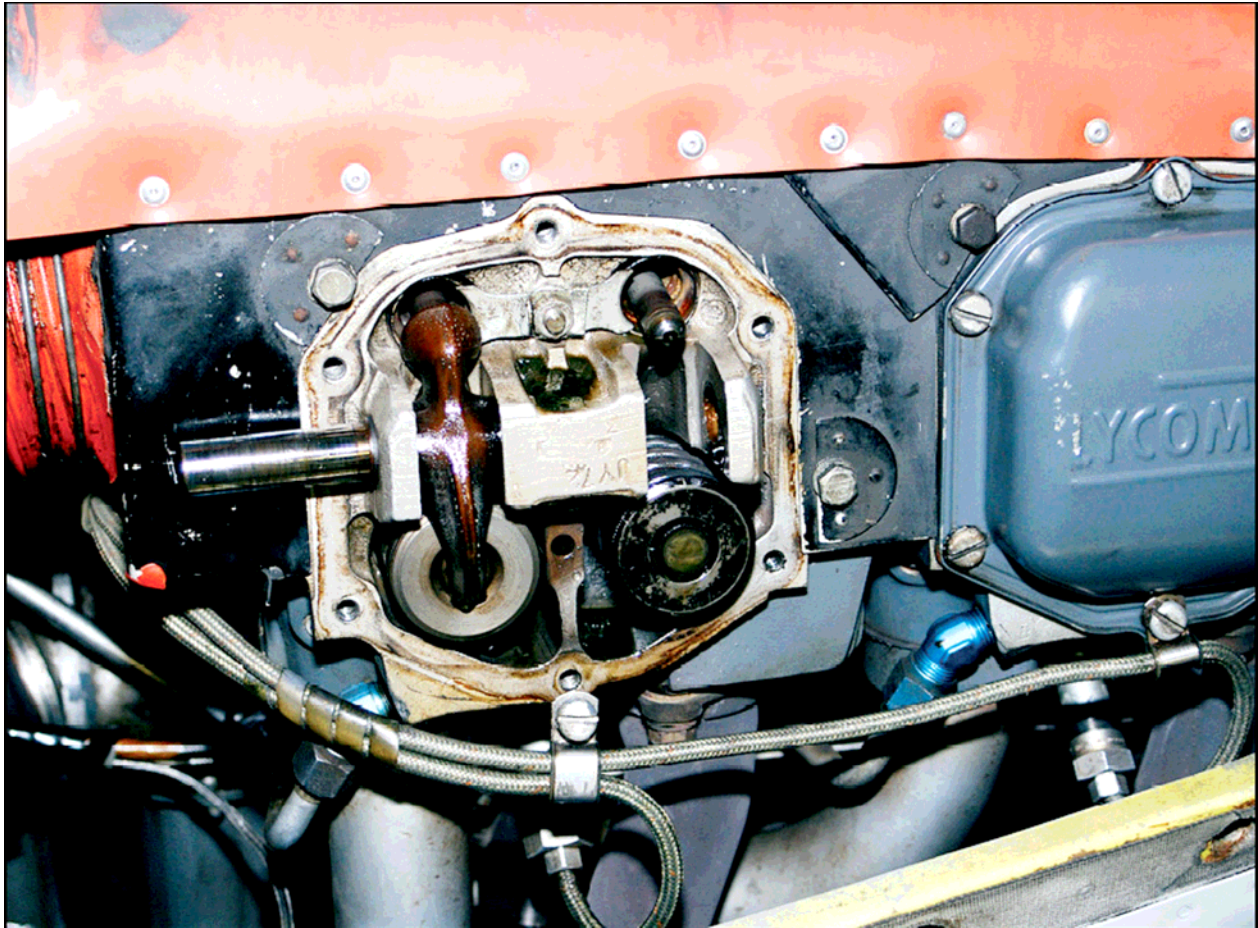
Valve sticking is a very common problem in small aircraft engines and although we have a number of things we can do to prevent this, it still happens. It is my hope that this article informs you that there is a relatively easy method to check valve stem clearances in order to identify tight valves and to repair a sticky or stuck valve stem without pulling a cylinder. The procedures I will be detailing have been briefly touched upon in the *Flyer* in the past. Experts say the likelihood of valves sticking greatly increases around 400 to 500 hours of engine time since overhaul and, not unexpectedly, Lycoming SB 388C mandates checking valve stem clearances every 400 hours in our engines, while Lycoming SI 1425A outlines procedures for preventing valve sticking. We have included both of those Lycoming publications along with this article. Although it is much more common for exhaust valves to stick, intake valves are not immune from this problem.

Let me give you two scenarios:

- **Scenario number one:** You are at your home field, and for any one of several reasons, are concerned about your valve stem clearances and discussing it with your A & P.



*Rope in cylinder*



*Rocker arm removed*

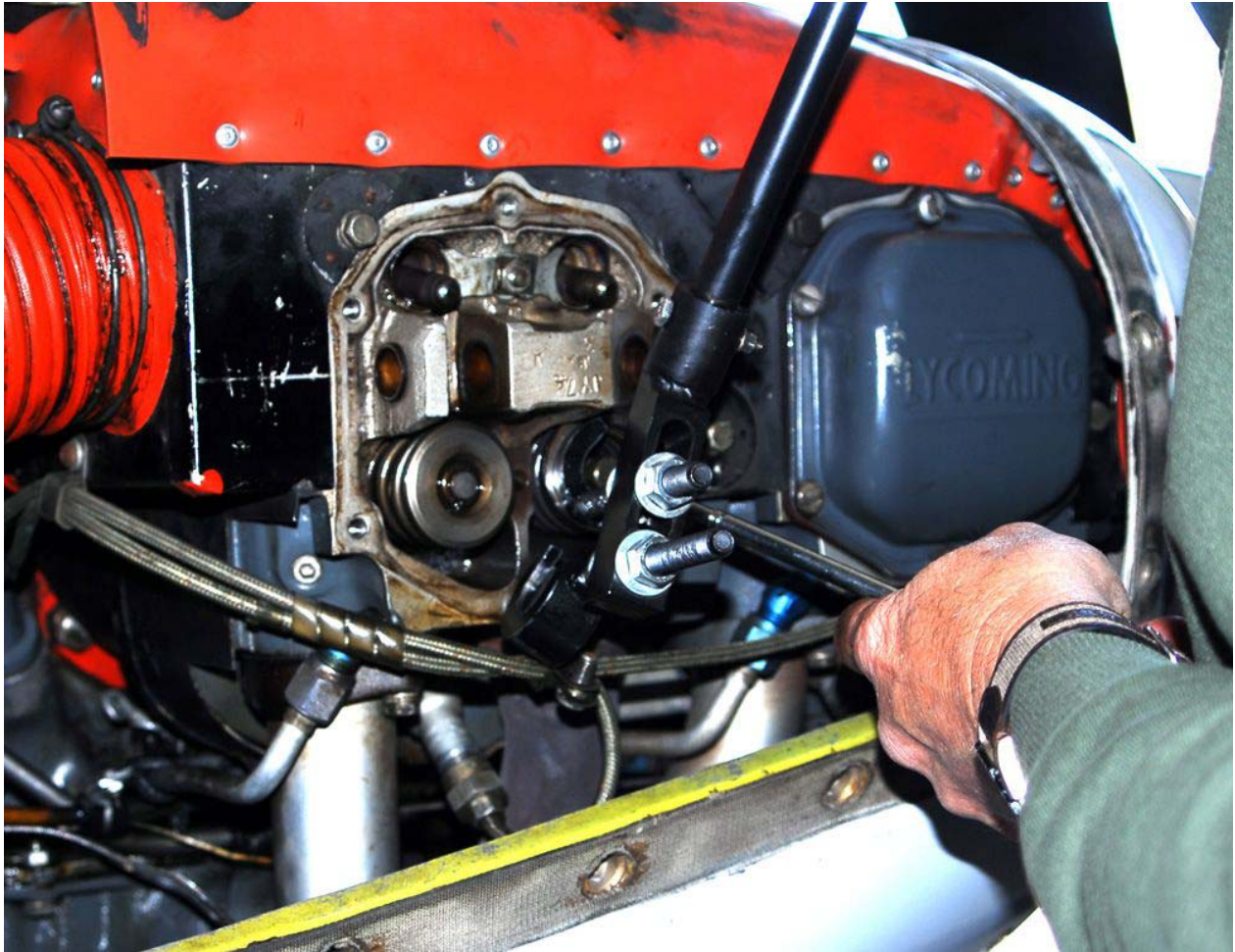
- **Scenario number two:** You are hundreds of miles from home at an airport with no mechanic, and are fairly certain you have a stuck valve. On startup, your engine ran rough on either magneto and would not smooth out. You performed the “poor man’s compression test” and after pulling the prop through all the cylinders, it felt like one of them was decidedly weak. You opened the cowling and felt a cold cylinder and, after pulling the top spark plugs and putting your finger over the holes while pulling the prop through, you confirmed the problem in one particular cylinder. You pulled the rocker box cover and saw that one of your valves was stuck in the open position. If it were stuck in the closed position, which is fortunately much less common, the problem would be significantly worse and would involve a bent push rod and tube and would mean having to pull a cylinder.

The procedures for doing this test and the repairs are basically the same for both the single engine and Twin Comanches, although my explanation and photos will be of the IO-320 engine in the Twin.

### Scenario Number One

1. Remove the top spark plug and remove the rocker box cover. Push the rocker arm shaft to one side, and the rocker arms will fall off in your hand. Make note of which rocker arm goes to the exhaust and which one goes to the intake. They are different and have different part numbers on them. You don’t need to remove the push rods unless you have a stuck valve.

