Casing & Piston Problems – Approaches to Repair

Evaluating/Diagnosing Problems

Tolerances

Removing Stuck Pistons

Using Ground Casing Mandrels

Using Brass Laps

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Casing Thread Repair

Valve Jobs

Porting Piston Valves

Other Casing Problems

Valve Oils

The key to successful and speedy piston and casing repairs lies in correctly diagnosing problems. Those problems that can slow or stop a valve include:

- Dirt and Debris
- Valve Corrosion
- Casing Dents
- Stress at Casing Knuckles
  - Mis-aligned tuning slides
  - Bent Bell Bows/Tails (trumpets/cornets)
  - Body Bends
- Casing Thread Problems
- Bent Valve Stems
- Bent Pistons
- Out-of-Round Pistons
- Valve Guide Problems
- Valve Guide Slot Burrs
- Improper Cross–Hatch on the Valve Surface
- Improper Valve Fitting

Tolerances

When measuring diameters of pistons casings, expect to find tolerances ranging from .001" - .0015" on student level brasswinds (this means that on any one side of the piston, there would be .0005" - .00075" of space). On professional brasswinds, tolerances can be between .0005" - .0001" ((this means that on any one side of the piston, there would be .00025" - .0005" of space). A typical piece of paper is approximately .003" thick.

It should be noted that when tolerances exceed .0015" between the piston and casing (measuring diameter), the instrument is leaking enough where performance will suffer, even when heavier-viscosity valve oils are used.

Evaluating/Diagnosing Problems

Inspection separates the pros from the amateurs and can save much time and effort resulting in a lower charge to the customer. Do not assume anything without visual confirmation during a piston or casing repair.

Inspecting Valve Casings for Damage

*Hold the instrument up with against a background light source. Reflected light inside the casing will reveal any **dents, stress at the knuckles, burrs or spanner brace problems**. Continue to inspect the casings in this manner as you proceed through the repair to discern progress and determine completion.*

2nd Valve Slide Damage

It is very common for the second valve slide on trumpets and cornets to push into the valve casing at the knuckles, seizing the piston altogether or jamming it during its stroke. The solution is to grab the 2nd slide as shown, flexing it outward to alleviate the stress at the casing. Some will use the first valve slide to gain leverage for the procedure, but it increases the chances for breaking the outer valve slide tube solder joints - creating more work.

Bent Bell Bows

The pressure a bent bell bow exerts on the first casing knuckle is enough to seize the piston, as shown in this photo. Notice the hand position to straighten the bow at the precise point of the bend.

Body Bends

*In this photo, the body of the instrument (the portion independent of the mouthpipe and bell) has bent, jamming the 3rd valve slide. To determine, sight the mouthpipe for straightness, if it is good then the body must be flexed back into position. Notice how the **lower** main tuning slide tube is out of parallel with the **upper** main tuning slide tube viewed from above (side plane). This problem is more common on student instruments without cross braces at the main tuning slide.*

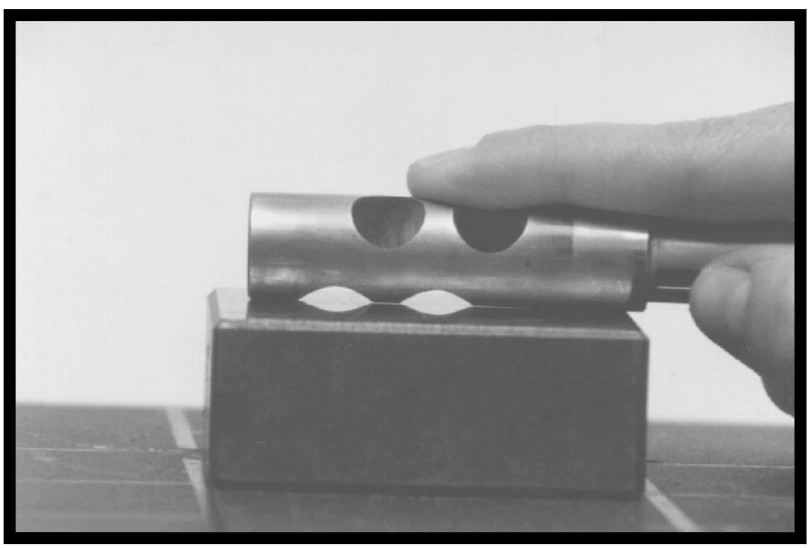
Damaged Casing Threads

Damage at the threads can jam a piston at the bottom of its stroke. Sometimes that damage can be barely discernible, especially on casings which are not counterbored at the bottom like on Bach/Bundy instruments. Place the piston in through the bottom of the casing - if it jams, you know the problem is at the threads.

Piston Problems?

