

Sticking Valves

Wayne Hadath

"There is a Lot to Learn but it is Learnable"

This year "Little Bit" and I have not done well at the races. My F1 Rocket has over 435 hours on it and the stock 260 hp IO 540 Lycoming with twin mags just didn't seem to have quite the snap it used to have. I had noticed recently that #2 cylinder had lower than normal CHT and EGT readings when the RPM was below 1,000. I had also noticed that the propeller seemed a little easier to move by hand. This summer Hot Starts which have never been a problem, were on a few occasions. I spoke with other aviators and got a list of possibilities: Bent Valve, Burned Valve, Warped Valve, Stuck Valve, Sticking Valve, Bad Plug, Intermittent Plug, Dirty Plug, Bad Sensors, Bad Mag, Intermittent Mag, Stuck Rings, Fouled Injectors..... non of them good but some worse than others.

I decided that I could not wait until winter so off came the cowls and the pressure plenum. A visual inspection showed nothing unusual. I pulled each injector and inspected it and cleaned it. All looked perfect. It was not a fouled injector.

I pulled the bottom spark plugs. They all looked 435 hours worn, kind of football shaped but they all looked dry, clean, nice and golden. I considered replacing them but I decided that I wanted to find the real problem and fix that first. I don't like changing too many things at once. I cleaned them and gapped them. I may do new plugs this annual to prepare for the next racing season.

The engine was warm from a recent flight so I decided to do a Leak Down test. I had been told that it is best to do Leak Down tests when the engine is warm but I have learned that it is

not necessary and Leak Downs can be done on a cold engine with the same results. I was very disappointed to find that # 1 cylinder showed 61 lbs and #2 showed 0 lbs. The rest were 77 or 78. I was beginning to think my flying/racing season was over and a big bill was headed my way.

I could hear the air leaking out, but where was the air going? As it happened I was able to get someone to listen while I applied air to the cylinder. We listened at the crankcase breather to determine if the leak was in the rings and all was quiet. We listened at the throttle body intake to determine if the leak was the intake valves and all was quiet. We finally listened at the end of the exhaust pipe and could hear and feel the exiting air. This was the same on #1 and #2 cylinders. This narrowed the problem down to exhaust valves. Were they bent, burned, warped or stuck? Or maybe the seats were bad. How could I determine what the valve problem could be? It was suggested that a light rap with a mallet on the rocker might loosen up the valve and help it seat better. I did this and there was a slight improvement on #2 up from 0 to 5 lbs but none on #1. Because the light rap on the exhaust valve stem improved the sealing it seemed reasonable to assume that some deposits might be holding the valves a few thou off their seat. If only I could look inside the cylinder to inspect the valves and their seating then I could make a proper diagnosis. Fortunately the Kitchener RAA Chapter has a bore scope that I was able to borrow. Snaking the scope's probe through the plug holes showed that the cylinder walls and piston crowns were in good condition, but the probe could not be bent back on itself to give a view of the valves. I checked all of the 6 cylinders and they all looked in great condition. The walls were not scuffed and there were very little deposits on the piston crowns and what was there was a nice golden brown. There was no evidence of blackening or overheating anywhere. So far everything was just the way I had hoped but not

being able to look at the valves was troubling. With out a way of looking at the valves it seem that pulling the cylinder was the next step but I had never pulled a cylinder before and it looked like a daunting task. I remembered that Tom Martin recently wrote an article on the "Old Rope Trick", which allows the valve spring to be removed and the valve to be pushed down its guide and then manipulated until the stem sticks out of the lower spark plug hole. I called Tom and did a Google search and soon I felt that maybe I could continue to trouble shoot the problem without pulling the offending cylinders. Lycoming has a "Service Instruction" No. 1425A dated January 19, 1988 under the subject of "Suggested Maintenance Procedures to Reduce the Possibility of Valve Sticking" which describes the "Old Rope Trick" and the tools necessary to perform it.

I was able to borrow an adjustable Reamer and bought 10 feet of 3/8 nylon rope (I actually bought 300 feet of different types of nylon rope but you only need a maximum of 10 feet). I could not find a Lycoming Valve Spring Compressor any where on the airfield so I found it a good excuse to fly to Brantford in my RV 10 to purchase one for my use and those who may need to use it in the future. ACS had one in stock for \$75.00. It did not come with instructions but I eventually figured out how to use it.

Here how it goes:

1. Remove the Rocker Cover. This will expose all of the doings.
2. There is a large pin which cannot be seen that secures the rocker arms. This pin is captured at each end by what look like plastic caps. These caps just slide in and are held in place by the Rocker Cover. Use your fingernail or such to remove the cap on the exhaust valve end. The intake valve will be the one that looks like it has the least amount of heat because it does. You will be able to recognize the exhaust valve because it has a metal cap under the rocker arm over the end of the valve stem which blocks you from

Top, and second down: Ten feet of rope will be fed into the spark plug hole with just a short tail hanging out. Do not allow it to twist as you feed it in. A lever type spring compressor may then be used to remove the keepers and springs

seeing the keepers. Once you remove the plastic cap you can easily push the pin out part way and remove the exhaust rocker arm. Remove only the exhaust rocker arm. Do not remove the push rod. Remove the cap on the end of the exhaust valve stem. It is just sitting there but you may need a pick or something to overcome the hydraulic pressure.

3. Rotate the prop to bring the piston to bottom dead centre. Use a wire or wooden dowel to confirm this. With the bottom spark plug removed, feed the 3/8 nylon rope through the spark plug hole into the cylinder cavity. Make sure the rope has no twists in it or it may kink or knot and you will not be able to remove it and cylinder removal may be necessary after all. Leave a 6 inch tail hanging.