2. Make sure the piston is at approximate bottom dead center. Stuff almost all of a ½-inch diameter, 10-foot rope into the cylinder. Turn the prop again until the piston is firmly pushing the rope against the valves and you can't turn the prop any longer.
3. Using a valve spring compressor tool and a pencil magnet, remove the keys which hold the exhaust valve spring seat in place. Put all this (springs, valve spring seat, keys, end caps, etc.) in the rocker box cover for safekeeping. Repeat this process with the intake valve. Note: The exhaust valve stem may have a cap on it in Lycoming engines, whereas the intake valve does not.



*Using spring compressor tool*



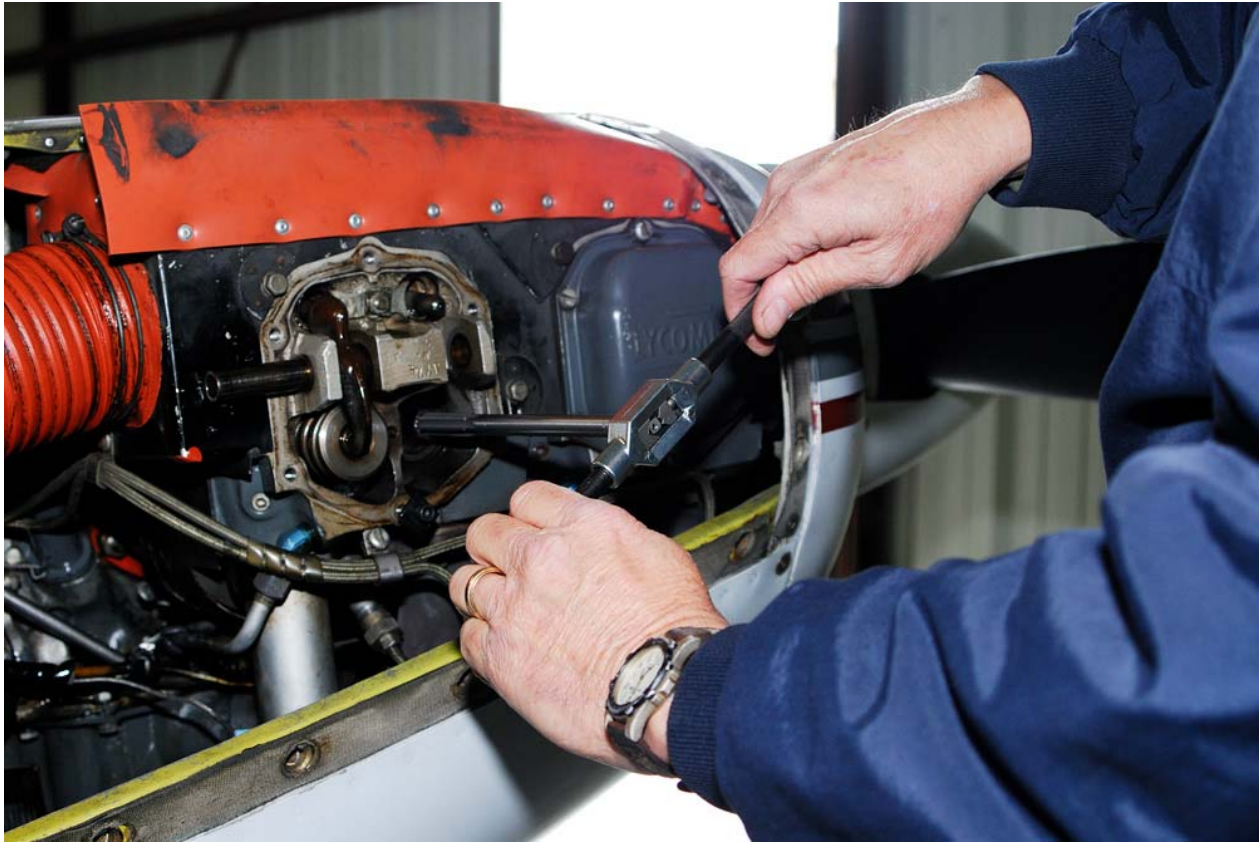
#### *Reamer in place*

4. Rotate the prop backward and remove the rope from the cylinder. Take the end of the valve between your fingers and wiggle it. There should be a small amount of “play” to the right and left and up and down. If the valve doesn’t have any play, then it is too tight. (If it really moves around, it is probably too loose and you may need a valve job, but that is a different problem.) Next grab the valve stem near the end and push it into the valve guide and move it in and out. If it moves easily, this is a good sign; it means you don’t have to ream this valve guide. Lycoming has some fancy tools to measure the clearances, but in my experience, your fingers will tell you what is too loose and what is too tight. **If neither the exhaust nor the intake valve guides need reaming, then you can skip ahead to step 8.**

If a valve stem is too tight, you must ream the valve guide. To do this, gently push the valve part way into the cylinder and grasp it with your mechanical fingers. You can visualize it easily if you insert the thin flexible light through the spark plug hole. Now push the valve all the way into the cylinder and set it down gently. CAUTION: Do not move the prop with the valve in the cylinder.

5. To ream a valve guide, you must use a valve guide reamer of the proper size. You can find these numbers in the Table of Limits Lycoming SSP 1776 which is also in the back of the Lycoming Engine Overhaul Manual. For my engines (Lycoming IO 320 B1A), the exhaust guides were reamed when new to a finished ID of a minimum of .4985 inch and a maximum of .4995 inch. The intake guides were .4040 min/.4050 max. I will leave it up to you and your IA and/or cylinder shop to determine which reamers you will need for your engine. Place the reamer in a reamer wrench. Put plenty of bearing grease on the flutes of the reamer to collect the debris. Line the reamer up with the valve guide so that you are going in very straight and ALWAYS turn the tool clockwise ONLY. Slowly turn the reamer and push it into the guide. Even when removing the reamer, you must still be turning clockwise. Turn the reamer until it

gets easy to turn and most of it has disappeared into the guide. Now slowly remove the reamer while turning it clockwise. Clean off the reamer with a clean cloth and avoid touching it with your fingers.



### *Reaming exhaust valve guide*

6. Once you have finished reaming, put a thin flexible “spaghetti” flashlight into the top spark plug hole to visualize the valve where it is lying on the side wall of the cylinder. It is at this point that you can inspect the valve head and the stem. If you see damage or unusual wear on the valve face, you can stop this process and prepare to remove the cylinder so that you can take it to a cylinder shop for a “valve job” where they will install a new valve, and probably a new seat and guide. Going through the same hole with a pair of strong mechanical fingers, or a powerful pencil magnet, grasp the end of the valve stem and bring it through the spark plug hole after you remove the light. Wrap a piece of safety wire around the valve stem to keep it from falling back into the cylinder. Grasp the valve stem and polish it clean using Scotch-Brite. Don’t use sandpaper and don’t scrape it with anything metal. Gently lower the valve back into the cylinder. At this point you can remove the bottom spark plug so that you can pour or squirt some solvent into the top plug hole and through the valve guide to wash out any carbon or metal created by your reaming.
7. Using the thin flexible light in the cylinder for visualization, grasp the valve stem in the middle with the mechanical fingers. Introduce the pencil magnet through the valve guide into the cylinder. (Unless you have three hands, you can turn the light loose.) Touch the magnet to the end of the valve and pull it toward the valve guide opening. Remove the mechanical fingers gently and introduce your wire hook to support the valve to a position level with the

valve guide. Often you can look through the valve guide around the pencil magnet and see the end of the valve stem lining up. Once you can definitely feel the valve advancing into the guide, you may encourage it by pushing on the other end of the valve with your hook. This takes a bit of practice, but soon you will be an expert. Push the valve about halfway back through the guide and squirt some oil into the guide and, using the magnet, work the valve in and out to lubricate the guide.

8. Put the rope back into the cylinder and push it up against the valve to hold it in place while you reattach the valve spring compressor tool and put the springs, the spring seat, and the keys back in place. I can do this by myself, but it is often easier if somebody can hold the prop (and the rope) against the valve while you are using the valve spring tool. Be careful not to pinch your fingers, as those springs are very strong if the tool slips off while you are compressing them.
9. Replace the valve stem cap (if the valve has one) and the rocker arms and rocker arm shaft. Sometimes the shaft will go in easily by tapping it lightly with your hammer and sometimes you will need the help of the valve spring compressor tool to relieve the tension on the springs and allow the rocker arms in place. Be careful how much you press on the valve spring tool because you can unseat the keys. After putting on the rocker box cover and inserting the spark plugs, you are finished with that cylinder. Once you get good at it, you can do a cylinder about every thirty minutes.



*Valve stem in spark plug hole*



*Supporting valve*

### **Scenario Number Two**

1. If you have an obviously stuck valve, then you are going to do this procedure a little differently than in scenario number one where you are just checking valve stem clearances with an eye to reaming guides, if necessary. A stuck (open) valve is going to require that you push it back in its seat so that you can remove the keys and springs. Sometimes this can take a bit of effort. Don't hesitate to use some Liquid Wrench, or similar solution, on the valve stem. Essentially you will have already removed the rocker box cover and spark plug in order to have diagnosed the stuck valve. Now you must use the rope to "unstick" the valve. Refer to steps 1 through 5 in scenario number one and using the "rope trick," push hard on the prop. When the valve breaks loose, you will usually hear a loud "clank." This accomplished, you can remove the keys, springs, etc. and then you will have to reverse course and push the valve into the cylinder so that you can ream the guide and polish the stem. Remember that the valve stem is still very tight and is probably still stuck, but in a different position. It may take some hammering to move the valve if it tightly stuck. You must use either an aluminum dowel or a brass punch put against the valve stem end. You should NEVER hit the valve directly with a hammer.
2. With the valve in the cylinder, you can proceed to step 6 in scenario number one, ream the valve guide, polish the valve stem with Scotch- Brite, and finish the rest of the procedures through step 9.
3. At your earliest convenience, you should check the valve stem clearances on the remainder of your cylinders.

