

# HUMA-AIR.COM

*Market Leader In Accuracy*

**Welcome to Huma-Air. We design and manufacture brand- and model specific precision regulators for PCP air rifles.**

---

By using only the highest quality materials such as aircraft grade aluminum, aluminum-bronze, chrome-moly steel and precision belleville springs, our ultra-compact regulators are high performing with less than 1% fluctuation.

## **Regulator installation guide Air Arms S4xx/S5xx**



For adjustment tips, frequently asked questions and a complete list of installation manuals and instructions on how to adjust your Huma-Air regulator

<https://www.huma-air.com/Fitting-instructions>



Or go there directly by scanning the QR code

**Before you start, realize this:**

- Working on a high pressure rifle could potentially be harmful or lethal to you or bystanders if you do not know what you are doing.
- The pictures of the rifle parts in this manual are universal and meant as an example to explain the working principle. They might not be equal to the parts in your rifle.
- Do not attempt to install this regulator yourself if you do not have a clear understanding of how these PCP rifles and regulators work.
- Do not attempt to install this regulator if you are not skilled to work on an air rifle; contact your local gunsmith to do the fitting.
- Installation and operation is done completely at your own risk.
- Installing this regulator might void your rifle's factory warranty.
- Your rifle may never be filled higher in pressure as stated in your rifle's manual.
- Do not attempt to fit this regulator in another rifle as mentioned in our order confirmation.
- These regulators are not suitable to use as a CO2 to HPA conversion, this could potentially be harmful or lethal to you or bystanders.
- We cannot be held liable for any accidents in relation to this regulator and its installation.

**Before you start, make sure that the rifle is unloaded, remove the magazine and make absolutely sure ALL the air is drained from the pressure tube. If there is a pressure gauge, it will give you just an indication. Dry fire the rifle or follow the manufacturer's instructions and double check to make sure all the air is out of the rifle**



**If the regulator is fitted and there is no output pressure after filling the pressure tube, something might be wrong causing the airflow to block totally.**

**Please beware even though there is no output pressure, the pressure tube is fully charged with high pressure air!!**

**If you are not able to relieve the pressure of the pressure tube according to the manufacturer's instructions or by dry firing the rifle then:**

**Contact a professional gunsmith to retrieve a solution!**

- **DO NOT try to unscrew or to open the pressure tube in any way.**
- **DO NOT try to pierce/drill or to use force to open the pressure tube or unscrew parts in an attempt to relieve the blocked pressure.**
- **These actions can cause serious injury or death to you or bystanders**

# Air Arms 400 Series HuMa Regulator Fitting Instructions

---

Fitting a Huma regulator to the Air Arms S400 and S410 rifle is a relatively straightforward process. However, the performance of the finished gun can vary significantly depending on how the regulator has been fitted and how the rifle has been set up.

While a rifle can be regulated using a minimum of knowledge and tools, it will never perform as well as one that's been set up by a knowledgeable individual with a good range of tools at their disposal.

This guide first covers the basics of fitting a Huma regulator to the Air Arms 400 Series rifle with a minimum of knowledge and equipment, before going on to discuss some methods of optimising the system to obtain the best performance.

It is strongly advised that this document is read in full before any work is started, both to allow you to satisfy yourself that you're comfortable with the work involved, as well as allowing you to decide how far you want to go into the conversion before you start.

## Disclaimer

This guide is provided on the understanding that all work is carried out at the individual's risk, and no responsibility will be taken for damage or injury sustained while following these instructions.

The guide assumes a level of basic mechanical knowledge and competence – if you're happy stripping your rifle to carry out basic maintenance and have access to a few common tools, you should be able to successfully fit a regulator.

The guide assumes competence and familiarity with handling firearms, and that the work and testing will be conducted in a suitable environment with an appropriate backstop / pellet trap to allow the rifle to be test fired safely.

Never fill your rifle to above the manufacturer's stated safe working pressure (SWP) - in the case of the Air Arms S400 this is 200bar.

It is your responsibility to ensure that your rifle remains within the UK legal muzzle energy limit of 12ftlb – and as such it is essential that you have the use of a chronograph to measure the rifle's muzzle velocity (and allow its muzzle energy to be calculated).

Allowing your rifle to exceed the legal limit does not just risk confiscation of your gun as well as possible criminal charges, but also damages the sport as a whole and only serves to make life harder for everyone – the introduction of anti-tamper measures on guns being a perfect example. For everyone's sake, please ensure that your rifle is legal when the work is complete.

As always – work slowly and carefully, and if in doubt stop and ask someone with an appropriate level of knowledge before proceeding.

## Scope of this Guide

This guide covers fitment of the Huma regulator to the current S400F and S410F rifles (typically those with a serial number of 100000 or higher), however it is also mostly applicable to earlier guns since differences are restricted to cosmetics and the location of some of the fixings (F-suffix guns have their loading bolt housing retaining bolts fitted from underneath, while earlier models have them fitted from the top or a mixture of both).

Rifles manufactured after 2007 / around serial no. 071300 will have left the factory with anti-tamper measures (AT) fitted – to prevent / discourage their disassembly and adjustment. This guide assumes that any AT fitted to the rifle has already been removed, and does not cover its removal.

If the AT on your rifle is still present and you're not 100% confident in removing it yourself (the shear bolt on the transfer port can be particularly difficult to remove without causing damage to the gun) it is strongly advised that you take it to a trusted gunsmith to do the work for you.

The basic principles and many of the operations covered in this guide are also applicable to the Air Arms 500 Series of rifles - including the HFT500, standard S510 rifles and Ultimate Sporter. The S510TC (Twin Cylinder) is not covered.

## Basic Guide

This guide is intended to cover the absolute basics of fitting a Huma regulator to the Air Arms 400 Series rifle with the minimum of tools and experience.

Following this guide will result in a regulated rifle that's safe, legal and consistent, that displays little or no velocity change as cylinder pressure falls (while in the operating pressure range of the regulator). The rifle will not necessarily give the best performance in this state, and can be optimised through the additional modifications described in the "Further Improvements" section found later in this guide.

