

Tuning your Benjamin PCP with the use of the Hammer Spring Tension Adjuster and Hammer Stroke Adjuster by Ray and Hans Apelles ~ *The "A" Team*

Caution: All testing should be done with muzzle pointed in a safe direction and into a safe backstop!!!!

There are many different ways a PCP may be tuned/adjusted. With the adjustable Hammer Spring Tension and Adjustable Stroke you have virtually all you need to tune a PCP to your liking.

This Document will give you a brief introduction into adjusting and from there you will need to experiment to get the performance you desire.

Principles

A certain amount of force is required by the hammer to open a valve to achieve a particular velocity with a given pellet. This can be applied in a variety of ways. At one extreme the hammer can be moved a long distance (stroke) with a low spring tension. At the other extreme the hammer can be moved a very short distance (stroke) with a very high spring tension. And there is everything in between. Each method yields a different firing characteristic. It is up to the end user to decide how he would like the gun adjusted to suit his needs and firing characteristic desires.

A long stroke, low spring pressure setting will give a very light cocking effort and long spring life. As the hammer opens the valve, the pressure from the reservoir combined with the valve return spring pressure will close the valve. With a light spring pressure the hammer is likely to be thrown back far enough (and off of the valve stem) that the hammer spring then gets re-tensioned and the hammer gets thrown forward to hit the valve stem again and expel more air. This can be heard and sounds as though the gun is burping out air for as many as 3 or 4 burps per shot.

A short stroke, high spring pressure setting will yield a heavy cocking effort and possibly shorter hammer spring life. As the hammer opens the valve, the pressure from the reservoir combined with the valve return spring pressure will close the valve. With a heavy hammer spring tension the hammer can't get thrown back so far (or possibly not even off the valve stem) as to tighten up the hammer spring and throw the hammer back onto the valve to burp out more air. There is the small possibility that the valve may also close slower, allowing more air to escape, because of the added hammer spring tension keeping the hammer against the valve. This method of tuning usually yields a shorter sharper crack at discharge. This method yields little to no Hammer Bounce.

The best balance between the long stroke low spring tension and the short stroke high spring tension is what is desired. The following guide will help you achieve a setting that will give you the desired velocity. It will be up to the user to achieve the balance they desire for an optimal setting. An optimal setting will give the highest efficiency yielding little to no hammer bounce, reasonable cocking effort and good shot consistency.

It would be a good learning experience to try each method so as to learn the characteristics of each in your particular gun. Start with the long stroke low hammer tension (which is very similar to the factory setting) and then try the short stroke high hammer tension method. After learning each you can then find a balance between the two. When finding the balance, if you can hear any air burp then you should adjust more to a shorter stroke higher hammer tension. You are looking for that fine balance which can only come from experience. At the end of this document you will find a method for determining charge pressure and shot count. It is advisable to do each for the 2 different methods so you can see the difference in shot count and velocity curve which will give you an idea of the efficiency you have achieved in each.

After finding your setting for each method, you can determine that setting by inserting the adjustment wrenches and counting how many turns to get back to the end stops. An example would be 7 turns in hammer spring, 5 turns in stroke yields 850 fps with xyz pellet with a 2000 psi charge for 25 shots. Using this method you can always get back to a particular setting while you are trying different settings.

Preparation:

A) Hammer Stroke Adjustment (HSA): With the gun assembled, adjust the hammer stroke to the longest stroke position. This is done by inserting the Hammer Stroke Adjustment (HSA) allen wrench through the Hammer Spring Tension Adjuster (HSTA), through the spring, into the hammer and catching the Hammer Striker. Then turn counter clockwise until the Striker is to the fully retracted position. This is the start position for your adjustments.

B) Hammer Spring Tension Adjustment (HSTA): With the gun assembled, adjust the Hammer Spring Tension to the least tension position. This is done by inserting the Hammer Spring Tension Adjustment (HTA) allen wrench into the end plug and catching the HSTA and turning counter clockwise until the Hammer Spring Tensioner is to the fully retracted position. This is the start position for your adjustments.

C) If it is possible, make an identical replacement of the transfer port but change the ID to .110" or smaller. It is rare that a PCP needs a transfer port larger than .110 to achieve 20 ftlbs. If you are trying to significantly reduce the power of (as an example) the Discovery then you may go smaller yet. As an example, one that we tuned used a .105" transfer port to get just below 20 ftlbs. The transfer port in the Discovery is large because it is designed to work with CO2 as well and needs the larger size for the lower pressure CO2 gas. A Transfer Port that is large enough to give you the velocity you desire but no more will give you a flatter velocity curve. It is not mandatory that you replace the transfer port but it is beneficial. In the case of the Marauder, turn the transfer port adjustment all the way in (clockwise) and then turn it out 4 revolutions (counter clockwise). This is the starting point for the adjustable transfer port which is now all the way open.

Adjustments:

1) Set up a chronograph station with the assembled gun on sand bags in front of the chronograph so your readings will be consistent. The Muzzle should be at least 18 inches from the first sensor to prevent incorrect readings.

2) Have initial adjustments of the PCP set to A, B and C above.

Note: you will initially be tuning for a particular charge range so you will need to charge the gun to the same pressure each time and every 5 shots or so to maintain pressure during setting. Changes in charge pressure will give you changes in readings that will confuse the issue. Once the settings are complete then you will determine correct charge pressure and number of shots for that pressure.

3) Charge gun to a pressure that will be a little above the middle of your desired charge range. Example: If you are looking to charge to 2000 psi and shoot to 1000 psi then charge to 1600 psi for testing.

Method 1

4) Turn in (clockwise) the hammer tension until you feel tension on the hammer spring and then turn 1 more revolution in.