I have made a list of the absolute minimum tools needed to do both a diagnostic check and to ream a valve:

1. Valve spring compressor
2. Valve guide reamers (one for the exhaust and one for the intake guides)
3. Reamer wrench
4. 10 feet of ½ inch diameter mountain climbing type rope
5. Small ball peen hammer
6. Wire hook for supporting valve in cylinder
7. Mechanical fingers (strong Snap-on two prong flexible type)
8. Strong pencil type magnet
9. Flexible flashlight (long spaghetti type to go in cylinder)
10. Spark plug socket and 3/8 inch socket wrench, extension, and ¾ inch open end wrench for removing spark plug
11. Small can of wheel bearing grease
12. Piece of Scotch-Brite for polishing valve stem
13. Brass punch or aluminum dowel

*Technical Editor's Note: This procedure is not authorized by the FARs, under the pilot authorized maintenance. With the proper tools, the pilot may do this only under the direct supervision of an A & P mechanic.*

**Note that the Lycoming Publications mentioned in this article are attached below for your convenience. Please scroll down.**



# MANDATORY

# SERVICE BULLETIN

DATE: November 22, 2004 Service Bulletin No. 388C  
(Supersedes Service Bulletin No. 388B  
and Supplement No. 1 to Service Bulletin No. 388B)

SUBJECT: Procedure to Determine Exhaust Valve and Guide Condition

PART 1 – Use of P/N ST-71 and P/N ST-310 Fixtures

PART 2 – A. Modification to P/N ST-71 and P/N ST-310 Fixtures to Allow  
Use of a Dial Indicator  
B. Optional Inspection Procedure Using a “Go/No-Go” Gage.

PART 3 – Example of Alternate Tools That Can Be Locally Manufactured

TIME OF COMPLIANCE: Helicopter Engines – 300 hour intervals or earlier if valve sticking suspected.  
All Other Engines – 400 hour intervals or earlier if valve sticking suspected  
until exhaust valve guides are replaced with guides made of improved  
material. (Refer to latest revision of Service Instruction No. 1485.)

To insure positive and trouble free valve train operation, the inspection procedure described in this publication should be accomplished as recommended in the Time of Compliance section of this publication. Failure to comply with the provisions of this publication could result in engine failure due to excessive carbon build up between the valve guide and valve stem resulting in sticking valves or; broken exhaust valves which result from excessive wear (bell-mouthing) of the exhaust valve guide.

This publication describes the approved procedures for checking exhaust valve guide condition.

## **PART 1 – USE OF P/N ST-71 AND P/N ST-310 FIXTURES TO DETERMINE VALVE GUIDE WEAR OR CARBON BUILD UP**

The illustrations used in PART 1 are primarily of a parallel valve cylinder and the P/N ST-71 fixture which uses one adjustable self-locking screw to measure valve stem movement on all parallel valve cylinders. The procedure for inspecting angle valve cylinders with the P/N ST-310 fixture is basically the same. Refer to Figure 2 for fixture installation. Valve guide wear (bell-mouthing) occurs on the inside diameter of the valve guide in a straight line with the center line of the rocker arm. Valve stem movement must be measured by moving the valve stem along this line. The P/N ST-310 fixture incorporates two adjustable self-locking screws located at different angles to accomplish this on two differently designed angle valve cylinder head configurations. Refer to Figure 2.

1. All Engines: Remove the rocker box cover and gasket from the cylinder head.
2. All Engines except "76 Series": Push out the valve rocker shaft and remove the exhaust rocker arm and rotator cap.
3. "76 Series" Engines: Remove valve rocker arm retaining nut, fulcrum, rocker arm, spacer washers and rotator cap.

### CAUTION

PHYSICALLY SEPARATE AND IDENTIFY BY CYLINDER EACH VALVE TRAIN PART AS IT IS REMOVED, SO THAT EACH PART MAY BE REASSEMBLED IN EXACTLY THE SAME LOCATION FROM WHICH IT WAS REMOVED.

4. All Engines: Remove push rods, shroud tubes and hydraulic tappet assemblies. Disassemble tappet and clean as described in the applicable overhaul manual.
5. All Engines: Wipe the oil from the top surface of the spring retainer by wiping with a cloth dampened with solvent. This will increase the friction between the valve spring retainer and pressure plate and should eliminate any slippage when the valve stem and spring are moved into position for a measurement.
6. Engines with Sodium Cooled Exhaust Valves: Install the gage adapter over the end of the valve stem and tighten it securely. If the adapter can be rocked on the valve stem by hand, it is not correctly secured. The valve retainer keys do not need to be removed from this type valve stem. Refer to Figure 1.

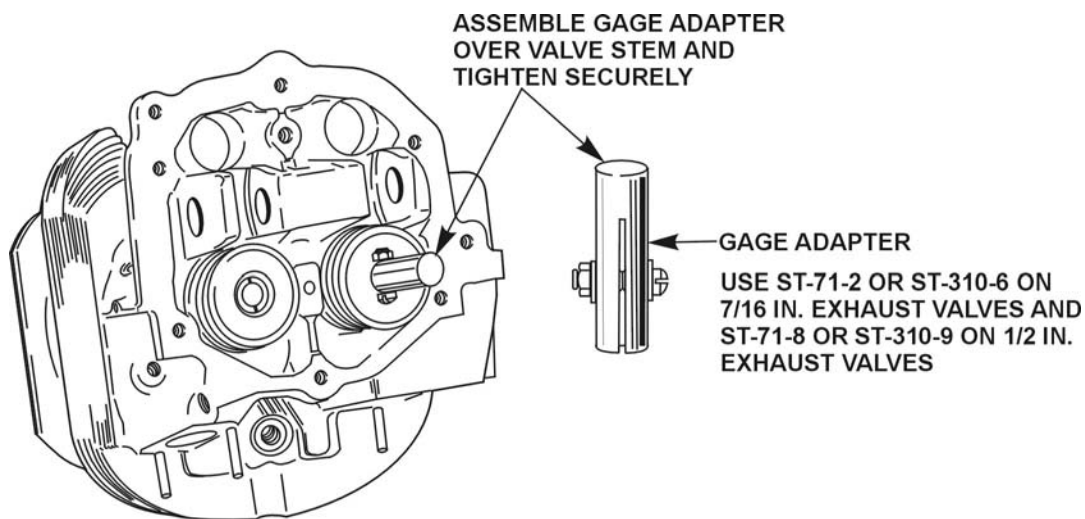
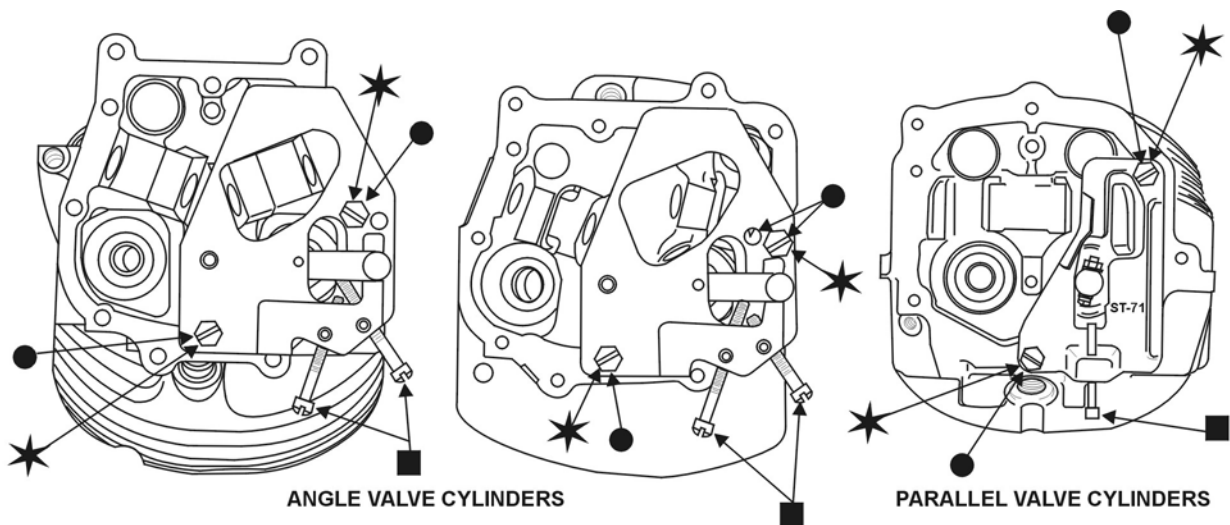


Figure 1. Gage Adapter Assembled on Exhaust Valve Stem

- 6A. Engines with Solid Stem Nonrotator Type Exhaust Valves: The tapered valve retention keys will not allow installation of the split gage adapter and must be removed. Proceed with installation of the P/N ST-71 or P/N ST-310 fixtures until the valve spring is compressed and the tapered keys can be removed. See step 8 for removal of tapered keys.
7. All Engines: Insure the adjustable self-locking set screws on the P/N ST-71 or P/N ST-310 fixtures are backed out (counterclockwise) to avoid interference with the adapter post attached to the valve stem. See Figure 2.



★ TIGHTEN CAP SCREWS EVENLY; ON SOME CYLINDERS CASTING MAY INTERFERE WITH LOWER CAP SCREW, PLACE WASHER UNDER HEAD IF THIS HAPPENS.

■ BEFORE INSTALLING FIXTURE, BACK THIS SCREW OUT TO AVOID INTERFERENCE WITH ADAPTER INSTALLED ON VALVE STEM.

● SOMETIMES INTERFERENCE IS ENCOUNTERED ALIGNING THE FIXTURE BOLT HOLES WITH ROCKER BOX HOLES, THESE 9/32 IN. DIA. HOLES CAN BE ENLARGED TO 3/8 IN. DIA.