## Tools

To fit the Huma regulator to your S400 or S410 you will require some basic tools, equipment and consumables, including:

- Good quality metric Allen keys, ranging from 1.6 to 5.0mm in size
- A chronograph for measuring your rifle's velocity, along with a safe backstop
- A good quality flat-bladed screwdriver (preferably hollow ground – blade thickness no more than 1.5mm)
- An electric drill (preferably a pillar drill, but a hand drill will do at a push)
- A drill bit of 1mm-1.5mm diameter
- A small countersink drill bit
- A rule or Vernier calipers
- Masking tape and a pen / pencil
- A half-round jeweller's file
- Abrasive paper (240—400 grit)
- A 10-12mm diameter wooden or plastic dowel that's around 100-150mm longer than your rifle's cylinder and has a 2-3mm wide slot cut in one end, running for around 50mm of its length
- A T10 Security screwdriver (depending on the rifle's age)
- A means of filling your rifle, such as a compressed air cylinder or manual pump
- A good supply of your rifle's favourite, quality pellets
- Good quality gun / mineral oil

In addition the following tools and supplies will make the job easier:

- A regulator pressure tester
- A bench vice with soft / shaped jaws
- A centre punch
- A hammer
- A small heat source such as a propane torch
- Pliers
- A set of metric spanners from 10mm-17mm in size
- A strap wrench
- A pair of heat resistant / welder's gloves
- Paper towel (preferably the blue industrial type)
- Silicone grease, such as Molykote 33
- Cold bluing solution
- An old, clean toothbrush
- A tool for firmly gripping the air cylinder without marking it
- A tool for removing the rifle's inlet valve housing from its cylinder

- A three-legged cylinder hone to suit the internal diameter of your air cylinder(around 27mm)

## Setting the Initial Regulator Output Pressure

The output pressure of the 16J / 12ftlb version of the Huma regulator can be adjusted between around 75 and 110 bar. The ideal output pressure will vary from one rifle to the next, being dependent on a number of factors including calibre, barrel length, condition, state of tune and age.

Guns with smaller barrel volumes (i.e. short barrels and small calibres) will require a higher operating pressure than those with larger barrel volumes.

As such, the following starting pressures are recommended depending on your rifle's calibre and barrel length:

Calibre	Barrel Length	Regulator Pressure
.177" / 4.5mm	395mm (Carbine)	110 bar
.177" / 4.5mm	495mm (Classic)	100 bar
.22" / 5.5mm	395mm (Carbine)	100 bar
.22" / 5.5mm	495mm (Classic)	90 bar

Insert your flat-blade screwdriver into the slot in the brass adjuster in the smaller-diameter end of the regulator and adjust to the appropriate pressure, according to the pressure scale on the attached sticker.

Don't worry about getting the figure exact as this is just a starting point and will likely require adjusting a number of times through trial and error before the ideal setting is reached.

## Stripping the Rifle and Preparation for Regulator Fitment

Providing there is no AT fitted, Air Arms rifles are usually very straightforward to work on.

To begin with the rifle should be checked to be clear – if present the magazine is removed and the rifle inspected to ensure that it is unloaded and un-cocked –leaving the bolt in the open (uncocked) position to show clear. If in doubt cock and dry-fire the rifle into a safe backstop before proceeding.

The next task is to ensure that the rifle is empty of air. This can be achieved by dry-firing the gun until completely empty (which will take a little while) or slackening off the filler adaptor gently with an appropriate spanner.

If unscrewing the filler proceed gently and unscrew it just enough for the O-ring to pop out and start releasing air – don't be tempted to unscrew it all the way while still pressurised and bear in mind that the O-ring might require replacement afterwards.

Once all the air has been released, unscrew the filler by 3-4mm, push the O-ring back into its groove in the inlet housing and nip the filler up again – remember there's no need to over-tighten it!



Separate the action from the stock by removing the single stock bolt on the underside of the for-end, between the trigger guard and gauge.





Next, remove the fill valve cover if still fitted and using a 2mm Allen key, slacken off the two grub screws on the barrel support and pull it forwards on the barrel, over the end of the filler valve assembly.

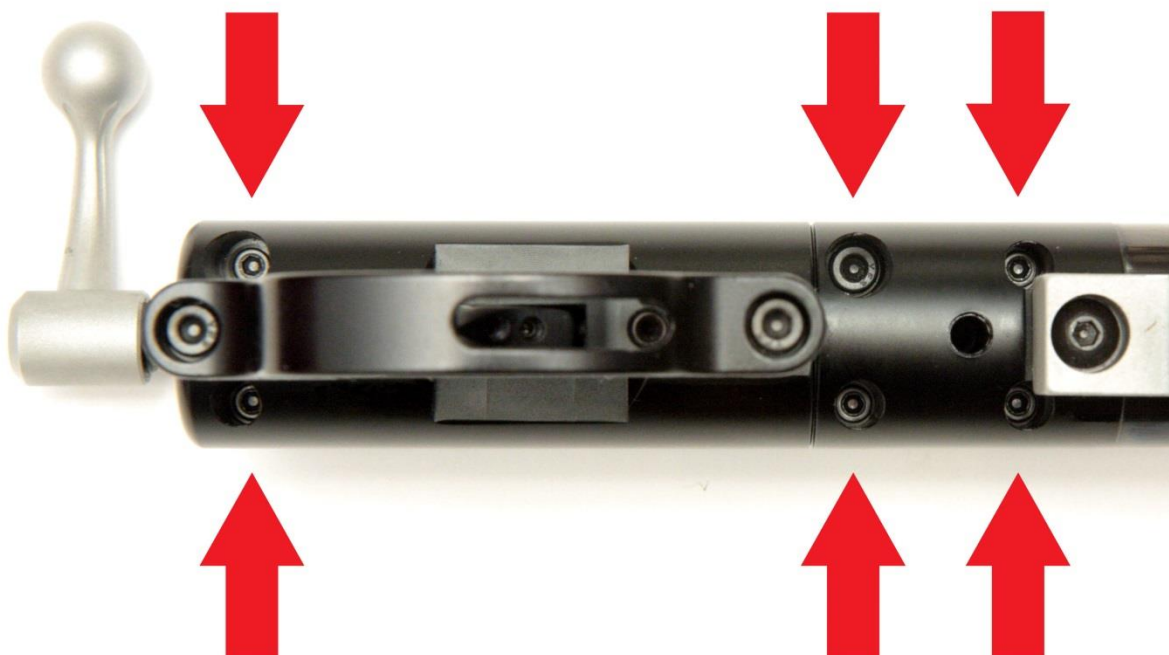


If working on an S410, remove the magazine indexing assembly by fully unscrewing the three retaining bolts using a 2.5mm Allen key, and removing the assembly en-block from the loading bolt housing.



