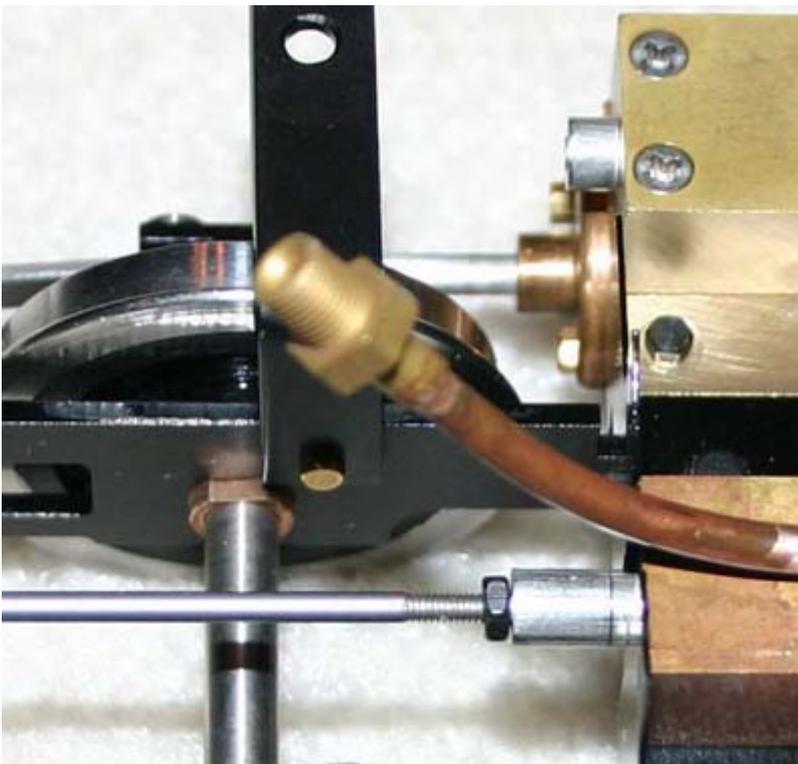


ACCUCRAFT RUBY – ADJUSTMENTS by Dave Hottmann



Oil the reversing valve and slide it back into the valve assembly. Then screw the reversing quadrant to the deck plate using two M2 x 4 screws. Note that you may have some problems inserting the screws because of paint in the deck holes. If you have a M2 tap you could clean out these holes. Otherwise I found it easiest to test fit the M2 screws from the bottom side, cleaning out the paint in the process. Inserting these screws is a real fiddly job. There wasn't enough clearance with the vertical part of the reversing quadrant to turn my screw starter.

I finally used the smallest needle nose pliers I own to start both screws. Then I used a hex driver to tighten them.



Adjusting the reversing rod:

There is a small machined groove about 3/8" from the end of the reversing valve. It can be seen in this photo just to the right of the nut at the end of the reversing rod.

Adjust the reversing valve so that when the reversing lever is in the forward position, this groove is just touching the brass back side of the valve assembly. You can do this by turning the reversing valve with your fingers. Once it is in the correct position, tighten the nut to its left against the back of the reversing valve to keep the reversing valve from turning on the reversing rod.



Take a rocker arm assembly and insert it through the hex nut in the frame from the outside. Then bring up the rocker arm attached to the eccentric on that side and slide it onto the rocker arm assembly rod from the inside. There is a machined flat spot on the rod you just inserted from the outside of the frame. The arm on the outside of the frame should be pointing up and the arm on the inside pointing down. If you have installed the rocker arm assembly properly, you should be able to see the flat spot on the rod through the hole in the inside rocker arm.



Using a 1.5 mm hex key, screw a stainless set screw into the hole in the inside rocker arm. The photo shows set screws protruding from both rocker Arms.