4. Rotate the prop to bring the piston towards TDC. This will compress the rope and hold the valve from opening.

5. Position your Valve Spring Compressor Tool and compress the valve spring. The half moon valve keepers should be easily removed. Remove the large washer retainer and the dual springs.

6. Rotate the prop to bring the piston to BDC and remove the rope. Be very careful to not touch the prop once the valve has been removed.

7. With both my valves, they move freely with the use of my finger in and out. They seemed to function perfectly. Gently push the valve down the valve guide into the piston cavity. It may need gentle persuasion with a punch and mallet. With cylinder #2 there was evidence of build up almost the full length of the valve guide but on #1 it was about 1 inch.

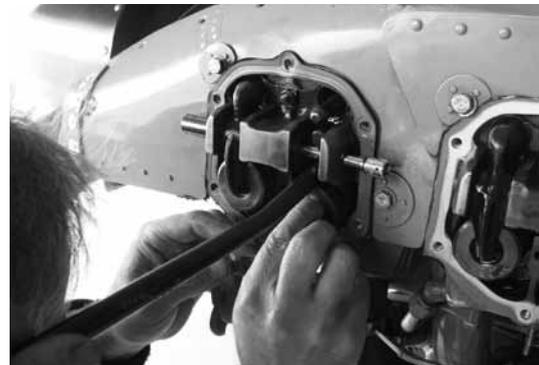
8. Remove the top spark plug. Get a 10 inch piece of wire and bend a C at one end. Insert it into the top spark plug hole and loop it around the valve

stem. With the use of a magnet on a stick inserted in the bottom hole and the wire from the top and with your tongue held exactly the right way the valve stem should slide out the bottom spark plug hole. The valve stem should have a nice film of oil and will have hard deposits on the part of the shaft which does not ride in the valve guide.

With the use of the bore scope I could now inspect the top and side of the Valve. All look good on both #1 and #2. There was no indication of any wear or abuse on the valve. I still could not inspect the valve seat. So I decided to remove the exhaust system to inspect the exhaust port and try and see the valve seat. I learned that the total removal of the exhaust is not necessary. Just unbolting it and letting it hang down is sufficient. With the exhaust out of the way I could inspect the exhaust port but I still was unable to inspect the valve seat. The exhaust system removal is worthwhile for inspection and it makes the reinsertion of the valve much simpler.

I had purchased some Avblend which is an additive for the oil to stop valves from sticking so I decided to spray some in the valve guide and on the upper shaft of the valve where there were deposits. It took 24 hours for the Avblend to soften the deposits so they could be removed with gentle scraping.

9. I borrowed an adjustable reamer and began gently reaming the valve guide. The purpose of the reaming is to remove the deposits but none of the valve guide material. I turned the reamer using a thumb ratchet and very gradually adjusted the reamer larger, regularly inspecting to make sure I was not removing any valve guide material. Once I felt the reamer engaging along its full length I stopped reaming. I used compressed air to blow out the valve guide and the cylinder. Make



Second from bottom: with the valve stem hanging out the plug hole, it may be cleaned of deposits...and (above) a reamer may be gently used to clean deposits from the guide.

sure you secure the prop from turning before you blow air into the cylinder. With the exhaust removed the reinsertion of the valve was quite easy and I was able to slide it in with the use a magnet on a stick inserted down the valve guide. When I moved the valve in and out with my fingers it slid easily and a solid clank was heard when it came up against the seat. I had earlier been shown an example of a worn valve guide. My guide and valve had very little side to side play and very little wear.

10. Reassembly is the reverse. Insert the rope and remember not to let it twist. Bring the piston up to compress the rope against the valve. Install the dual springs and large retainer washer. Using the Valve Spring Compressor Tool, compress the springs and insert the valve keepers. Release the springs and inspect the keepers for proper seating. Install the metal cap on the end of the exhaust valve. Position the rocker arm and slide the keeper pin into position. Install the plastic retainer caps. Install the rocker cover. If you are using silicone gaskets be careful not to over tighten. Turn the propeller and

remove the rope and install the spark plugs. Install the exhaust system - my system has reusable gaskets. I use anti-seize and new washers any time I drop the exhaust.

After reassembly I did a Leak Down test on #1 and #2 cylinders and # 2 came up to 79 lbs which was the same as it was when it was brand new. # 1 came up to 74 lbs which was somewhat disappointing but I am hoping and it may be false hope that some debris may be holding the valve from completely seating. We shall see the next time I have the cowls off. At 74 lbs I will have to decide this winter if the Cylinder has to come off.

I buttoned everything up and pushed out and here is what I noticed. The propeller was more difficult to move by hand just like the old days. The CHT and EGT numbers were good at any RPM. The engine start was sharp and crisp and had that old bark and wing rock that I remember now but had forgotten. On the test flight the engine seem to be smoother and GPS Ground speeds and Indicated Airspeeds seemed to be higher. Hot starts were back to being a non issue.

I have decided to begin the search for a bore scope that is flexible or capable of looking at the valves seats. I think it would be a valuable tool in engine troubleshooting and a good practice to do each annual. I have also decided to drop my exhaust system each winter and spray Avblend up inside the exhaust chamber to soften any deposits that have accumulated over the season. By dropping the exhaust and hand turning the prop it is simple to get the Avblend on the exhaust valve stem and up inside the valve guide.

Yes, it would have been easier to just call on the mechanic and trust to his years of experience but I am glad that I chose to do this myself and I gained valuable confidence, knowledge and experience. It was comforting though to know that he was just around the corner if I needed his help or reassurance. It was also great to look inside my engine to confirm that racing my F1 Rocket does not seemed to being hurting my engine at all.

There are two SARL races left for the 2010 racing season and hopefully "Little Bit" and I can make it to both to see what our real world numbers are.