Lay the action on its top and remove the six loading bolt housing retaining bolts in the underside of the action, working front to back and keeping your finger and thumb between the barrel and cylinder to prevent contact. Note that on current rifles these bolts are different sizes and will require both 2.5 and 3.0mm Allen keys.

When all bolts are out lift the striker housing, exhaust valve and cylinder assembly away from the bolt housing and barrel – making sure not to lose the 6x1mm transfer port O-ring that sits between them.



Holding the action vertically with its rear uppermost, unscrew the single bolt at the rear of the striker housing using a 5mm Allen key and lift the striker housing away from the exhaust valve assembly. Slide the striker off of its guide rail at the rear of the exhaust valve assembly along with the striker spring and its seat.

Remove any spacers that might be present between the striker spring and striker itself - these will not be required again, but ensure they're kept somewhere safe for future use as necessary.



Remove the pressure gauge and gauge mount from the underside of the exhaust valve housing by unscrewing the single bolt that holds the mount to the valve housing, using a 3.0mm Allen key. Be careful not to lose the 6x1mm O-ring that seals the mount to the valve housing – note that these have a hard life and often require replacement during routine work.



Place a piece of masking tape around the circumference of the air cylinder so that its centre is around 50mm from the cylinder's rear edge (where it meets the exhaust valve assembly). Using a rule or straight-edge mark a pencil line on the masking tape on the top of the cylinder that runs through the centres of the transfer port and blind hole in the top of the exhaust valve housing, as well as another line on the masking tape on the underside of the cylinder that runs through the gauge mount and stock bolt holes on the underside of the exhaust valve housing.





Unscrew the air cylinder from the exhaust valve housing – this is easier on some guns than others, but can usually be done by hand. If the cylinder proves difficult to remove I supply a collet tool for gripping the cylinder, which is available on my website [\[LINK\]](#). In extreme cases heat from a hot air gun or gas torch can be useful in shifting particularly stubborn cylinders.



To allow regulator fitment the brass exhaust valve “pot” or “plenum” requires removal. It’s a push fit onto the valve spring retainer and is assembled with retaining compound. Ideally this needs to be heated moderately with a torch or heat gun to allow it to be gently wiggled, twisted and pulled off using padded pliers or a gloved hand.





## **Drilling the Regulator Vent Hole**

### **The Advantage of Venting the Regulator**

To get the best performance from your regulated rifle the regulator requires a vent or breather hole in the air cylinder.

While not absolutely essential, allowing the regulator to vent to atmosphere brings two significant advantages:

- The regulator output pressure (and hence muzzle energy) is less susceptible to fluctuations due to changes in ambient temperature.
- Should the regulator develop a leak, the gun will lose pressure (making the issue obvious), rather than allowing the regulator to pressurise - increasing output pressure and causing significant variation in muzzle energy.

The vent hole can be drilled before the regulator is fitted for the first time, or alternatively the more cautious might choose to set up the rifle with an unmodified cylinder (to check for correct operation etc) and add the vent hole once the setup is complete. Please note that adding the hole at a later date will still require the rifle to be stripped and the reg removed before the hole is drilled.

Since the vent hole is an irreversible modification, some owners may prefer to source and modify a second air cylinder for their gun and keep the original intact and allow the rifle to be reverted to an un-regulated state should this be desired in the future.

### **Finding the Correct Location for the Regulator Vent Hole**

The position of the regulator vent hole is extremely important. Its location along the length of the cylinder needs to place it between the two O-rings on the exterior of the regulator body. With the current 16J standoff length the hole needs to be around 51mm from the rear edge of the air cylinder (as illustrated below).

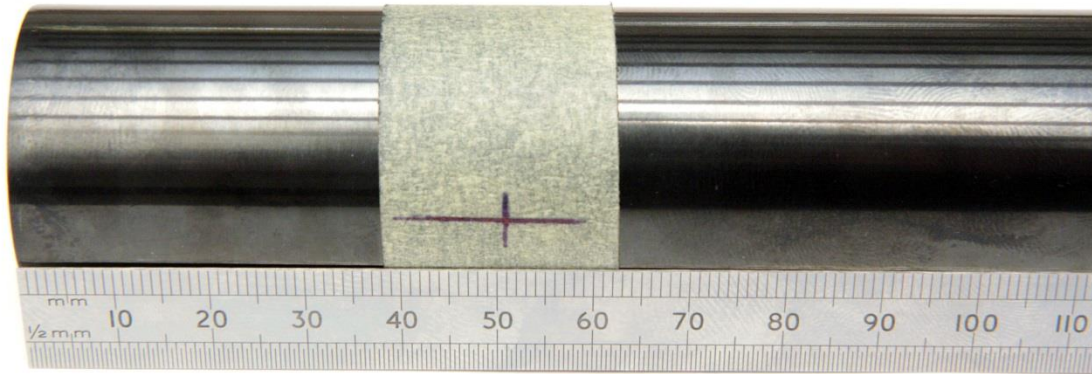


Since dimensions can change with revisions in component design, arrange the exhaust valve housing, standoff and regulator together as illustrated above and measure the distance from the cylinder mating face on the exhaust valve housing to the mid-point between the two O-rings on the regulator to check this value for yourself.

The position of the vent hole around the cylinder's circumference is also important, and to an extent a matter of personal choice:

- Locating the hole on the underside of the cylinder keeps it out of sight but increases the chance of water and debris ingress to the cylinder, should these become trapped between the rifle's cylinder and stock.
- Alternatively, locating the hole on the upper surface of the cylinder reduces the chance of contamination entering the cylinder, but makes the hole visible with the stock fitted.