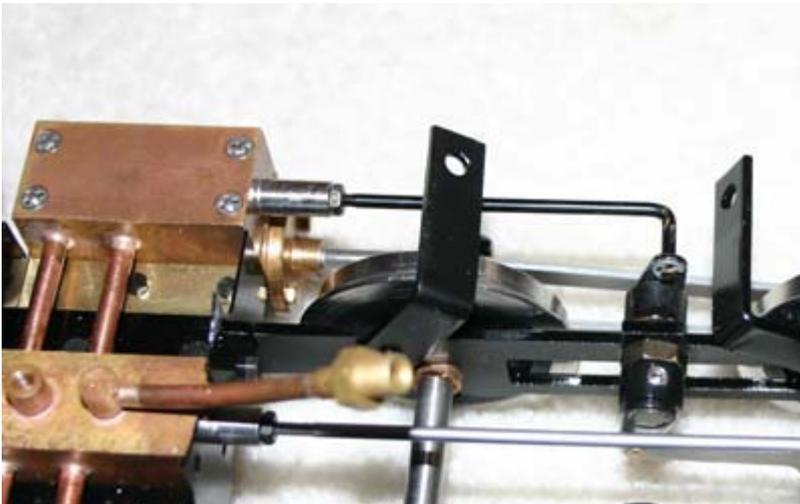
Use your fingers to rotate the drivers, rotating the eccentrics in the process. You should see the tab on the outside rocker arm move back and forth freely.



In the short leg of each valve rod are two grooves. Place a small E-clip on each inside groove. This is a very fiddley job. What worked best for me is to use a large set of needle nose pliers to push the E-clip onto the rod.

Then screw a M2 nut onto the long end of the rod. Finally remove the valves from the valve assembly with your fingers and screw the valves onto the long end of the rods.

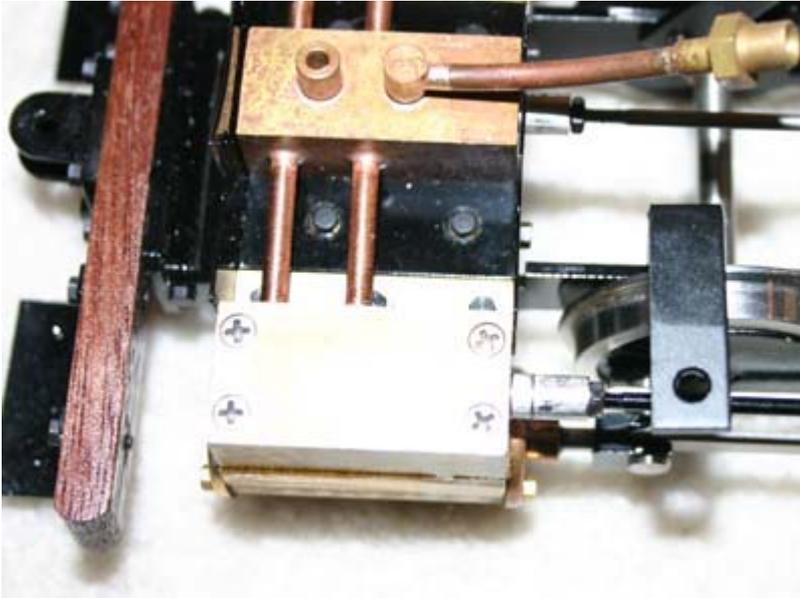
In the photo, the top valve rod has been screwed into the valve. The bottom rod is shown without the valve.



Oil the valves and slide them back into the the valve assembly. You are about to push the short end of the valve rod through the small hole in the arm on the rocker arm on the outside of the frame. On my Ruby, it helped to use a small twist drill in my fingers to ream out the hole in the tab slightly as paint makes the hole smaller than it should be.

Once the short end of the rod is through the hole in the arm, place an E-clip in the outside groove that will appear when the short part of the rod is pushed through the arm as far as possible. It is very easy to lose one of these E-clips.

The reason mine is silver rather than black in this photo is I was able to find a replacement at the second hardware store I visited. This E-clip is a SAE size but is an almost perfect match for the small E-clips on the Ruby.



Adjusting the Valve Travel:

Rotate the drivers with your fingers. You should see the valves move in and out. Each valve has a small machined groove. You can see the groove in this photo. Valve movement is shown in mid-stroke.

At the valve's furthest insertion into the valve assembly, the groove should be touching the back end of the brass valve assembly. If it doesn't, use your fingers or a needle nose pliers to turn the valve on the valve arm until the machined groove is just touching the brass at full insertion. Then tighten the nut against the back of the valve to keep it from turning on the valve rod.