Figure 2. Compressor Plate Installed on Cylinder – Angle and Parallel Valve Cylinders

NOTE

Older P/N ST-71 fixtures may require a modification before being used on “76 series” cylinder heads. Refer to Figure 3 for modification dimensions and instructions. Current production P/N ST-71 fixtures include this modification.

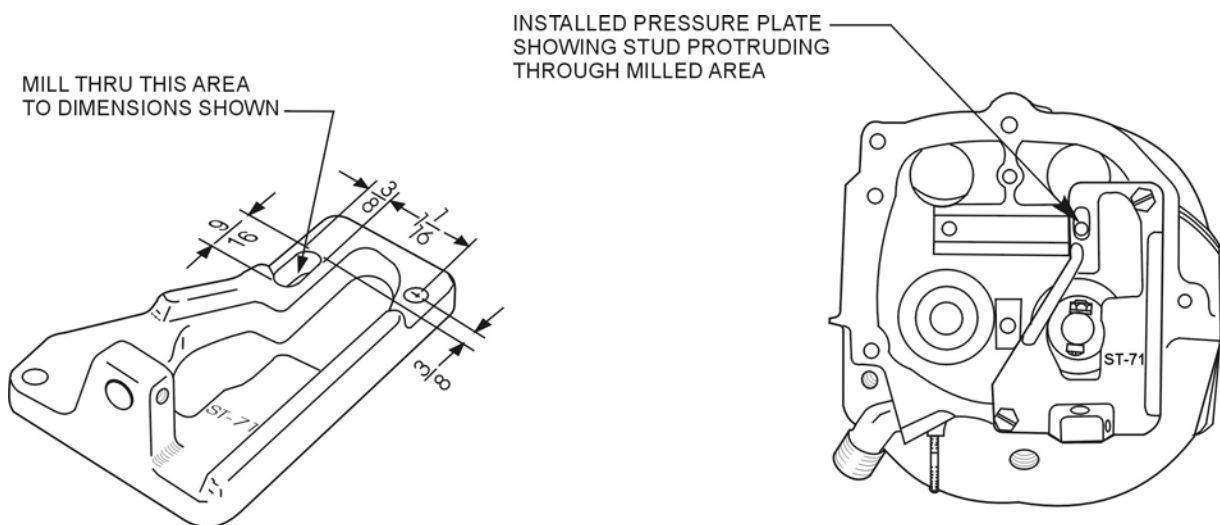


Figure 3. Details for Modifying P/N ST-71 Compressor Plate for use on “76 Series” Engines

8. Engines Equipped with Solid Stem Exhaust Valves: Remove the tapered valve retaining keys by moving the piston of the cylinder being inspected to near its top end of travel. This will eliminate any chance of the valve sliding into the cylinder after the tapered keys are removed. Fabricate a small hooked tool as shown in Figure 4 and insert it between the valve keys engaging the hook of the tool with the underside of the valve tip as shown in Figure 4. Tap on the fixture with a plastic headed hammer while exerting a steady pull on the valve stem, with the hooked tool, until the valve keys release.

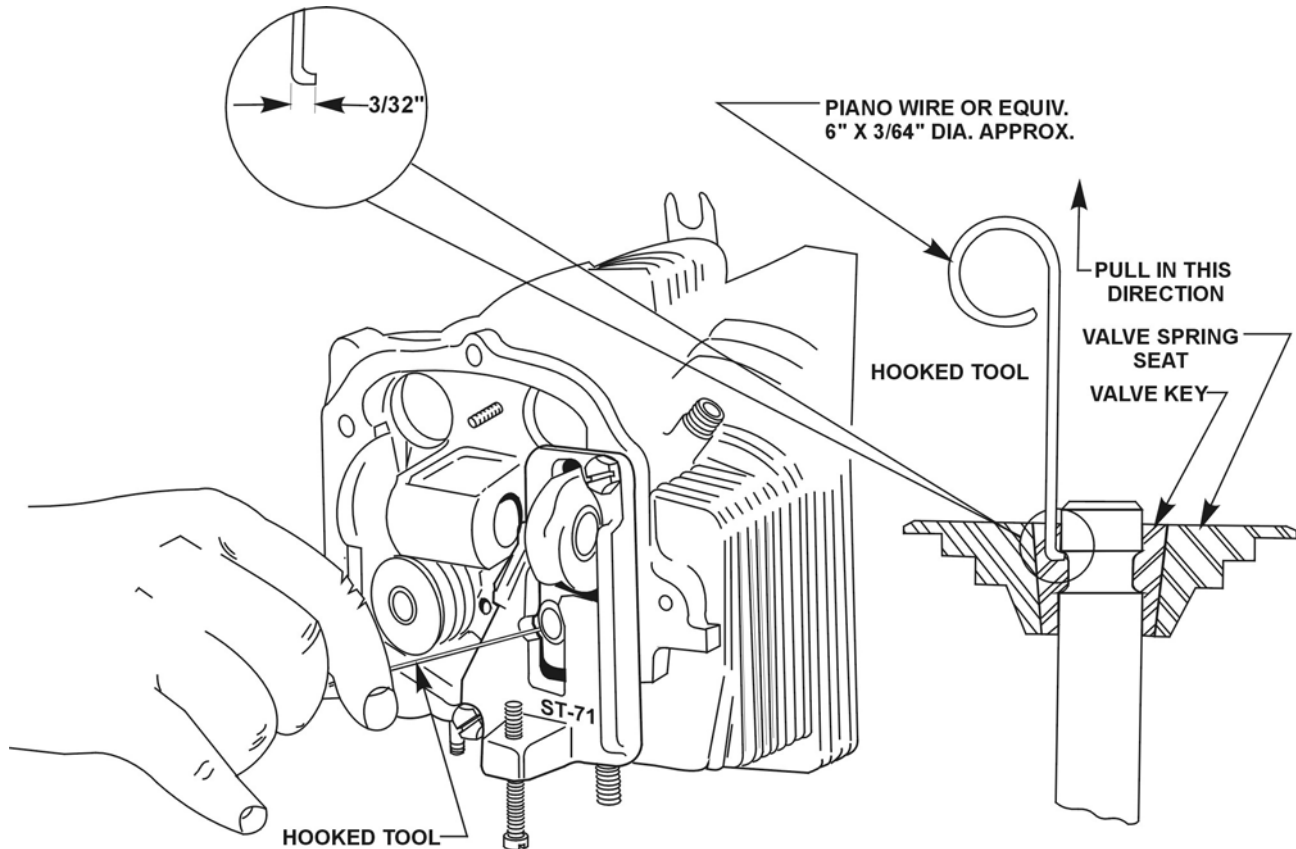


Figure 4. Method of Using Hooked Wire Tool to Pull Valve Into Position for Removal of Tapered Keys

- 8A. If the valve keys do not readily release, remove the pressure plate and using air pressure or 3/8" rope, as described in the latest revision of Service Instruction No. 1425, to hold the valve in the closed position, reinstall the fixture, tapping on it as it is drawn on the cylinder head.
- 8B. Once the valve keys are loosened and removed install the split gage adapter on the end of the valve stem. Release the air pressure or remove the rope and move the piston to near the bottom of its travel.

9. All Engines: Push the assembled valve stem and gage adapter in against the upper spring retainer as far as it will go. This will move the valve off of the seat and eliminate any interference when the valve stem is moved.

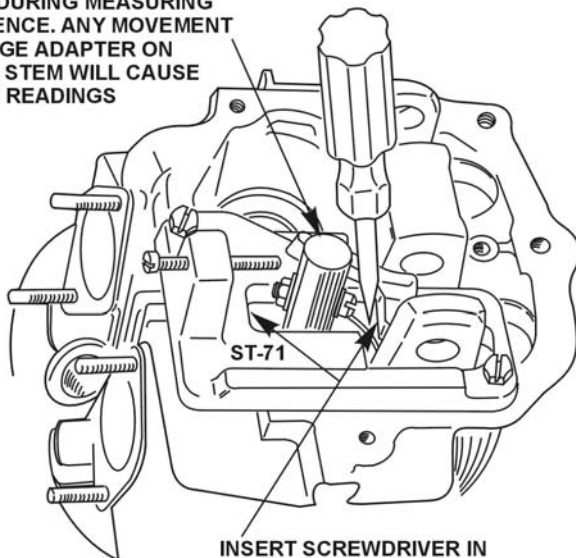
#### NOTE

In the following steps 10 and 11, a screwdriver with a 3/16 inch blade x 4 inch long shank is sufficient to move the valve both ways. Excessive pressure applied to the screwdriver will cause erratic measurements.

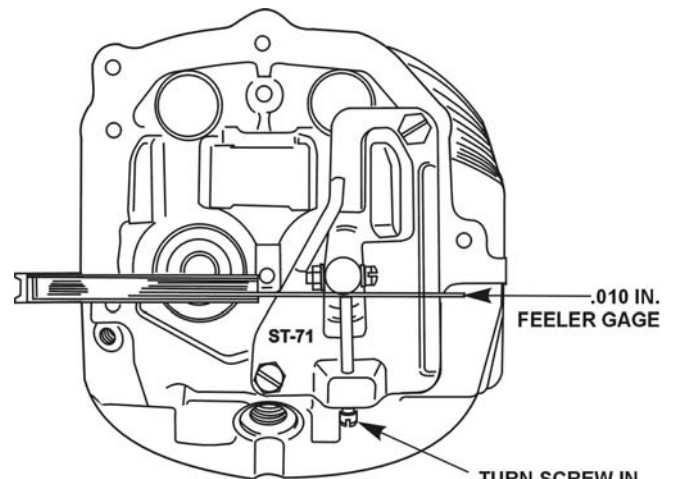
10. All Engines: Insert the blade of a screwdriver in the area between the exhaust valve spring and fixture as shown in Figure 5; and using the pressure plate as a fulcrum, press the blade of the screwdriver against the exhaust valve spring, forcing it toward the self-locking set screw as far as it will go. Relax the pressure on the screwdriver. Friction between the fixture and the outer spring retainer should keep the valve stem from returning to its normal position. If the valve stem does have a tendency to move, maintain a slight pressure on the spring with the screwdriver.