Once a choice has been made for the location of the vent hole, mark its longitudinal position on the masking tape on either the upper or lower surface of the cylinder, using the distance measured for the ideal position of the vent hole from the rear of the cylinder - as shown below:



### Drilling the Vent Hole

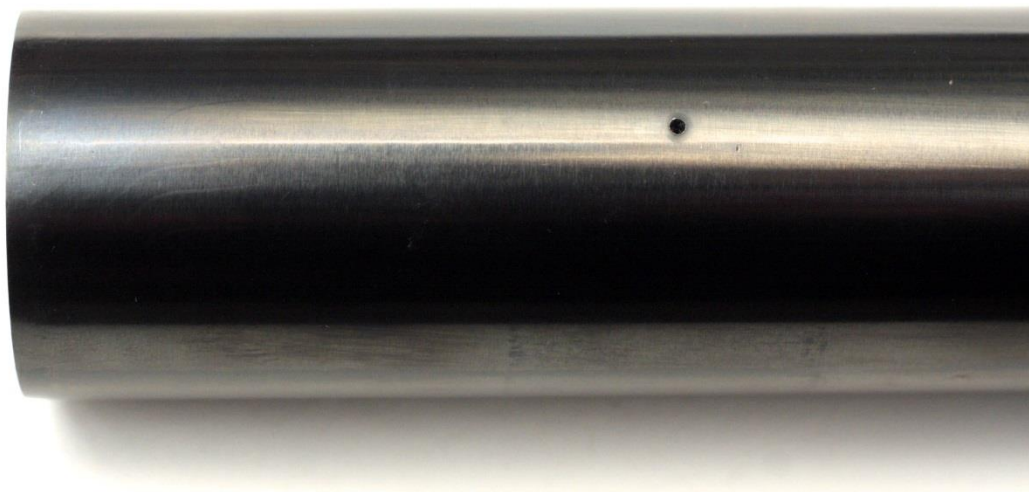
Now the position of the vent hole on the cylinder has been marked with a pencil line, finalise this location by marking it with a centre punch.

Using a 1-1.5mm diameter drill (preferably mounted in a drill press with the cylinder firmly clamped squarely in place) carefully drill a hole through one side only of the air cylinder, perpendicular to its circumference and length.

Using an appropriately fast chuck speed, work slowly and use plenty of lubrication in the form of light mineral oil or cutting fluid. Once the hole has been made, clean any swarf and oil from the cylinder.

Completely de-burr the hole on the inside of the cylinder using the half-round jeweller's file, remove the masking tape from the exterior of the cylinder and use a small countersink bit to manually de-burr the hole on the exterior of the hole as necessary.

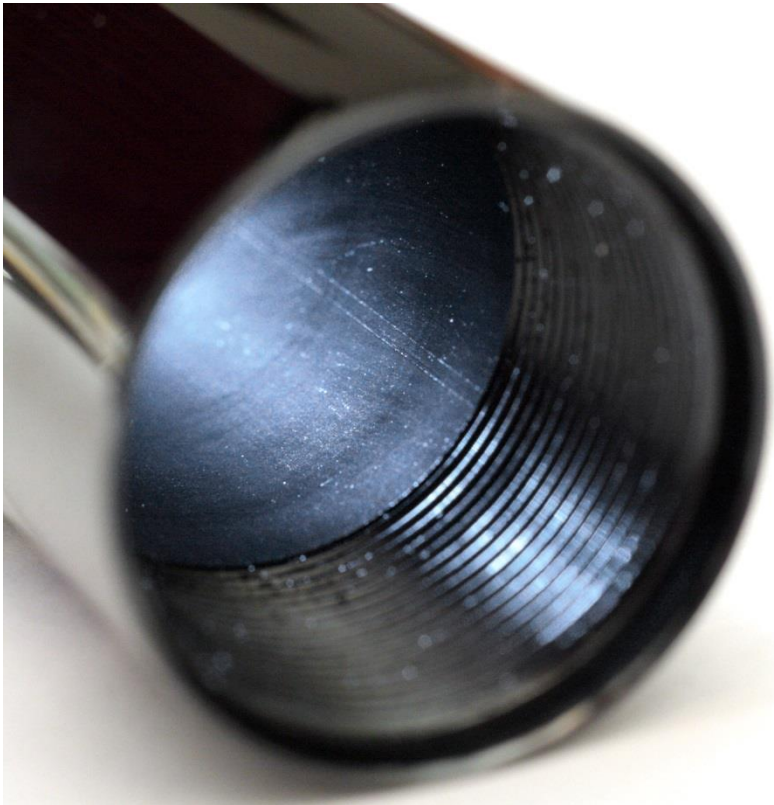
You may wish to touch up any "white" metal surfaces left after this process with cold-blue solution.



## **Preparing the Internal Surface of the Cylinder**

Air Arms cylinders are made from seamless drawn hydraulic tube and as such can have surface imperfections that run along their length. In unregulated rifles this isn't an issue, however most retro-fitted regulators are located inside the cylinder and are required to seal against its interior surface – which can lead to problems.

The cylinder shown below is as received and clearly shows the longitudinal scores that can result from the drawing process.



It's possible for small surface imperfections on the inside of the cylinder to cause very slow leaks; allowing air to bleed past the external seals and escape from the breather hole in the cylinder.

Consequently, while not absolutely essential it's highly recommended that the inside of the cylinder is re-finished to remove any surface imperfections that might be present since manufacture. This can be achieved through the use of abrasive paper or a cylinder hone.

### **Abrasive Paper**

Potentially the cheapest way to attain the desired surface finish in the cylinder, a strip of abrasive paper can be mounted (along with a suitable backing material) in the slotted end of a wooden or plastic dowel and wound around its diameter until an appropriate size to fit snugly inside the rifle's cylinder. This assembly is chucked in an electric drill, inserted into the desired portion of the cylinder and worked back and forth along the relevant section of the cylinder's length while spinning to abrade its internal surface.

Dimensions aren't critical but the abrasive strip and backer should typically be between 30 and 40mm wide. The backing material serves to increase the effective diameter of the abrasive strip when wound around the dowel, and to provide some pre-load between the abrasive and cylinder wall. It also serves to allow some compliance, reducing the need for the dowel and cylinder to be perfectly aligned and allowing the abrasive to better conform to the internal surface of the cylinder.

A household cleaning cloth ("Jay-cloth") makes an ideal backer since it can be folded to varying degrees (and cut as necessary) to alter the strip's width and effective diameter when wound around the dowel.