5) Chronograph a shot to see where your velocity is.

6) Increase hammer tension 1 turn.

7) Repeat 5 and 6 until your desired velocity is reached.

8) Shorten your hammer stroke 1/2 turn.

9) Chronograph a shot to see where your velocity is.

10) If your velocity stayed the same go to 8. If your velocity decreased go to 6.

11) Keep making adjustments (remember to charge every 5 shots) and chronographing until you are satisfied with the feel of the shot cycle. This is learned through experience and can not be adequately explained.

Method 2

4) Cock Hammer.

5) Turn in (clockwise) the hammer tension until you reach full coil bind and can not turn the hammer tension in any further (gun may fire during this adjustment). Fire gun. Cock the hammer again. If it will not cock then turn hammer tension out 1/2 turn. Cock gun again. Repeat until gun will cock reliably.

6) Turn hammer tension out 2 to 3 turns.

7) Chronograph a shot to see where your velocity is.

8) Shorten your hammer stroke 1/2 turn.

9) Repeat 7 and 8 until your desired velocity is reached.

You may see that as the stroke is decreased the velocity will actually increase. This is a common phenomenon as a more efficient setting is reached.

10) Keep making adjustments (remember to charge every 5 shots) and chronographing until you are satisfied with the feel of the shot cycle and velocity. This is learned through experience and can not be adequately explained.

Fine Tuning Velocity with an Adjustable Transfer Port

If your PCP has an Adjustable Transfer Port (as does the Marauder) then you can fine tune the velocity.

1) Turn the adjustment screw in $\frac{1}{4}$ turn at a time and chronograph a shot.

2) Make another $\frac{1}{4}$ turn adjustment and chronograph another shot.

Repeat the process until you reach your desired velocity.

During this process you may notice that the PCP gets quieter and blows less air but the velocity doesn't change much.

This is common as you are achieving a more efficient setting. Your shot count will increase as well.

Another benefit of a PCP with an adjustable transfer port is that you can dramatically flatten a velocity curve by restricting the transfer port and increasing the energy used to open the valve stem.

You will increase the usable charge pressure band and increase shot count in the process.

You will have to experiment with the settings to achieve this type of balance.

It will not be explained in detail here. It is mentioned here so you can strive to achieve such a balance as you are gaining experience with the other adjustments.

Testing for charge pressure and shot count

- 1) Charge gun 100 psi over the test charge pressure and fire a shot through the chronograph. Record the charge pressure and the velocity.
- 2) Repeat 1 until you notice a velocity drop of approximately 100 fps compared to your set velocity with your test charge pressure.
- 3) Charge to the highest pressure recorded in 2.
- 4) Shoot an entire charge through the chronograph recording each shot. The velocities will slowly climb, reach a point where they level off or peak and then decrease. Continue until the velocity decreases to match the velocity from shot #1.
- 5) Decide what is an acceptable velocity spread from your shot string. If shooting Field Target a 20 or 25 fps spread should be your maximum and some even go to 35. If hunting or plinking a 50 or even a 100 spread may suit your needs. Each individual must make that determination for their needs.
- 6) Examine your recorded shot string. Find the peak or leveled off velocity and subtract your acceptable velocity spread from that peaked or leveled off velocity. This is the start and end velocity.

As an example: The velocity from shot #1 may have been 800 fps. The velocity peak was 900 fps. The acceptable spread is 25 fps. The start and end velocity of the string should then be $900-25=875$ fps.

- 7) Look down the recorded shot string till the first instance of 875 fps (from our example) is recorded. See what shot number that 875 shot is.

From our example: shot #1 was 800 fps and shot #10 was 875 fps.

- 8) Charge gun to the pressure of shot #1 in the string and fire (from our example) $10-1=9$ shots over the chronograph. Shot #10 would now be the correct velocity, and the charge pressure that is in the reservoir is the correct charge pressure to achieve it.
- 9) Determine the charge pressure in the reservoir: Using a filler or pump with a gauge, charge gun slowly until the needle on the gauge stops or jumps. That stopping or jumping is also when you may hear the check valve open (a little click sound). That point on the gauge is the pressure that is left in the gun and should be your determined charge pressure. The gun should not be charged above that pressure for the way the hammer tension and hammer stroke is balanced. The gauge on the gun itself can also be used to determine charge pressure. Always charge the gun to the point on the gauge when you were about to take shot #10 from the example above. The Gun's gauge is not always accurate but it should be fairly consistent. Being a small gauge it can be difficult to always hit the same spot. A magic marker mark or wax pencil mark on the gauge may help. A piece of clear packing tape can be put over the gauge face and then cut to the edge of the gauge. Then mark the tape with a magic marker and apply another piece of tape over the first to prevent the mark from wearing off. The start and end pressures can be marked in this way so you can tell at a glance if you are within your preferred pressure band.
- 10) Shoot 5 or 10 shots over the chronograph to remove some of the charge from the reservoir.
- 11) Charge gun to the determined pressure and shoot over the chronograph recording each shot. When the velocity from shot #1 is reached after the velocity peaks that is the last usable shot from the charge. There may be a few shots after that velocity is reached that match it so shoot and record a few more shots to see if the velocity drops. Cross off any shots that are below your starting velocity once your ending velocity has reached your starting velocity. Count the number of shots and that is your shot count for the charge for the way the hammer tension and stroke are balanced.

These are just starting points for tuning your PCP. If the charge pressure, velocity spread and shot count are not what you would like then start over from the beginning at a different initial charge pressure. The more experience you get following these basic procedures the more you will be able to wring out of your equipment.

Enjoy and shoot safe.

Ray and Hans Apelles ~ *The "A" Team*