#### CAUTION

DO NOT BUMP ADAPTER POST DURING MEASURING SEQUENCE. ANY MOVEMENT OF GAGE ADAPTER ON VALVE STEM WILL CAUSE FALSE READINGS



INSERT SCREWDRIVER IN THESE AREAS AND USE THESE TWO SURFACES AS FULCRUMS WHEN PRYING AGAINST VALVE SPRING RETAINER



TURN SCREW IN UNTIL IT TOUCHES FEELER GAGE. DO NOT TURN FAR ENOUGH TO MOVE ADAPTER

Figure 5. View Showing Screwdriver in Position to Move Exhaust Valve Stem

Figure 6. Feeler Gage in Position Between Set Screw and Adapter Post

11. All Engines: Using a .010 inch feeler gage between the set screw and gage adapter as shown in Figure 6, turn the set screw toward the gage until a slight drag is obtained on the feeler gage. Do not turn the screw far enough to move the adapter and valve stem.
12. All Engines: Using the screwdriver, push the valve spring as far away from the set screw as it will go, and using a combination of feeler gage blades determine the gap between the tip of the set screw and the gage adapter. Refer to the following Table of acceptable limits.

Valve Guide I.D.	Recommended Allowable Valve Stem Movement	
	Minimum Clearance	Maximum Clearance
.4040/.4050	.010	.030
.4360/.4370	.010	.030
.4370/.4380	.010	.030
.4375/.4385	.010	.030
.4985/.4995	.015	.030
.4995/.5005	.015	.030
.5000/.5010	.015	.035

- 12A. The measurement obtained in step 12 includes the .010 inch used in step 11 as a starting dimension. Determine the actual distance the exhaust valve stem has moved in the following manner.

EXAMPLE

.019 = Total thickness of gage required to measure valve movement.

.010 = Thickness of gage used to establish a starting point.

.009 = Actual amount the valve stem has moved: This indicates insufficient clearance between the valve stem and valve guide which can be corrected by reaming the valve guide I.D. to remove a build up of carbon deposits. (Refer to the latest revision of Service Instruction No. 1425 for valve guide reaming.) Using the same procedure, if the dimension obtained in step 12 had been .038 inch, the actual amount the valve stem moved would be .028 inch indicating that wear on the inside diameter of the valve guide is below the maximum limit and the valve guide is suitable for further service. If valve stem movement is in excess of the maximum limit listed in the table, the valve and guide must be replaced.

13. All Engines: Rotate the piston to near its top end of travel again and remove the gage adapter from the valve stem. Install any valve keys that were removed in step 8 or 8A and insure they are properly seated on the valve stem.
14. All Engines: Remove the fixture from the cylinder by backing out the capscrews alternately to release pressure on valve springs evenly.
15. Engines Equipped with Solid Stem Exhaust Valves: The stem of an exhaust valve, installed in an engine that is operated on highly leaded fuels, can become damaged by erosion or "necking". In addition to the preceding valve stem and guide clearance check, the exhaust valve stems must be examined for this condition. Remove the exhaust manifold and visually inspect the exposed area of the valve stem, between the exhaust valve seat and guide. Any evidence of erosion is reason to replace the exhaust valve and guide.
16. All Engines: Complete the preceding checks on all cylinders, enter the inspection results and any corrective action accomplished in the engine logbook.
17. All Engines Except "76 Series": Using new seals and gaskets, install the hydraulic tappet assemblies, shroud tubes, push rods valve rotator caps (if required), rocker arms and shafts, and check dry tappet clearance. If all parts are returned to their original position, dry tappet clearance will not change. Refer to applicable overhaul manual for dry tappet clearance check.
18. "76 Series" Engines: Using new seals and gaskets, install the hydraulic tappet assembly, shroud tube, push rod, rocker arm fulcrum and spacers, valve rotator cap, and rocker arm. Check dry tappet clearance as described in the applicable overhaul manual. If all parts are returned to their original position and are aligned properly, the dry tappet clearance will not change.

## PART 2 – A. MODIFICATION OF P/N ST-71 AND P/N ST-310 FIXTURES TO ALLOW USE OF A DIAL INDICATOR

The procedure described in the preceding PART 1, utilizes a feeler gage to measure the distance the exhaust valve stem has moved. Although this method is satisfactory, it has been found that it is much easier to measure movement of the valve stem if a dial indicator is used instead of the feeler gage. Refer to Figure 7 for modification of a P/N ST-71 fixture and to Figure 8 for modification of a P/N ST-310 fixture.

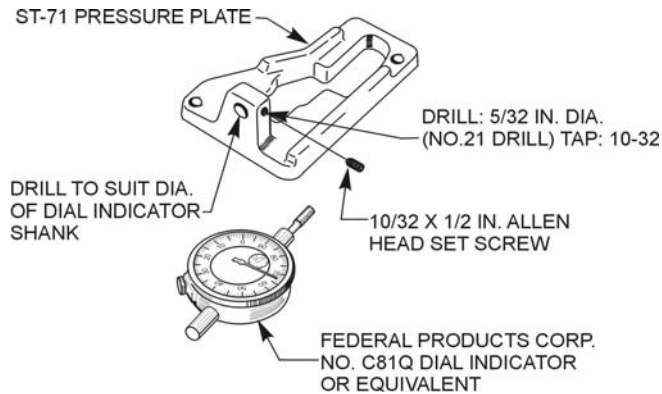


Figure 7. Details for Modifying Tool  
P/N ST-71 for Use with a Dial Indicator  
(Parallel Valve Cylinders)

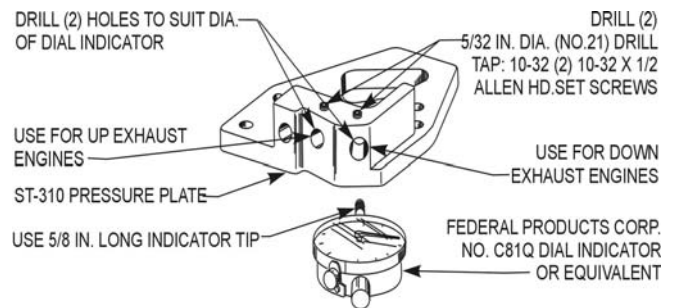
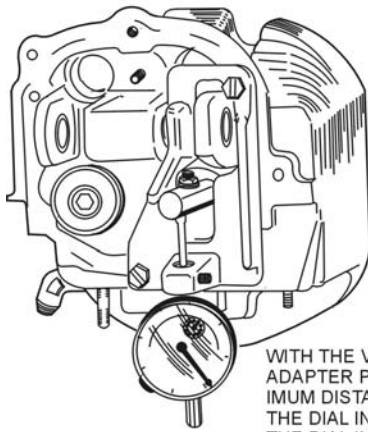


Figure 8. Details for Modifying Tool  
P/N ST-310 for Use with a Dial Indicator  
(Angle Valve Cylinders)

### NOTE

The dial indicator shown in Figure 7, 8, 9 and 10 is Model C81Q manufactured by Federal Products Corp., Providence RI. If a comparable dial indicator is available for use, the adjustment screw holes in the fixtures can be drilled to accommodate the indicator.

1. Install the adapter post and fixture in the same manner as described in PART 1, and push the adapter post and valve stem in against the valve spring retainer as far as it will go.
2. Insert the blade of a screwdriver in the area between the valve spring and fixture and push the valve and adapter post away from the dial indicator as shown in Figure 9.
3. Move the dial indicator toward the adapter post until the indicator is preloaded approximately .010 inch, and lock it in place with the set screw.
4. Adjust the dial of the indicator to read "0" (zero) as shown in Figure 9.
5. Insert the screwdriver between the fixture and valve spring on the opposite side and push the valve spring toward the dial indicator as shown in Figure 10. Relax the screwdriver and record the reading on the dial indicator. The measurement should be within the limits specified in the table with PART 1. If not, perform the required repair procedure as described in PART 1.



WITH THE VALVE STEM AND ADAPTER PUSHED TO ITS MAXIMUM DISTANCE AWAY FROM THE DIAL INDICATOR, PRELOAD THE DIAL INDICATOR TO .010 IN. APPROX. AND LOCK IN PLACE WITH THE SET SCREW. ADJUST DIAL INDICATOR TO 0.

Figure 9. Dial Indicator in Position to Check Valve Guide Clearance

AFTER THE DIAL INDICATOR HAS BEEN PRELOADED USE A SCREWDRIVER TO MOVE VALVE STEM TOWARD DIAL INDICATOR. RELAX PRESSURE ON SCREWDRIVER AND RECORD INDICATOR READING. INDICATOR READING SHOULD BE WITHIN LIMITS SHOWN IN TABLE.

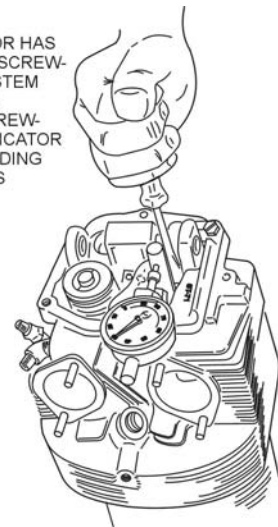


Figure 10. Pushing Valve Stem and Adapter Post Toward Dial Indicator to Establish Valve Guide Condition

### PART 2 – B. OPTIONAL INSPECTION PROCEDURE USING A “GO/NO-GO” GAGE.

1. Remove all spark plugs and exhaust manifold. If compressed air is to be used to hold valve, one spark plug should not be removed.
2. Remove rocker box cover and gasket from cylinder.
3. On all engines except the “76 series”, push out rocker shaft to remove exhaust rocker and rotator cap. On “76 series” engines, remove rocker box covers, rocker arm retaining nuts, rocker arm fulcrums, spacer washers, and rocker arms.