240-400 grit Wet and dry paper is the abrasive of choice and can be used dry, or preferably with a lubricant such as oil, paraffin or water. If using water be sure to thoroughly dry and re-oil the cylinder when finished.





### **Cylinder Hone**

Honing the cylinder is basically the same process as described above, but a two or three-legged cylinder hone is used instead of the dowel assembly – typically the size required is often sold for the

purpose of re-finishing the cylinder bores of vehicle brake calipers and can be purchased from a number of automotive-based sources for £10-15, Try to buy from a reputable source since there's plenty of cheap rubbish about.

Providing a decent quality example is used the hone should provide more control, take less time and hassle and ultimately give a better finish than wet and dry paper. Initially the two or three stones should be lightly oiled, installed into the cylinder and the spring loading on the legs increased to force the stones into hard contact with the cylinder walls. Once the original finish of the cylinder has been removed the spring tension can be reduced to give a finer finish. Care should be taken when removing the hone from the cylinder to squeeze the legs together and out of contact with the cylinder walls, to prevent longitudinal scratches.



### **Re-finishing, cleaning and Inspection**

The rear section of the cylinder should be polished from the front edge of the threaded portion (not the threads) to just past the point where the front of the regulator will be located. You may want to put a couple of marker pen lines on the dowel or hone shaft as a visual aid to preventing going “too far” into or out of the cylinder. While the threads are best left alone, it won't matter if a longer section than necessary of the cylinder is re-finished.

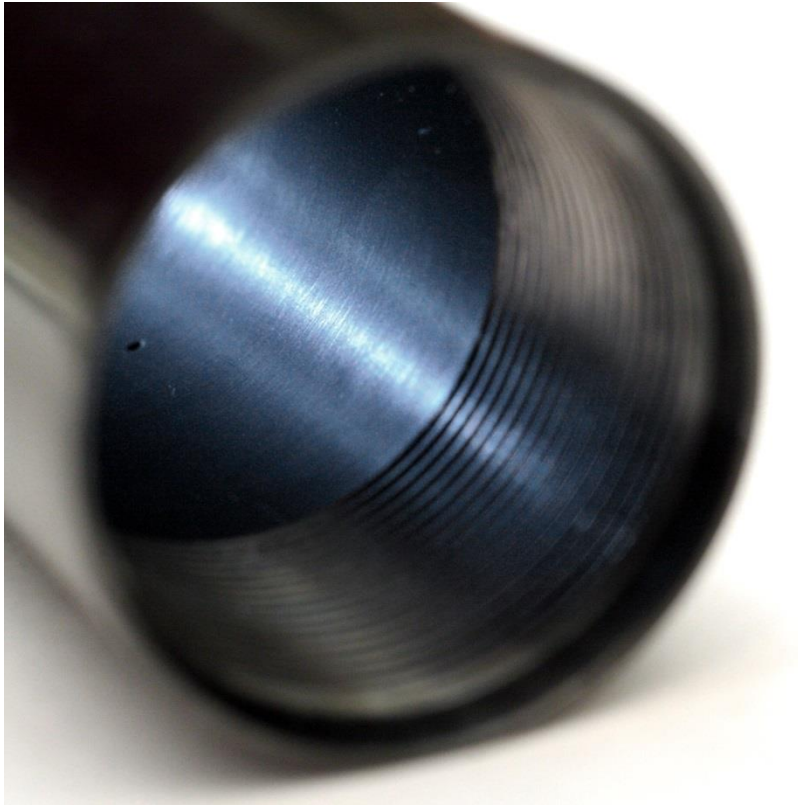
Avoid spinning the dowel or hone excessively fast in the drill and slowly work the assembly back and forth along the cylinder's length over a stroke of maybe 30-40mm.

Regularly check the abrasive for clogging – cleaning and re-lubricating as necessary. Frequently clean and inspect the inside of the cylinder for finish – the surface should be an even, matt grey colour with many light, evenly-sized scratches running mostly in the direction of its circumference.



Inspect for remaining imperfections by looking down the cylinder at a light source while observing its internal surface finish, as well as running a finger or finger nail around the internal circumference to feel for any deeper scratches or depressions - especially those running along the cylinder's length. Polish or hone until the surface is even and there are no imperfections.

The resultant finish should look similar to that in the image below:



When finished thoroughly clean the cylinder of oil and abrasive using an old, clean toothbrush to get the worst out of the threads and breather hole and paper towel to finish the job. You may wish to flush the threads out with isopropyl alcohol or similar to be confident that all abrasive has been removed.

Lightly oil all surfaces afterwards to prevent corrosion – especially those that have just been polished.

## **Regulator Fitment and Rifle Reassembly**

### **Seal Replacement and Additional Work**

Before reassembly you may wish to take this opportunity to replace the O-ring seals in the rifle. While unnecessary on rifles less than a couple of years old, it might be prudent to replace at least the smaller O-rings on earlier rifles (and any that show noticeable degradation in the form of excessive hardness, brittleness or having taken a "set" in the shape of their housings).

Exhaust valves also degrade over time - earlier white nylon variants apparently being less susceptible to this than their later black counterparts. Exhaust valves are past their best and should be replaced when a small but noticeable radial ridge can be felt when running a finger nail from the outside to the inside of their sealing face.

### **Regulator Fitment**

Ensure that the regulator and its standoff / spacer are clean and dust- free. Apply a small amount of light mineral oil or silicone grease to the two O-rings on the exterior of the regulator and place it larger-diameter-end-down on a clean, flat, horizontal surface.

Lower the rear of the cylinder over the regulator until the first O-ring on the regulator body is in contact with the threads in the rear end of the cylinder. Keeping the cylinder as upright as possible, gently press it down over the regulator, feeling for excessive resistance to avoid damaging the O-rings as they're pushed over the threads.

If excessive resistance is felt, work around the cylinder's circumference applying load until it becomes better aligned with the regulator and continues to slide over it, until the rear faces of the regulator and cylinder are flush.

Next, position the standoff on the flat surface, so that it is resting on one of its flat ends. Put the rear of the regulator on top of the standoff's upper face and continue to push down on the assembly until the rear face of the standoff is flush with the rear of the cylinder.

Finally, use your dowel or another cylindrical item of similar diameter to the standoff to push the regulator further into the cylinder, until its rear face is around 45mm below that of the cylinder.