Step 3 - Setting Ruby Valve Timing for Outside Admission (Factory Method)



Beginning with the right side of your engine (shown in photo) rotate the drivers until the side and valve rods are at rear dead center as shown in the photo. Note that the side and valve rods are parallel with each other. Without changing the position of the drivers, turn your engine upside down.



Insert a set screw in the eccentric and screw it in with a 1.5 mm hex wrench until it is nearly tight.

Then without rotating the drivers, rotate the eccentric until the two set screw holes are both the same distance from the axle.

In this photo, the hex wrench is protruding from the right set screw. Note the position of the set screw holes. Because the engine is inverted, the right side is at the top of the photo. Then tighten the set screw. Insert the second set screw but don't tighten it for now.

Repeat the process on the left side of the engine. When you complete this step, the boiler assembly is complete and your Ruby is set up for outside admission. You can move on to air testing your Ruby.

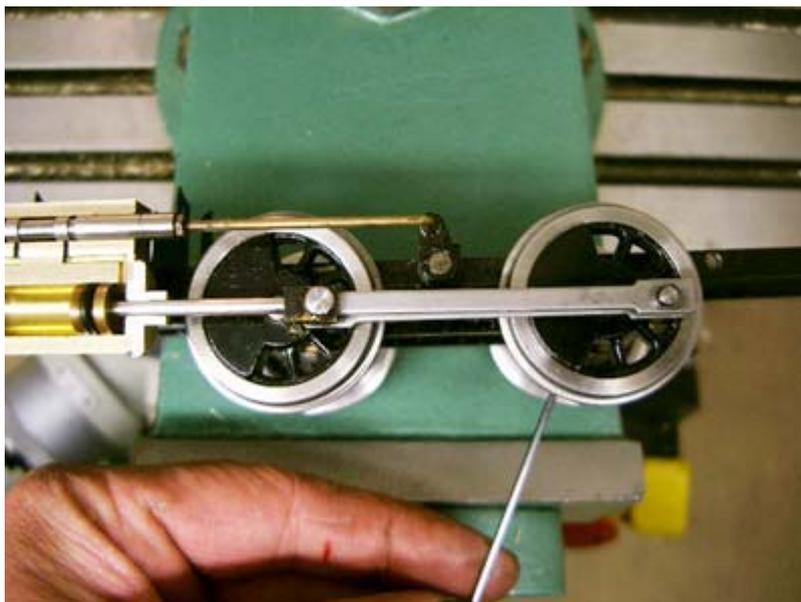
Optional Step 3 - Setting Ruby Valve Timing for Inside Admission (Hottmann Method) - By Dave Hottmann

Out of the box, Rubys are set up as outside admission piston valve engines in forward direction. Outside admission is how the steam flows through the valve and is admitted to the piston. Many of you have observed that Rubys run better backwards. A big reason for this is that Rubys are inside admission piston valve engines in reverse. Rubys run better with inside admission than with outside admission. Because you are more likely to run your Ruby forward than in reverse, you may want to change your Ruby so it runs using inside admission when it is running forward.

To change from outside to inside admission in forward, the steam flow is changed without requiring any change to the valve motion. The eccentrics control the valve motion and admission timing. The steam flow change can be accomplished by rotating the eccentrics 180 degrees, making the engine inside admission in forward and outside in reverse. A byproduct of this change is that the Johnson bar will operate in the reverse direction from that of the prototype. When the Johnson bar is forward, the engine will move in reverse. When the Johnson bar is in reverse, the engine will move forward. This reversal of the Johnson bar action can be corrected, but correction is not necessary for the engine to function properly and is not covered in this article.



Here is a cutaway view of the outside admission used by the Ruby as shipped. Note that steam pressure tries to push the piston valve out of the valve block. This applies back pressure on the valve linkage and eccentrics. This back pressure causes friction that leads to wear of the eccentrics and linkage. The back pressure also creates friction that the engine has to overcome, hurting your Ruby's performance. Steam pressure enters the valve bore through the hole at the end of the paper arrow from the direction valve. There is a hole in the center of the valve at the front end that connects the front of the valve with the narrow groove. The wide groove is exhaust and there is hole behind it that connects to the direction valve block.



Rotation of the eccentrics is accomplished by loosening the two 1.5mm Allen head set screws that secure its position on the axle. This can be done without disassembling the engine. In rotating the eccentrics 180 degrees I have found it best to loosen the second set screw with the rod pin in the 3 or 9 o'clock position. Note the position of the Allen wrench in the photo. The second set screw has been loosened and the Allen wrench is holding the eccentrics in position.