#### CAUTION

PHYSICALLY SEPARATE AND IDENTIFY BY CYLINDER AND VALVE LOCATION, THE VALVE TRAIN COMPONENTS AS THEY ARE DISASSEMBLED, SO THAT EACH PART MAY BE REINSTALLED IN EXACTLY THE SAME LOCATION FROM WHICH IT WAS REMOVED. PAY PARTICULAR ATTENTION TO VALVE STEM KEYS. THESE TEND TO WEAR IN UNIFORM DISTINCTIVE PATTERNS, AND SHOULD BE RETURNED TO THE SAME POSITION AS THEY WERE REMOVED.

4. Position crankshaft just after bottom center on the intake stroke.
5. Insert about 8 feet of 3/8 inch nylon rope through the spark plug hole; then turn the crankshaft until the piston moves the rope snugly against the exhaust valve.
  - a. An alternate technique for holding the valve in position is with air pressure using shop air and a compression check fitting.



CAUTION

THE PISTON IS HELD AT BOTTOM DEAD CENTER BY FIRMLY HOLDING THE PROPELLER TO PREVENT THE ENGINE FROM TURNING WHEN AIR PRESSURE IS APPLIED THROUGH THE DIFFERENTIAL COMPRESSION DEVICE TO THE COMBUSTION CHAMBER. USE GLOVES OR RAGS TO PROTECT THE HANDS WHILE HOLDING THE PROPELLER BLADE. ALSO, BEFORE ATTACHING THE COMPRESSION TESTER, CHECK THE AIR SUPPLY REGULATOR TO MAKE SURE THE AIR PRESSURE TO THE CYLINDER IS NOT EXCESSIVE. AIR PRESSURE IN THE CYLINDER CAN CAUSE THE PROPELLER TO TURN. KEEP CLEAR OF THE PATH OF THE BLADES.

6. Compress the exhaust valve spring and remove valve keys. (The rope or air pressure inserted in the combustion chamber in the preceding step provides a base to support the valve in the event the keys tend to stick.)
7. Remove the nylon rope or bleed off the air pressure and insert light through the upper spark plug hole. Then start pushing the valve from its guide. Before the valve stem is free from the guide, secure it from falling into the cylinder with mechanical pickup fingers, working through the spark plug holes and/or exhaust ports as shown in Figure 11.



Figure 11. View Through Exhaust Port Showing Mechanical Fingers Holding Valve Stem

8. Move the valve (secured by the mechanical fingers) completely out of the guide and position it away from the guide to avoid interference when using GO/NO-GO gage made in accordance with following table.

Nominal Exhaust Valve Guide ID	GO Gage	NO-GO Gage
.4045	.4040	*
.4375	.4370	*
.4380	.4375	*
.4990	.4985	*
.5000	.4995	*
.5005	.5000	*

\* - This gage to be sized in accordance with Table of Limits, SSP-1776, for hours on engine.

9. With the appropriate gage (GO/NO-GO), check the valve guide for either wear or carbon build up.
  - a. The NO-GO gage must not enter. If it does, the valve guide has had too much wear and must be replaced in accordance with the overhaul manual procedure.
  - b. The GO gage side must enter totally inside the valve guide; if such is not the case or if there is a friction point, ream the guide in accordance with latest revision of Service Instruction No. 1425.
10. Using a magnetic pencil and flexible mechanical fingers, position tip of valve in guide and very carefully work the valve back into its guide. Extreme caution should be exercised during this operation, making sure the valve is placed within the guide and not cocked, as damage could be done to the guide or valve.

#### CAUTION

NEVER USE THE PISTON TO PUSH THE VALVE THROUGH THE GUIDE.

11. Install valve springs and valve spring seats in same position as removed. Compress valve spring and install keys in their respective position. In some cases it has been found that when the valve spring is compressed, the valve slides down the guide, making it impossible to install the keys. If this condition exists, reinsert the nylon rope (steps 4. and 5.) to hold valve firmly on its seat while installing valve keys.
12. Remove hydraulic lifter and clean free of all oil, inspect for any malfunction. Clean ID of cam follower. Reinstall hydraulic lifter.
13. Install push rod, then rotating cap, rocker arm and shaft.
14. Check dry tappet clearance in accordance with the Service Table of Limits in the appropriate Lycoming Overhaul Manual.
15. Install rocker box cover and new gasket.

#### CAUTION

DURING REASSEMBLY, VALVE TRAIN COMPONENTS MUST BE REPLACED IN THEIR ORIGINAL LOCATION. ON "76 SERIES" ENGINES, GIVE SPECIAL ATTENTION DURING REASSEMBLY TO ALIGNMENT OF ROCKER ARMS, SPACERS AND ROCKER ARM FULCRUMS WITH THE ROCKER ARM RETAINING STUD. ALL PARTS MUST BE IN PROPER ALIGNMENT TO ASSURE CORRECT DRY TAPPET CLEARANCE. MISALIGNMENT COULD RESULT IN ENGINE DAMAGE.

16. Make sure all flashlights, ropes, etc. have been removed from within the cylinder before proceeding to the next cylinder.
17. Install spark plugs. (Install exhaust manifold after all exhaust valve guides are cleaned.)
18. Make appropriate logbook entry.

**PART 3 - EXAMPLE OF ALTERNATE TOOLS THAT CAN BE LOCALLY MANUFACTURED**

A tool may be fabricated to measure wobble. Tool must measure parallel to the rocker at the following height above the rocker box cover surface of the cylinder (machined O.D. surface of rocker box cover surface).

Angle Valve Clearance –  $0.750 \pm .015$

Parallel Valve Clearance –  $1.190 \pm .015$

There must be no tool deflection when valve is pushed against the dial indicator to determine the wobble. (Refer to Figure 10.)

Figures 12, 14 and 16 are detailed drawings of tools that can be made locally by any machine shop. These tools are not available for purchase.

The tool shown in Figure 12 mounts on the valve rocker shaft, of all engines except “76 series” engines, and is secured in place with set screws that lock against a valve rocker shaft bearing boss. 5/8 inch I.D. rocker arm spacer washers are used to hold the fixture against the boss. See Figure 13. Mounting this type fixture on the valve rocker shaft insure that the dial indicator is correctly aligned to measure valve stem movement. Figure 14 is an example of a tool that can be made for use on “76 series” cylinder heads. The fixture is attached to the cylinder head on the 5/16-18 stud that secures the rocker arm and related components. Use a standard 5/16-18 nut to secure the fixture on the stud. The 17/32 in. wide x 1/8 in. deep slot that holds the rocker arm components in alignment also aligns the fixture. See Figure 15. An adapter post is also required to extend the length of the valve stem. The post can be made from any suitable size, smooth finish, straight round stock. Refer to Figure 16 for dimensions and Figure 13 and 15 for installation.

To insure an accurate measurement when the inspection procedure is accomplished with either of these tools, or similarly made tools, the exhaust valve springs must be removed before the adapter post is installed on the tip of the valve stem. To insure that the valve seat does not interfere with the valve as it is moved from one position to the other, the valve must be pushed approximately 1/2 inch into the cylinder. The valve stem can now be pushed in either direction with fingertip pressure.

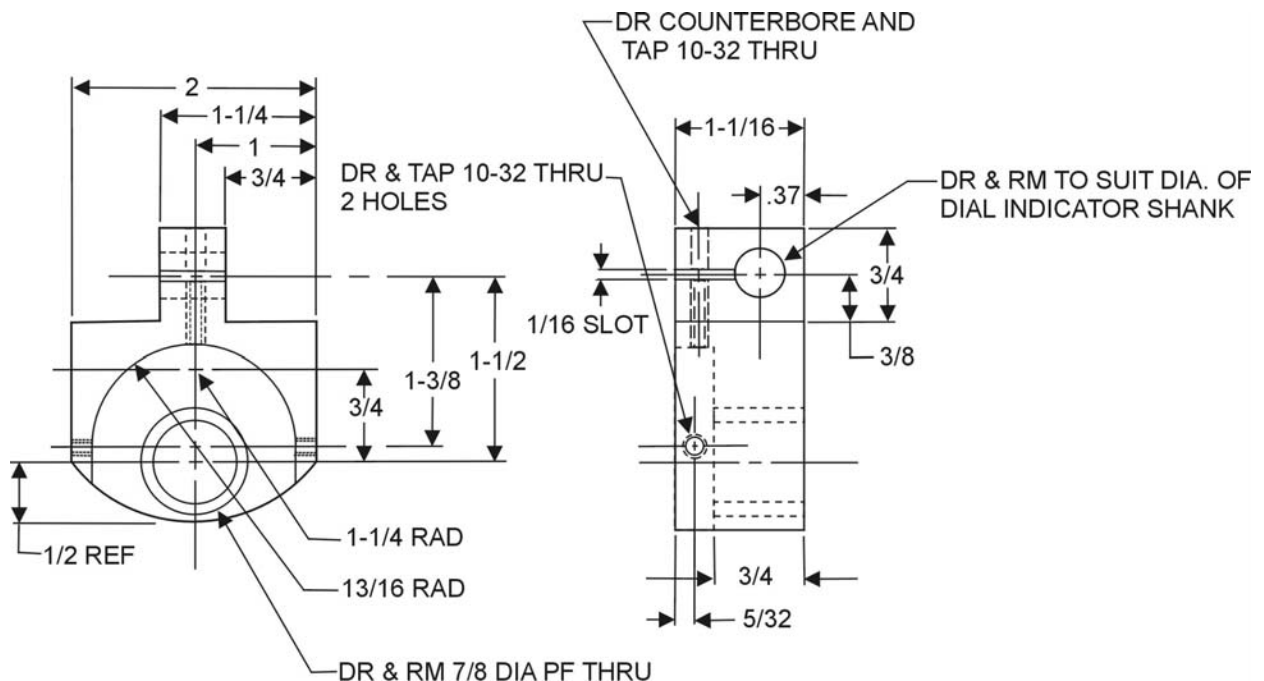


Figure 12. Detail of Tool for Parallel and Angle Valve Cylinders with Rocker Arm Shaft