Place a smear of mineral oil or silicone grease on the exhaust valve assembly's O-ring, and holding it with the brass valve retainer pointing upwards, place the regulator standoff on the front face of the housing so that the exhaust valve retainer sits inside the cut-out in the rear of the regulator standoff.

The correct orientation of these parts can be seen in the image below (note that the regulator will already be present inside the cylinder when the valve assembly and standoff are fitted):



Screw the cylinder onto the exhaust valve housing – if excessive tightness is felt back off any try again, if it persists separate the two parts and push the regulator a little further into the cylinder.

Do not be tempted to rely on the assembly of the cylinder and valve assy to push the regulator into the cylinder – this can result in damage to the regulator and standoff. Also, ensure that the standoff is in the correct orientation with respect to the valve retainer (and cannot move because the regulator is too far forward) before the cylinder is pressurised – otherwise serious damage to both components will result.

Ensure that the rear of the cylinder and mating face of the valve housing are in firm contact – these parts only need to be hand-tight and there is nothing to be gained from excessive tightness as they'll be next to impossible to separate when pressurised.

### **Reassembly of the Remaining Action Components**

Re-assembly is broadly the reverse of disassembly, with a few additional procedures and points of note. A spot of oil on the threads of each bolt before refitting is always a good idea, and never be tempted to over-tighten bolts - a gentle "nip" is all they require and excessive force will damage the threads. Similarly most O-rings will benefit from a light smear of oil or synthetic grease prior to reassembly.

Refit the gauge and mount assembly to the underside of the exhaust valve housing - making sure not to omit the seal between them (be this the original or a new replacement).

The action should now be air-tight and now is a convenient opportunity to test the regulator for correct operation and the action for leaks. Connect the filler valve on the front of the cylinder to your

pressure source, and slowly fill the cylinder to around 150bar on the gauge on the pump or air bottle – this is the pressure on the input side of the regulator.

Allow the action to stand for 5-10 minutes while listening / feeling for leaks and noting the pressure on the rifle's gauge throughout. Place a spot of mineral oil over the breather hole in the cylinder and watch for bubbles / fizzing that would indicate a leak.

Now that the regulator is fitted, the rifle's gauge should display the regulator output pressure (rather than the pressure in the gun's cylinder).



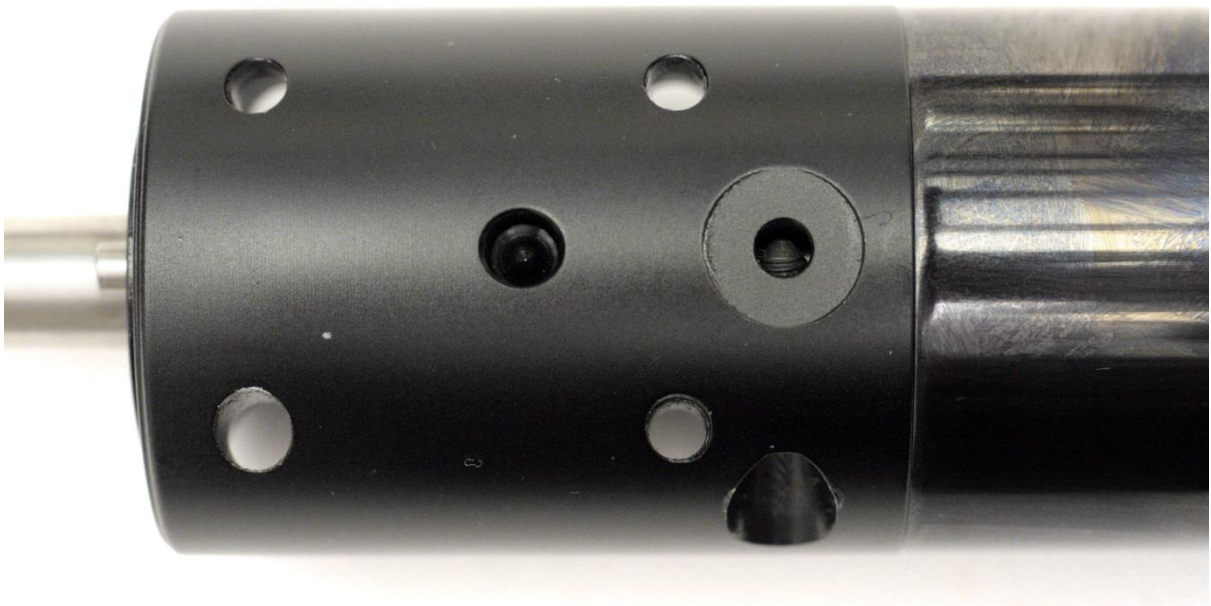
It's usual for this to creep up slightly during the first few minutes of pressurisation as the regulator "settles". In the unlikely event that pressure continues to climb until the rifle's pressure gauge is displaying a value close to the 150bar in the cylinder, there is a leak either within the regulator or at the O-rings around its circumference (the latter case only being possible if there's no breather hole in the cylinder).

If the regulator is allowing full cylinder pressure to pass through to its output side, de-pressurise and strip the assembly to inspect the regulator's inlet valve seat according to my video here ([LINK - assuming that you have stripping instructions on this reg on your youtube channel ;\)\)](#)).

Assuming there are no leaks, the next step is to remove the restriction at the transfer port to allow the rifle to function better at the lower operating pressure of the regulator. Remove the cover screw on the transfer port adjuster (depending on the rifle's age and history this may be an AT-shear bolt if not already removed, a socket cap screw, a T10 security cap screw, grub screw or nothing at all).



Looking at the transfer port itself in the exhaust valve housing from above, you'll notice the conical-end of the port adjuster screw projecting into the port.



Using a 1.6mm Allen key inserted into the port adjuster hole in the side of the exhaust valve housing



and into the rear of the port adjustor screw, turn the screw anti-clockwise until it can no-longer be seen from above projecting into the transfer port. Refit the cover screw.



Next, re-fit the striker and spring to the guide rail on the rear of the exhaust valve housing, then add the spring seat to the rear of the striker spring and fit the striker housing over the whole assembly. The guide rail should be thoroughly cleaned before re-assembly, but not lubricated since the striker runs on self-lubricating bushes.