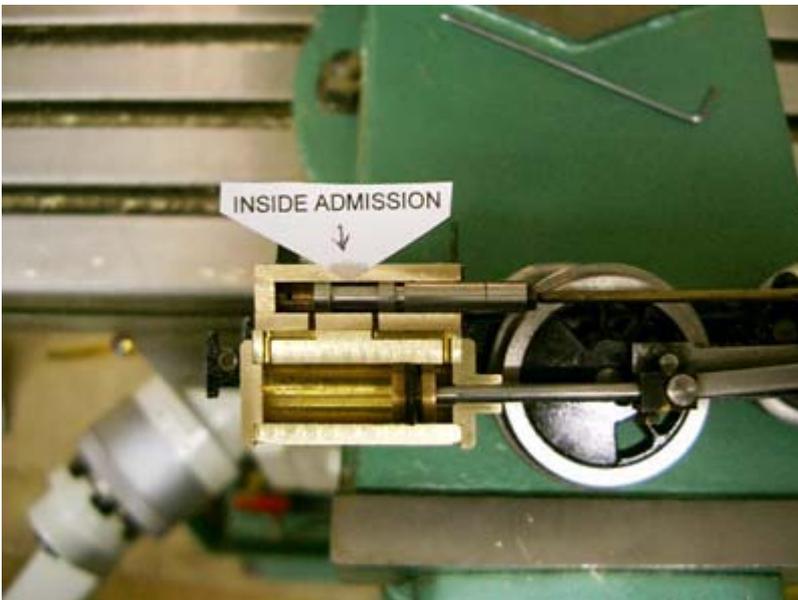
Editor's note: This series of images and instructions assumes you are converting a Ruby that is already set for outside admission to inside admission. If you are assembling the kit and skipped Step 3, you will not need to loosen the set screws on the eccentrics. Your eccentrics are already loose.



While holding the eccentric's position with the wrench, rotate the drivers 180 degrees. In this photo the Allen wrench is holding the eccentric still and the driver has been rotated 180 degrees. Then without rotating the drivers, rotate the eccentric until the two set screw holes are both the same distance from the axle. See the photo on the previous page for guidance. Then tighten one of the two set screws. I leave the other set screw loose until I have air tuned the engine. Note that the side and piston rods are parallel as in Step 3. But the rods are at front dead center rather than rear dead center.

Repeat this on the other side.

Editor's note: If you are setting up your Ruby kit's eccentrics for the first time, rotate the drivers until the side and piston rods are at front dead center. Then follow the instructions on aligning the eccentric set screws and tighten one of the screws.



After rotating the eccentrics 180 degrees the engine is now operating with inside admission in forward. Instead of steam pressure pushing the valve out of the block as it does with outside admission, there is only whatever pressure is left in the exhaust applying pressure to the valve linkage and eccentrics. You can also see how the steam moves from the wide groove through the passages to the rear of the piston. The steam then pushes the piston forward and rotates the driver through the rod.

Admission begins when the passages start to "communicate" or open to each other. Admission keeps happening through a portion of the piston's travel but is cut off when the passages are no longer in alignment. For optimum performance, you'll need to experiment with valve timing adjustments. See my article on air tuning that follows for suggestions.

Step 4 - Air Tuning Your Ruby - By Dave Hottmann

Once your valve timing is set, your chassis should be tested with compressed air. Compressed air to test your Ruby can come from a variety of sources:

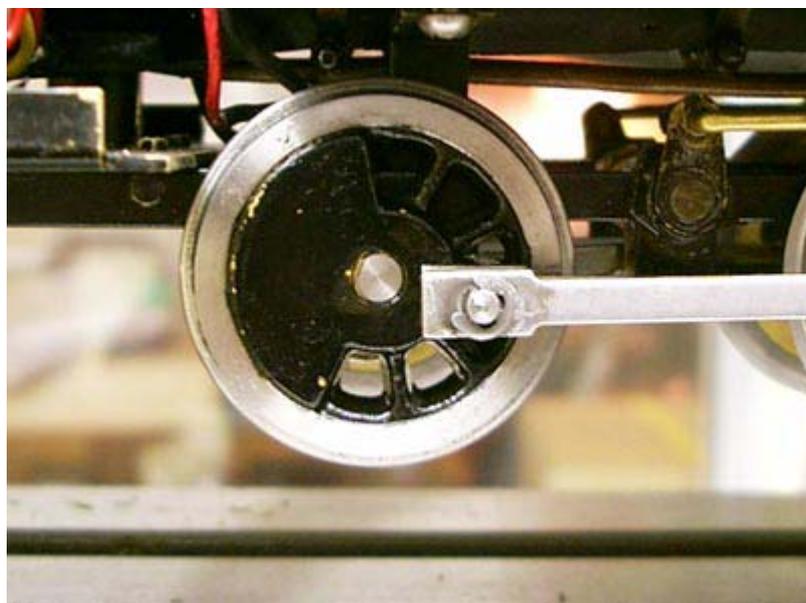
1. A bicycle pump.
2. An air compressor.
3. A compressed air source like a tank.
4. A garden sprayer with a hand pump (like the one I use).

First oil all your engine moving parts with a lightweight machine oil like 3-in-1. Use your hand to rotate the drivers and work the oil into the moving parts. Check to see whether there are any positions in the rotation where the drive or valve mechanisms bind. A common source of binding is that the eccentrics are not centered on the axle. After you rotate the drivers by hand for a while, working in the oil and correcting any problems causing binding to occur, the

mechanism should begin to smooth out.

You can use the techniques that follow to air tune your Ruby whether it is set to outside or inside admission. See my article on converting a Ruby to Inside Admission for a discussion of this issue. Rubys are shipped set for outside admission when moving forward. For outside admission Rubys, the line on the direction (or center) valve should meet the valve block when the Johnson Bar direction is set to forward. If you have converted your Ruby for Inside admission, the line on the direction (or center) valve should meet the valve block in when Johnson Bar direction is set to reverse. I prefer to tune for the best forward operation possible and live with a not-as-smooth reverse operation. A perfect forward is seldom possible because of very small machining imperfections in your Ruby's drive train.

Air tuning can be done without disassembling the engine. Or it can be performed on a Ruby kit after the cylinder head has been installed, The principles discussed in this article also apply to air tuning other steam engines. By tuning with air at slow speeds you can see the admission events in the rotation of the drivers, and gain a better understanding of what it takes to get a steam engine to run and to run well. Air tuning should be done with the engine supported on blocks or stationary rollers so the drivers are free, and with an empty boiler and oiler. Water or oil that gets into the cylinders can cause hydrolocking and drive you crazy. Use low air pressure of 5-20 psi and adjust the flow with the throttle valve on a fully assembled Ruby. If you are air tuning a partially assembled kit, you will need to control air pressure at the source. This can be difficult with a bicycle pump or a garden sprayer. Make sure the moving parts are lubricated and free of binds. A new engine may have binds that won't go away until it is broke in. As a result, it may be difficult to tune. After break-in it may need more tuning.



Background Information

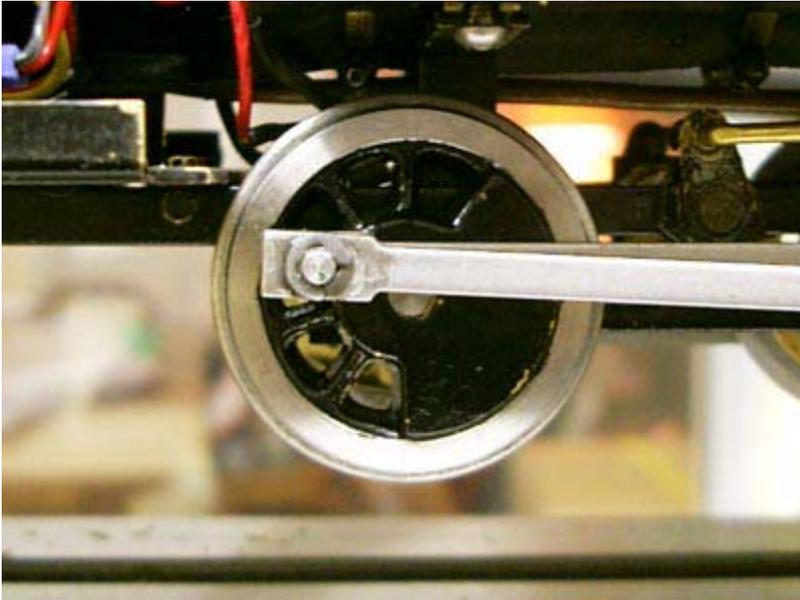
Admissions should start barely after dead center of the rotating direction of the driver. Dead center is when the piston is at the end of it's travel and the rod pin on the driver is at 3 or 9 o'clock.