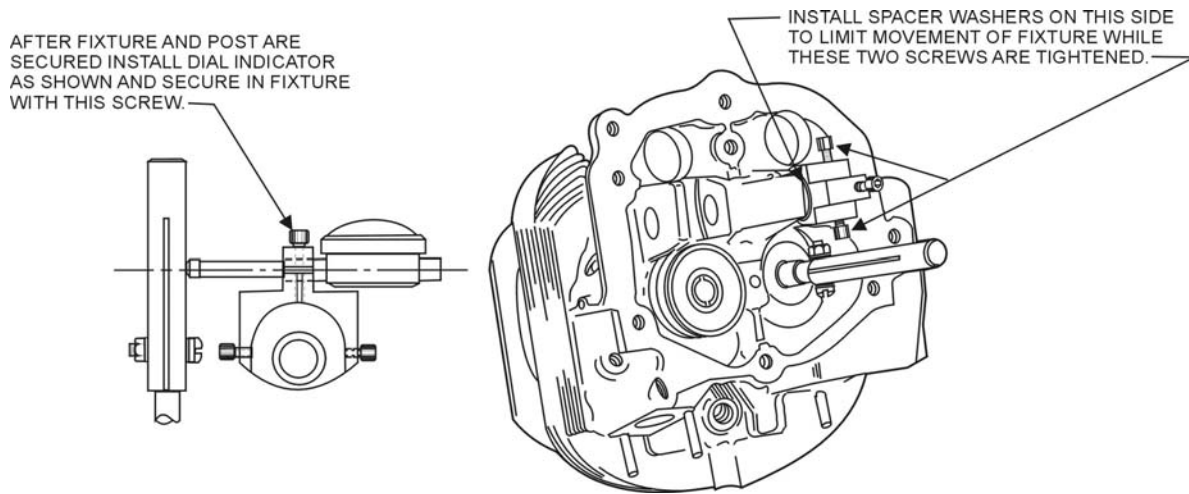


Figure 13. Tool Mounted on Rocker Arm Shaft – Parallel Valve Cylinder

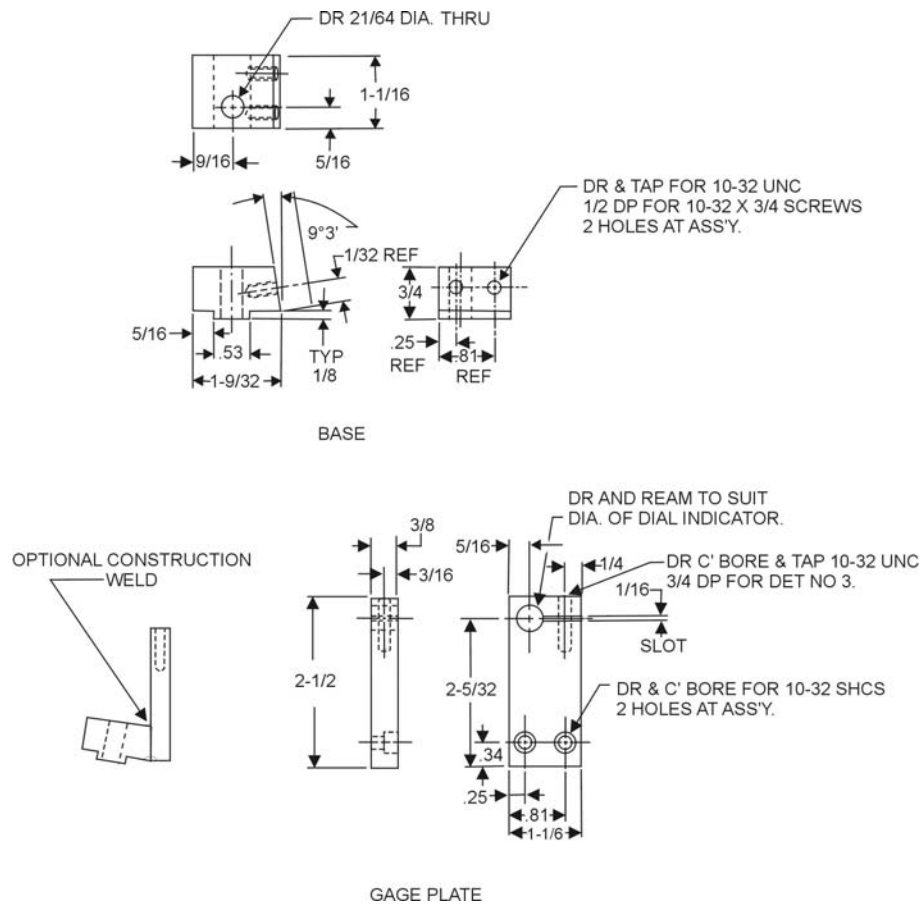


Figure 14. Detail of Tool for "76 Series" Cylinders

The procedure for measuring valve stem movement is the same as described in PART 2, except that a slight fingertip pressure must remain against the valve stem as the dial indicator is preloaded, and again when the valve stem and adapter post are moved toward the dial indicator until the dial indicator reading is recorded.

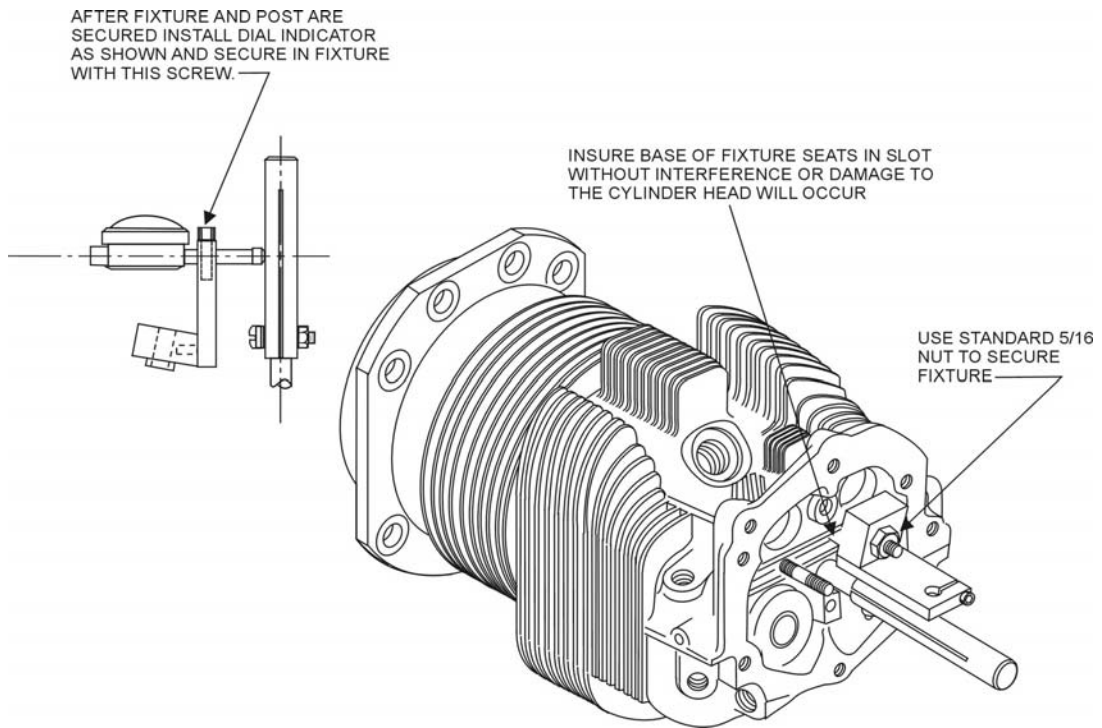
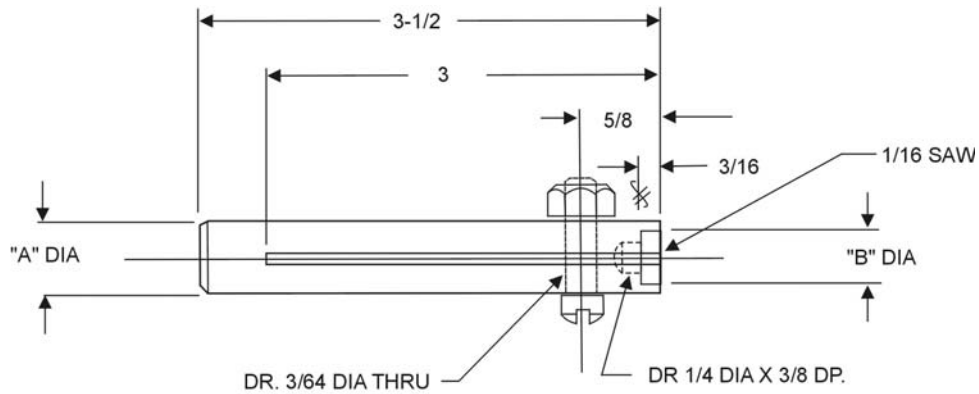


Figure 15. Tool Mounted on "76 Series" Cylinder Head

NOTE

The tools described in this section locate the tip of the measuring instrument 2-1/2 inches from the top of the valve guide. This dimension should be maintained on all locally manufactured tools.