Roll the pistons on a flat surface, inspect for two problems:

- **Straightness**
- **Roundness** (if they are consistently true from top to bottom)



Backlit, a wealth of information is available when a piston is rolled on a flat surface, such as a bench block or leveling stone. More information on discerning piston problems follows the casing repair section.

Stuck Pistons Due to Casing Damage

When a valve is stuck in the casing due to casing damage which cannot be repaired
Prior to removal of the piston, the most important rule of thumb for the technician is:

PRESSURE TO REMOVE THE PISTON MUST BE PLACED ON THE PISTON WALL EDGE, NOT THE BOTTOM REINFORCING DISC.

The reinforcing disc at the bottom of both top and bottom sprung pistons may either collapse (billowing the piston at its base) or break away causing damage to a port (it's most commonly soft soldered in place).

Common solutions include:

- Fabricating a driver out of wood, delrin, abs, or other material to match the diameter of the piston – using it to push or tap the piston out.
- Pulling the piston out by the valve stem.
- Using another piston as a driver, tapping on the valve button – ***not recommended,*** as residual damage to the driver piston will likely result.

Using Ground Casing Mandrels

Ground casing mandrels are available from Ferree's Tool & Supply for all piston brasswinds. They are extremely effective for repairing casings and are highly recommended, as they are the least likely to expand or warp the casing. And while they must be purchased in exact sizes to match a particularly brand, the cost can be quickly recovered.

The ground casing mandrel is sold in exact sizes. For example, a Bach Stradivarius trumpet's casings are honed at .664" - this is the size that would be ordered from the supplier. There can be some crossover on the sizes as well - .664" will also work on most Yamaha and Olds brand trumpets. Note: Yamaha trumpet casings now may require the use of a .665" mandrel.

The ground casing mandrel has different uses for different situations, making a thorough inspection of the casing interior vital. Never assume a problem without first observing the damage from the interior of the casing.

Casing Dents

To remove a dent from a casing wall, the mandrel is inserted into the casing with the handle end of the mandrel protruding out of the casing closest to the damage. Be mindful of the mandrel shoulder touching the casing threads – flared/compressed threads can result.

If the mandrel is the proper size, the technician can be aggressive with this step in removing a casing dent. Shown above is an effective technique for removing a dent. Two firm (plastic head) mallets are used, the smaller one pressing into the dent with the larder striking the smaller very firmly. The technician can be aggressive here.

Inspect your work! Always monitor progress by inspecting the casing wall interior.

It's probable that, after tapping directly with a mallet, one will have to tap lightly with a steel hammer. Marring is inevitable with this procedure as the casings are thick and soft, though an accurate hand and light touch will minimize the distortion.

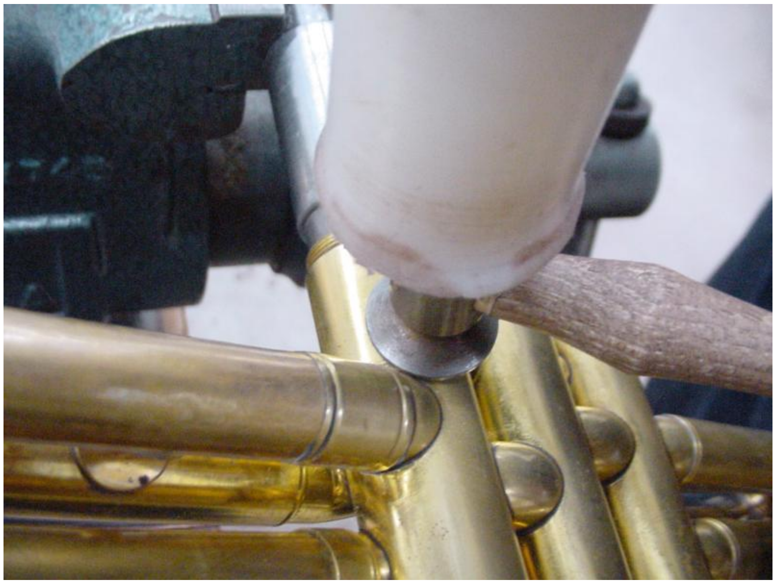
Inspect again! The casing wall interior should be absolutely dent/distortion free

Knuckle Damage and Spanner Brace Damage

Occasionally, stresses on the instrument body force the knuckles to protrude into the casing wall.