Making sure the guide rail is centred within the striker housing, push and hold the striker and exhaust valve housings together (Against the force of the striker spring between them) and secure the whole assembly together by loosely fitting the single retaining bolt through the rear of the striker housing and into the tapped hole in the rear of the striker guide rail.

Ensure that the striker assembly is correctly oriented with respect to the rest of the action (i.e. the gauge and trigger assemblies are both on the underside of the action and roughly aligned, as shown in the image below) - at this point parts should be able to rotate relatively freely with respect to each other to allow fine alignment when fitting the breech block.



Lay the bolt housing upside-down on its dovetail and place the 6x1mm transfer port seal in the corresponding circular recess in the housing's underside. Making sure the loading bolt is forward, carefully offer the rest of the action up to the bolt housing and loosely refit the six retaining bolts. Once all are fitted, gently successively tighten opposite bolts (left to right, front to back).

If the rifle is an S410, refit the magazine indexing system with its three bolts, making sure that the peg on the cam plate inside is correctly aligned with the corresponding cut out on the loading bolt inside the bolt housing.

Refit the barrel band to the inlet valve housing and nip up the two retaining grub screws.

The final re-assembly operation is to fit the stock with its single bolt.

## Muzzle Energy Testing

Since some pellets are more efficient than others (PCPs typically give higher muzzle energy with heavier pellets) it is strongly recommended that the rifle is tested and set up with the most efficient pellets to ensure that it remains inside the UK legal energy limit with all pellets.

JSB currently provide among the most efficient and accurate pellets, and hence make a good choice for both testing and general use. It is recommended that .22 rifles should be set to around 11.5ftlb (570ft/s) with 15.9gn JSB Exact / Air Arms Diabolo Field pellets.

.177 rifles should be set up to produce no more than 11.8ftlb (715ft/s) with 10.34 JSB Exact Heavy / Daystate FT Heavy pellets, 11.3ftlb (775ft/s) with 8.44gn JSB Exact / Air Arms Diabolo Field pellets or 11.0ftlb (795ft/s) with 7.9gn JSB Exact Express / Air Arms Diabolo Express pellets.

Chronograph five shots - the velocity and energy of which should be somewhere near the figures above. If the muzzle energy is not correct, the rifle needs to be de-pressurised, stripped and the regulator removed and adjusted. In this state of tune the regulator pressure should be decreased to lower muzzle energy and increased to raise it.

The removal and refitting process is as already described, with the exception that the regulator can be removed from the cylinder by screwing an M3 bolt into the tapped hole in the rear of its brass piston and using this to draw the unit out through the rear of the cylinder. Loading bolt housing bolts are usually M3, so one of these is ideal for the job.



Alternatively it's possible to de-pressurise the rifle, remove the barrel support and inlet valve



assembly, and insert a long, flat-bladed screwdriver down inside the cylinder to adjust the regulator in small increments ( $1/8$  or  $1/16^{\text{th}}$  of a turn since the pressure scale cannot be seen).

Note that the inlet valve housing can often be difficult to remove from the cylinder and it is not advised to attempt this without the correct tools. I can provide through my website a collet tool for gripping the air cylinder ([LINK HERE](#)) as well as a two-pinned tool for removing the inlet housing ([LINK HERE](#)). Note that the application of heat can also aid the separation of the inlet valve housing and cylinder. The parts only need to be reassembled hand-tight.

Another approach to correcting excessive muzzle energy is to screw in the transfer port adjustment screw, although this is a less preferable solution than reducing the regulator pressure.

In this configuration increasing the regulator output pressure will increase muzzle energy, while decreasing the output pressure will reduce muzzle energy. It is recommended that the regulator is adjusted in increments of 5 bar or so at a time, reducing the amount of adjustment incrementally as muzzle energy gets closer to the desired value.

Once muzzle energy has been set the rifle is ready to use!

## **Further Improvements**

The basic setup described in the previous section is good enough to get the regulated rifle up and running, but this system is not operating at its optimum.

This is for a number of reasons, but essentially it's because some fundamental parts of the rifle are still set up to work at the higher operating pressure of an un-regulated rifle, and as such require modification to best serve a regulated system.

Typically an un-regulated rifle displays a "velocity curve" - where the velocity starts out slightly low at the gun's fill pressure (around 180 bar for an S400), climbs a few percent and peaks as cylinder pressure falls (typically at around 140-150 bar) before falling away again as cylinder pressure continues to fall past this point (typically falling below the starting velocity at around 120-130 bar).

Following the "Basic Setup" guide in the previous section forces the rifle to operate at a lower pressure than it was designed to (typically 80-110bar), and as such is effectively running on the less-efficient "downward slope" of its (unregulated) velocity curve.

Adjustment of some operating parameters can alter the unregulated velocity curve to make it better fit the requirements of a regulated system; reducing the pressure at which the velocity peaks and allowing it to coincide with the lower regulator operating pressure.

The two most important issues in changing this behaviour are discussed below, along with suggestions as to how they might be corrected, lessened or worked around.

**Excess Exhaust Valve Duration**

Because the regulated rifle subjects the exhaust valve to a lower pressure than it would have seen when operating without a regulator, there is less force holding the valve shut. As a result the valve is now easier to open and the unmodified striker assembly hits the valve "harder" than it now needs to - resulting in the valve staying open longer than necessary (excess duration) and wasting air.

There are a number of ways to resolve this issue, depending on the facilities, time and funds available. Below are a few suggestions - roughly in ascending order of cost and commitment!

***Exhaust Valve Spring Pre-load Adjustment***

The Pre-load of the exhaust valve return spring can be adjusted by screwing its retainer in and out, and hence altering the amount of spring force (in addition to any pressure loading) that contributes to holding the exhaust valve shut.

Adding pre-load to the exhaust valve spring will have the effect of reducing valve duration, and correspondingly reduce air wastage if duration is excessive.

The exhaust valve spring retainer is accessed as described in the previous section: "Stripping the Rifle and Preparing for Regulator Fitment". Once the valve spring retainer is accessible it's locking grub screw needs slackening off to allow it to rotate - this is located on the underside of the exhaust valve housing:



Once the preload on the exhaust valve return spring has been adjusted, its locking grub screw should be very gently nipped up to prevent it from moving.

Given the limited influence of the exhaust valve spring on the system, it is probably wise to increase preload to its maximum, test the muzzle energy and work backwards as necessary, should the adjustment result in reduced muzzle energy.