7/16 ASS'Y A = 9/16, B = .402-405 RM.

1/2 ASS'Y A = 5/8, B = .498-496 RM.

DIAMETERS "A" AND "B" MUST BE CONCENTRIC

Figure 16. Adapter Post – Required with Both Tools

NOTE: Revision "C" combines Service Bulletin No. 388B and Supplement No. 1 to Service Bulletin No. 388B and adds dimensions for fabrication of a tool to measure wobble.

**SERVICE  
INSTRUCTION**

Service Instruction No. 1425A  
(Supersedes Service Instruction No. 1425)  
Engineering Aspects are  
FAA Approved

DATE: January 19, 1988

SUBJECT: Suggested Maintenance Procedures to Reduce the Possibility of Valve Sticking.

MODELS AFFECTED: All Textron Lycoming Reciprocating Engines.

TIME OF COMPLIANCE: As required.

Field experience has shown that engine oil contamination increases the possibility of sticking and/or stuck valves. This situation occurs when the contaminants in the engine lubrication oil become deposited on the valve stems, restricting the valve movement, and resulting in intermittent engine hesitation or miss. If corrective action is not taken to remove the deposits, a valve could become stuck causing engine damage.

Since the rate of oil contaminant accumulation is increased by high ambient temperatures, slow flight with reduced cooling, and high lead content of fuel, owners and operators experiencing these conditions are encouraged to consider the following suggestions for operation and maintenance if they have experienced valve sticking.

**PART I OIL AND FILTER CHANGES**

The prime cause of valve sticking is the accumulation of harmful contaminants in the oil and oil filter. Textron Lycoming recommends 50-hour interval oil change and filter replacement for all engines using full-flow filtration system and 25-hour intervals for oil change and screen cleaning for pressure screen systems. Operating the engine with a clean air filter is

also important for keeping dirt from accumulating in the oil supply. Therefore, the entire air induction system should be well sealed to prevent the entry of unfiltered air.

It is also important that the cooling air baffles and baffle strips be in good condition to prevent localized overheating problems.

When the aircraft cannot be flown frequently, the oil should be changed even sooner than the 50-hour interval. The oil should then be changed every 25 hours to eliminate moisture and acids that collect in the oil of an inactive engine. For aircraft that are not flown for long periods of time, the oil should be changed every four (4) months, if the aircraft is not flown at least 25 hours within this 4-month period. Short ground runs should be avoided.

Exposing the engine to sudden cool down, as in a rapid descent with the power reduced, or shutting the engine down before it has sufficiently cooled down can also induce valve sticking.

**PART II**

Investigations have shown that exhaust valve



sticking occurs more frequently during hot ambient conditions. The lead salts that accumulate in the lubricating oil from the use of leaded fuels contribute to the deposit build up in the valve guides. They are mostly eliminated each time the oil and filter are changed. Depending on the amount of deposits, sticking between the valve stem and guide can restrict the valve movement. This condition is often identified by an intermittent engine hesitation or miss.

Operating with any of the following conditions present can promote deposit build-up reducing valve guide clearance and result in valve sticking.

- a. High ambient temperatures
- b. Slow flight with reduced cooling
- c. High lead content of fuel

If any of the above is present or hesitation is observed, then inspection and cleaning is recommended (Refer to Part III of this instruction). Inspection and cleaning intervals can only be determined as a function of individual operating conditions.

### PART III CLEANING PROCEDURE

1. Remove all spark plugs and/or exhaust manifold. If compressed air is to be used to reseat valve, the exhaust manifold should not be removed.

2. Remove rocker box cover and gasket from cylinder.

3. On all engines except the 76 series, push out rocker shaft to remove exhaust rocker and rotator cap. On 76 series engines, remove rocker box covers, rocker arm retaining nuts, rocker arm fulcrums, spacer washers, and rocker arms.

#### CAUTION

Physically separate and identify by cylinder and valve location, the valve train components as they are disassembled, so that each part may be reinstalled in exactly

the same location from which it was removed. Pay particular attention to valve stem keys. These tend to wear in uniform distinctive patterns, and should be returned to the same position as they were before removal.

4. Position crankshaft just after bottom center on the intake stroke.

5. Insert about 8 feet of 3/8 inch nylon rope through the spark plug hole; then turn the crankshaft until the piston moves the rope snugly against the exhaust valve.

(a) An alternate technique for holding the valve in position is with air pressure using shop air and a compression check fitting.

#### CAUTION

The piston is held at bottom dead center by firmly holding the propeller to prevent the engine from turning when air pressure is applied through the differential compression device to the combustion chamber.

Use gloves or rags to protect the hands while holding the propeller blade. Also, before attaching the compression tester, check the air supply regulator to make sure the air pressure to the cylinder is not excessive.

6. Compress the exhaust valve spring and remove valve keys. (The rope or air pressure inserted in the combustion chamber in the preceding step provides a base to support the valve in the event the keys tend to stick.)

7. Remove the nylon rope or bleed off the air pressure and insert light through the upper spark plug hole. Then start pushing the valve from its guide. Before the valve stem is free from the guide, secure it from falling into the cylinder with mechanical pickup fingers, working through the spark plug holes and/or exhaust port. As shown in Fig. 1.



**Figure 1.** View Through Exhaust Port Showing Mechanical Fingers Holding Valve Stem

8. Move the valve (secured by the mechanical fingers) completely out of the guide and position it away from the guide to avoid interference when the guide is reamed. See figure 2.

**NOTE**

Refer to Textron Lycoming, Service Table of Limits and Torque Value Recommendations, SSP1776 or latest revision thereof, for valve guide dimensions when selecting a reamer. See special tools section of this instruction for reamer part numbers.

9. Place ordinary cup grease on the flutes of the reamer, so the deposits will be removed with the reamer.

10. Work the reamer by hand and make sure cutting position has gone through entire length of guide. The one-inch pilot should be completely visible through the exhaust port or through spark plug hole using a dental mirror.

11. Wash the guide with Varsol or equivalent solvent and blow out with compressed air. Check the ID of the valve guide using the correct plug gage. Inspect the reamed hole to determine if the reamer has cut all the way to the exhaust port end of the guide; if it has not, and the exhaust port end of the hole appears dark colored it is evident the guide is bell-mouthed and should be replaced. Lubricate valve guide.



**Figure 2.** View Through Exhaust Port Showing Mechanical Fingers Supporting Exhaust Valve Away From Guide

12. Using a magnetic pencil (reference Special Tool List) and flexible mechanical rings, position tip of valve in guide and very carefully work the valve back into its guide. Extreme caution should be exercised during this operation, making sure the valve is placed within the guide and not cocked, as damage could be done to the guide or valve.

**CAUTION**

Never use the piston to push the valve through the guide.



13. Install valve springs and valve spring seats in same position as removed. Compress valve spring and install keys in their respective position. In some cases it has been found that when the valve spring is compressed, the valve slides down the guide, making it impossible to install the keys. If this condition exists, reinsert the nylon rope (steps 4 & 5) to hold valve firmly on its seat while installing valve keys.

14. Remove hydraulic lifter and clean free of all oil, inspect for any malfunction. Clean ID of cam follower reinstall hydraulic lifter.

15. Install push rod, then rotating cap, rocker arm and shaft.

16. Install rocker box cover and new gasket.

**CAUTION**

During reassembly valve train components must be replaced in their original location. On 76 series engines, give special attention during reassembly to alignment of rocker arms, spacers and rocker arm fulcrums with the rocker arm retaining stud. All parts must be in pro

per alignment to assure correct dry tappet clearance. Misalignment could result in engine damage.

17. Make sure all flashlights, ropes, etc. have been removed from within the cylinder before proceeding to the next cylinder.

18. Install spark plugs (Install exhaust manifold after all exhaust valve guides are cleaned).

**NOTE**

Any available reamer that is of the correct dimension can be used for this valve guide cleaning procedure. The following special tools section lists all Textron Lycoming valve guide reamers along with the reamer dimensions and corresponding plug gage. Reamers are manufactured with cutting tips made from various materials to ream valve guides made from different materials. Always consult Textron Lycoming Tool Catalog SSP-578, or the latest revision thereof, for the correct reamer when finish reaming a newly installed valve guide.

**SPECIAL TOOLS REQUIRED:**

Lycoming P/N	Nomenclature	Plug Gage
64684	Reamer .4040/.4050 Finished ID	64514
ST-27	Reamer .4370/4380 Finished ID	ST-26
64900	Reamer .4375/.4385 Finished ID	64901
ST-113-1	Reamer (Ni-Resist) .4985/.4995 Finished ID	64927
ST-113-2	Reamer (Ni-Resist) .4985/.4995 Finished ID	64927
ST-143-1	Reamer (Ni-Resist) .4995/.5005 Finished ID	ST-155
ST-143-2	Reamer (Ni-Resist) .4995/.5005 Finished ID	ST-155
ST-309-1	Reamer (Ni-Resist) .5000/.5010 Finished ID	ST-314
ST-309-2	Reamer (Ni-Resist) .5000/.5010 Finished ID	ST-314
ST-315	Reamer (Bronze) .5000/.5010 Finished ID	ST-314
ST-338	Reamer (Hand Expansion) .5000/.5010 Finished ID	ST-314
ST-25	Compressor, Valve Spring and Bar (all engines except 76 series and TIO-541)	
ST-266	Compressor, Valve Spring and Bar (TIO/TIGO-541)	
ST-419	Compressor, Valve Spring and Bar (76 Series)	
	A Flexible Two-Prong Mechanical Finger	
	A (pencil) Magnet (Maximum diameter 3/8") capable of reaching a minimum of 4"	

NOTE: Revision "A" adds changes for oil and filter recommendations.