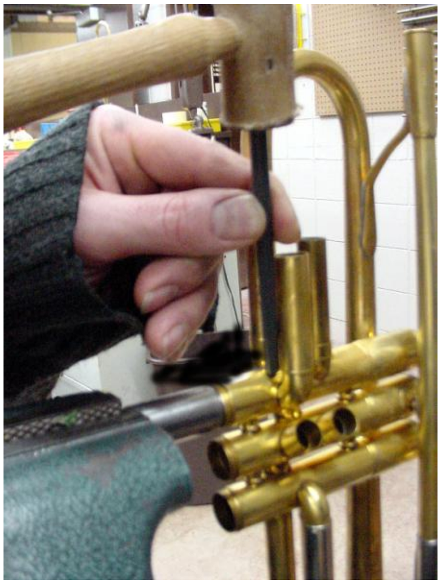
Be certain to inspect for any stresses on the knuckle before applying this technique. A bent bell bow or misaligned valve slide can easily seize a piston at the knuckle. Also, relieve stress at the knuckle by heating the tubes or ferrules

Most techs find that the method described for removing casing wall dents has little if any effect with this type of damage. It is recommend to place a dent hammer directly on the affected area, tapping lightly on the dent hammer. This guarantees accuracy and efficiency, and reduces marring.



When working a casing knuckle, be certain to have the edge of the dent hammer precisely where the casing and knuckle meet. Light taps with the mallet will force the knuckle back out of the casing. Also consider heating the ferrule or slide tube attached to the knuckle to help relieve stress that could be holding the knuckle in position.

Below: Use a dowel to gain access where the dent hammer can't reach when tapping around a knuckle.



Spanner Brace Damage

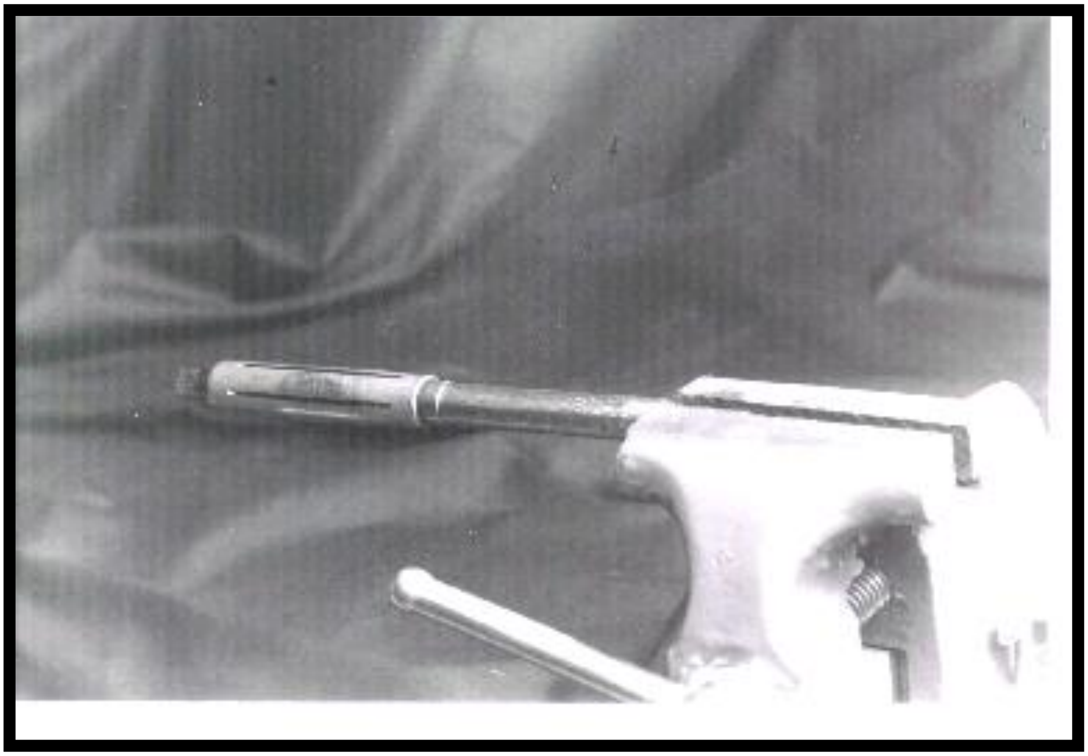
The same approach is taken when the spanner brace is pushed into the casing. Again, observe inside the casing to confirm the problem.

In addition to tapping, sometimes flexing the casing block with the mandrel in the affected casing is enough to actually pull the spanner brace back out of the casing wall.

Using Brass Laps

Brass Casing Laps are available from both Allied Supply and Votaw Tool (those from Votaw are machined to match casing diameters and come with a T-handle installed. They are expanded by tightening the threaded tapered pin on the end of the tool. Since the tool is expandable, four or five of various sizes are all that is required for a vast majority of piston brasswinds. Some shops use the lap for all casing repairs, while some save this tool for use as a last resort.