While adjusting the exhaust valve spring preload will improve the rifle's operation with a regulator, it is not in itself sufficient to get the best from the system.

### ***Shortening / Replacement of the Striker Spring***

An obvious way of reducing the magnitude of the striker's impact on the exhaust valve is to reduce the spring force acting on the striker.

Unfortunately other than the addition of -pre-load spacers, the S400 series offer no means of adjusting spring force on the striker - leaving only the options of cutting down the original spring or fitting a shorter or lower-spring-rate replacement to reduce mean spring force and suit the lower operating pressure.

In practice suitably-sized replacement springs can be difficult to acquire – springs are available in small quantities from a number of suppliers, however in small numbers they're usually disproportionately expensive per unit. Ideally a replacement spring would be of similar rate but shorter than the original, to reduce spring pre-load.

Cutting down the original spring is irreversible and can be hit and miss. If the original spring is cut the affected end must be correctly re-finished by heating, closing the open coil and grinding flat.



Finally, reducing the spring force on the striker will increase lock time (the time between the trigger release and striker impact with the valve) which will make the rifle somewhat harder to shoot accurately.

In summary cutting or replacing the spring is a workable solution but one that's less than ideal in many respects.

### ***Lightening the Striker***

Reducing the striker's mass lowers its momentum and hence reduces exhaust valve dwell. It will also reduce lock time, which is a bonus.

In operation there are few drawbacks to running a lightened striker, however the practical aspect of doing so can be a little challenging.

Choices are to either modify the original item (difficult since it's hardened) or to make a complete replacement, which is within the reach of competent machinists, but one still has to be careful with design and material choices as many lightweight materials (Acetal, Aluminium) lack the strength to endure repeated valve impacts.

The most viable option is probably a slimmed-down version of the original, remade in steel. The adventurous might consider a composite design comprising a body made in lightweight material with hardened steel inserts at the faces that are subject to wear and impact.

Ideally mass would be variable to allow fine-tuning of the system using this value, however in practice this is difficult to achieve.

### ***Shortening the Striker's Stroke***

"Short-stroking" the striker to reduce its impact on the exhaust valve involves effectively lengthening the striker's "nose", to reduce the distance it has to travel from sear release until impacting the valve.

Similarly to lightening the striker this has few operational disadvantages, again serving to reduce the lock time as a convenient side-effect.

Due to the peculiarities of the S400's striker setup short-stroking really requires a new striker, that's preferably adjustable to allow fine-tuning - however in practice this is a challenge.

### **Transfer Port Flow Limitations**

When reducing the operating pressure of a rifle by regulating it (typically from a mean of around 150bar to around 75-100bar, so a reduction of around 35-50%), ideally the transfer port needs enlarging to allow the same mass flow rate of air at the lower operating pressure.

As standard the transfer port in the S400 series is adjustable, being an unrestricted 3mm in diameter at its largest - more than sufficient for any legal limit, un-regulated application.

This size will also allow an operating pressure low enough to make regulation viable, however larger ports still would allow the use of even lower regulator pressures - giving a wider working pressure range while operating "on-reg", and hence a greater number of shots per charge.

### ***Increasing Transfer Port Size***

The transfer port runs from the outlet side of the exhaust valve, through the valve block, loading bolt housing and breech seal carrier; terminating just behind where a loaded pellet would be located in the breech.

Increasing the diameter of the port in these three components is a relatively simple process (with the correct tools) of drilling / reaming out the port in these parts to the larger size.

While a well-setup Classic length S400 in .177 might have an ideal regulator operating pressure of around 100 bar with a 3mm diameter port, enlarging that to the feasible maximum of around 3.6mm would increase its flow area by around 44%, reducing ideal regulator pressure to perhaps 80-90 bar. If the rifle were being filled to 200bar, this greater operating pressure range would give between 10 and 20% more shots per charge.

Ports can be enlarged further still (the real limit being around 4.0mm), however care must be taken to avoid going so large that the pellet is allowed to fall into, and be damaged by, the port during loading.

If the port is altered at all, it's important to ensure that there are no burrs left – especially in the brass seal carrier at the breech that could cause damage to the pellet during loading.

Be aware that increasing the transfer port size will also increase muzzle energy, so striker impact will have to be reduced further (as per the previous section) to compensate, which will reduce ideal regulator pressure.

It must be noted that this process is irreversible and in some cases replacement parts for earlier guns are no-longer available. Once the ports are enlarged it will be very difficult to revert the rifle back to an un-regulated state - consequently there's no going back so think very hard before deciding to take this route with your rifle!

## **Overview and Final Thoughts**

In summary it can be seen that the performance of a regulated Air Arms S400 can vary significantly depending on how it has been set up. It might help to consider three possible "states of tune" for a regulated S400:

### ***Basic Tune***

As described in the first section (should basic section include section on exhaust valve spring preload?) - straightforward to accomplish with some basic knowledge and tools, fully reversible (if no breather hole is drilled or a new cylinder is purchased) but far from optimum in terms of air efficiency or number of shots per charge.

### ***Intermediate Tune***

As per the basic tune but with the system further optimised to improve shot count and air efficiency, using some of the less exotic processes described in this section. Transfer ports are left untouched, striker impact is reduced by shortening / replacing the striker spring and / or fitting a custom lightweight and / or short-stroked striker if facilities are available to make one.

If necessary the rifle can be reverted back to an un-regulated state easily and with a minimum of readily available parts (an air cylinder and possibly striker spring).

A good choice for those who don't want to irreversibly-alter their rifle - perhaps because it is an earlier variant, is collectable or has sentimental value.

### ***Full Tune***

As per the intermediate tune, but taken to an extreme to get the very best performance from the gun.

A custom lightweight and / or short-stroked striker will be fitted and ports enlarged to their absolute maximum - allowing the rifle to operate at the lowest possible working pressure and hence give the greatest number of shots per charge.

Due to the large amount of irreversible modifications done to substantial parts of the rifle, returning it to an un-regulated state would be difficult with earlier guns and most likely financially non-viable in all cases.

Of course it's feasible to start at the most basic state of tune and allow the gun to evolve as skill, funds and facilities allow. Ultimately it's up to you to decide how far you want to go!