An early admission of air (or steam) occurs before piston dead center. The early admission causes the driver to hesitate or stall as the early admission causes the piston to try to push/pull the driver backwards for a brief moment before dead center. Early admissions are hard to see and can mimic a bind in the drive train.

A late admission is when the driver stalls or pauses after piston dead center.

Steam isn't coming through soon enough, and hesitation occurs until the drivers have rotated sufficiently for the valves to allow steam to be admitted. Late admissions are much easier to detect than early admissions.

On the right side of the engine you want the admissions to start when the rod pin has just passed 3 and 9 o'clock. Admissions should start on the left side just before 3 and 9 o'clock. Here's the right side just after 3 o'clock. Note that the rod pin center is below the axle center.



Here is the right side just after 9 o'clock. Note that the rod pin center is above the axle center.

Basic steps to follow in tuning your Ruby:

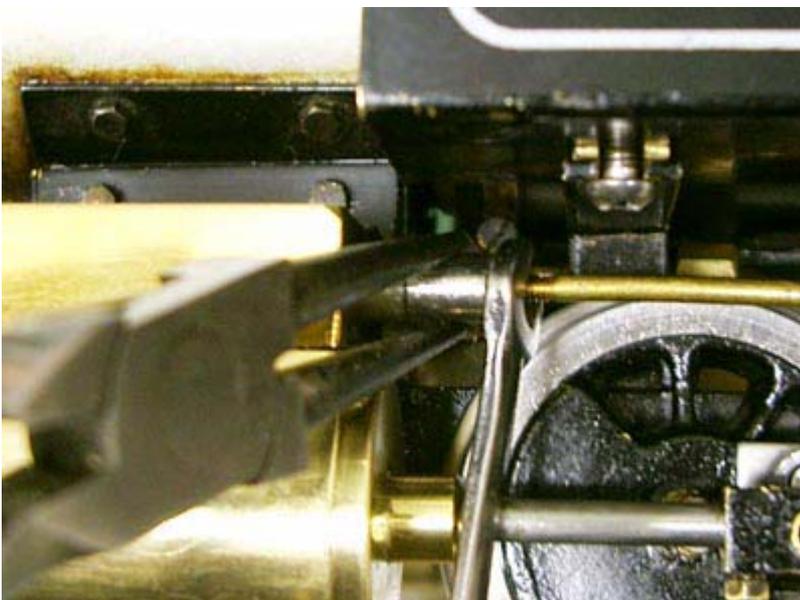
1. Work on one side first. When you are finished, move to the other side.
2. If your biggest problem on a side is an early admission, retard the eccentrics on that side until the biggest problem is a late admission.
3. Adjust the valves on that side to make the lates equal at 3 o'clock and 9 o'clock.
4. Then adjust the eccentrics on that side to get rid of the lates.
5. When you have finished the process on one side of the engine, repeat the steps 2 through 4 on the other side of the engine.



Running an Air Test:

Place the engine on blocks, add air pressure to the boiler, and open the throttle until the engine is running. If you are testing a partially assembled Ruby you'll need to control the pressure from your air source as the throttle valve is not yet installed. Let it run long enough to work out any water or oil. Then turn the throttle down until the engine stalls or hesitates. If the engine stalls, start it running again with a finger and confirm the stall points. Make note of where the hesitations and stalls are. When looking at the engine from the right side (as in this photo) poor admission events near 3 and 9 o'clock are because of adjustment problems on the right side of the engine.

Poor admissions near 12 and 6 o'clock when viewing the positions of the right side drivers occur because of adjustment problems on the left side of the engine. We'll address the right side problems first. A garden sprayer is being used for the air supply in this photo.



Adjusting the Valves:

Pick the worst 3 or 9 o'clock admission event as a starting point for adjustments. After the worst event is determined, remove the air supply or turn the throttle off.

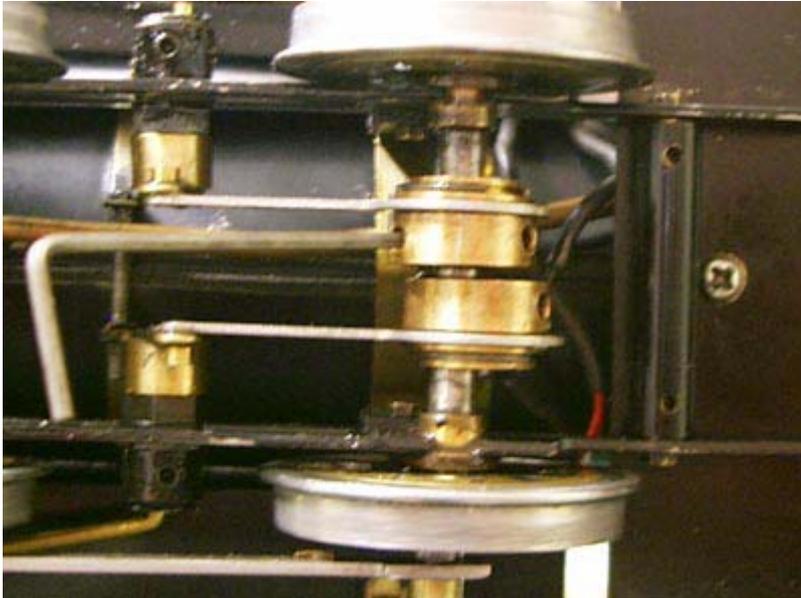
If the worse event is an early event, move on to **Advancing and Retarding the Eccentric** and retard the eccentric and retest until your worse event is a late event. Then return here and continue with **Adjusting the Valves**.

At this point your worse event should be a late event. An example of a late event is 4 o'clock on the right side. From the point of the worst event rotate the driver backwards 90 degrees. Then rotate forwards 90 degrees while watching the direction the valve moves.

This determines which way you will need to adjust the valve. For late admissions events the valve will need to be

adjusted so the valve is deeper in the valve assembly so the passages communicate sooner. For early admission events the valve will need to be adjusted the opposite direction.

The valve and rod have right hand threads. To adjust the valve loosen the lock nut with a 4 mm open end pliers and rotate the valve with a pair of needle nose pliers. Make sure you are adjusting in the correct direction and keep your adjustments small. Then tighten the lock nut. As you adjust the late out of 3 or 9 o'clock the other will be come late. Adjust and rerun the air test until the late events at 3 and 9 o'clock are equal. When the late events are equal then you can move onto the next step - **Advancing and Retarding the Eccentric.**



Advancing and Retarding the Eccentric:

To advance the eccentric, loosen the 1.5mm Allen head set screws (as shown in the photo) and rotate the eccentric a small amount in the drivers' forward rotating direction. This is called advancing because things will happen sooner. Retarding the eccentric is rotating in the opposite of the drivers' forward rotating direction. Advance and rerun your air test until the engine runs smoothly and slowly. Sometimes the valve will need to be readjusted after adjusting the eccentric. When you advance one too many times and the engine hesitates at 3 and 9 o'clock, then retard the eccentric a tiny bit and call it "good enough". Keep adjusting and fussing until the engine will run about 1 revolution per second or less.

Once the adjustments are complete on the right side, go through the same process on the left.

It's best to have small hesitations after every piston dead center on air. If the admissions are not late enough on low pressure air they can be too early with steam pressure. To keep from having the eccentrics advanced too much, make sure reverse still works. Not all the admissions will be equal, one or two can be stronger than the others. This occurs because of machining imperfections in the manufacture of the Ruby.

Something else that might help you fine tune is to raise the air pressure to 10 psi and adjust the flow and driver rpms with the throttle and load the drivers lightly with your finger. This can be a better way on a new stiff engine. The advantage to air tuning is it allows you to run the engine slow enough that you can see the admission events. You also won't burn your fingers.

When I first started tuning with air it took me hours. If I stick to the basic rules and am lucky it only takes 20 minutes. Have fun air tuning your Ruby.

http://www.mylargescale.com/articles/articles/SteamClass/Ch4_01.asp

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