Laps are used a variety of ways. Some spin the laps in a bench motor or with a variable speed drill, coating the laps with lapping compound to grind dents out of casings or with paraffin to burnish dents out. ***Neither of these uses is recommended as the casing diameter can be enlarged through both the grinding and burnishing operations. It only takes .001" of enlarging to make a brasswind leak.***



Recommended Use – As a Burnisher for Specific Points Inside a Casing

The Brass Laps can pick up where the ground casing mandrels leave off. There are instances where a specific point inside a valve casing must be burnished back to round. The advantage of the lap is that it can be placed loose at a specific point inside the casing, tightened to burnish that spot, and then loosened again for removal. This will help prevent over-expansion of the entire casing.

Other Casing Repair Tools

THE SLOTTED VALVE CASING MANDREL

Available exclusively through Badger State Tool & Supply, *the slotted valve casing dent mandrel* is a universal-sized mandrel with horizontal slots cut into the smooth face to create a cutting/burnishing effect. While usable as a dent removing tool on its own, some repair techs use this mandrel following use of the Ferree *ground casing mandrel* to remove any burrs or bumps which may remain in the casing.

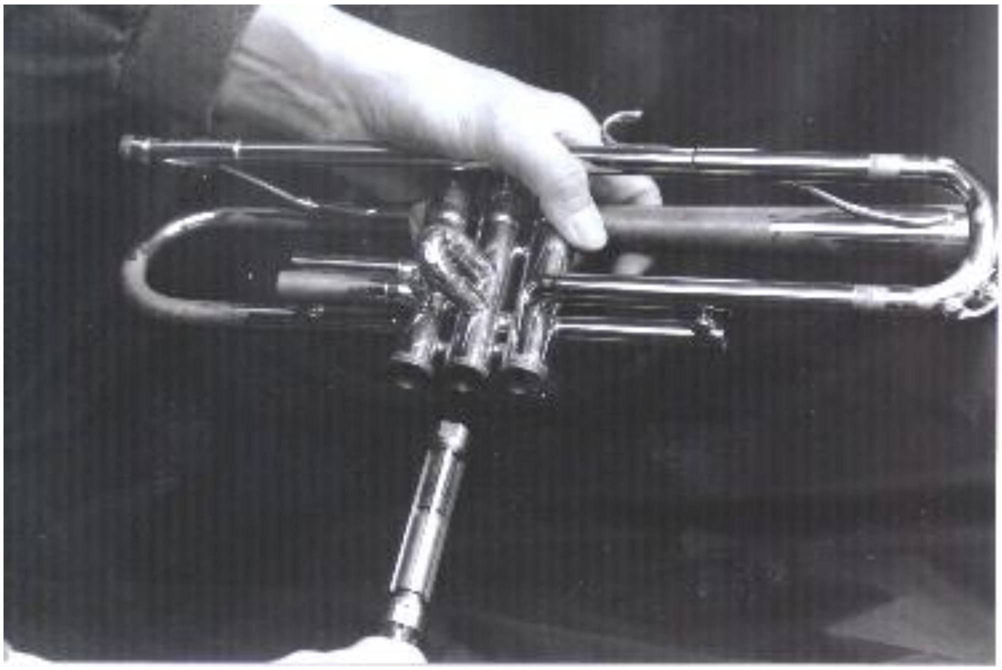
The dent is rubbed over the top face of the mandrel. Following this procedure casing must be blown out with compressed air and thoroughly wiped out to insure against damaging shavings and debris. Also, care of the mandrel itself is vital, as any burr on the mandrel face or slot may seriously score and scratch the casing wall.

Any tool can damage an instrument if pressure is not applied appropriate for the given problem. With the

slotted casing mandrel, pressure must be applied directly over the dent, or an excessive amount of material may be removed.

THE ADJUSTABLE CASING REAMER

Once a very common casing repair tool, the *reamer* has since taken a back seat to other tools such as ground casing mandrels and brass laps, though many shops have reamers available as a last-resort type tool.



A reamer is designed to cut dents out of the casing. It will have up to six cutting blades which are adjustable in diameter by moving them up and down the tapered steel center shaft. Proper diameter is achieved through trial and error - place the reamer as far into the casing as possible to check for diameter as the reamer is largest toward the base of its shaft. Once size is achieved, place the reamer into the casing and turn the reamer *clockwise* by hand, paying attention to visually center the tool as much as possible. Great care must be taken to avoid gouging and rifling the casing.

USING THE REAMER AS A BURNISHER - RECOMMENDED

Turning the reamer *counterclockwise* makes it an effective burnisher - ***this is the recommended application of this tool***. The same sizing for cutting is required for burnishing, though care must be taken to insure the centering of the tool to avoid gouging and rifling. Some techs dull the cutting edges to further guarantee a damage-free burnish.

Straightening Bent Pistons

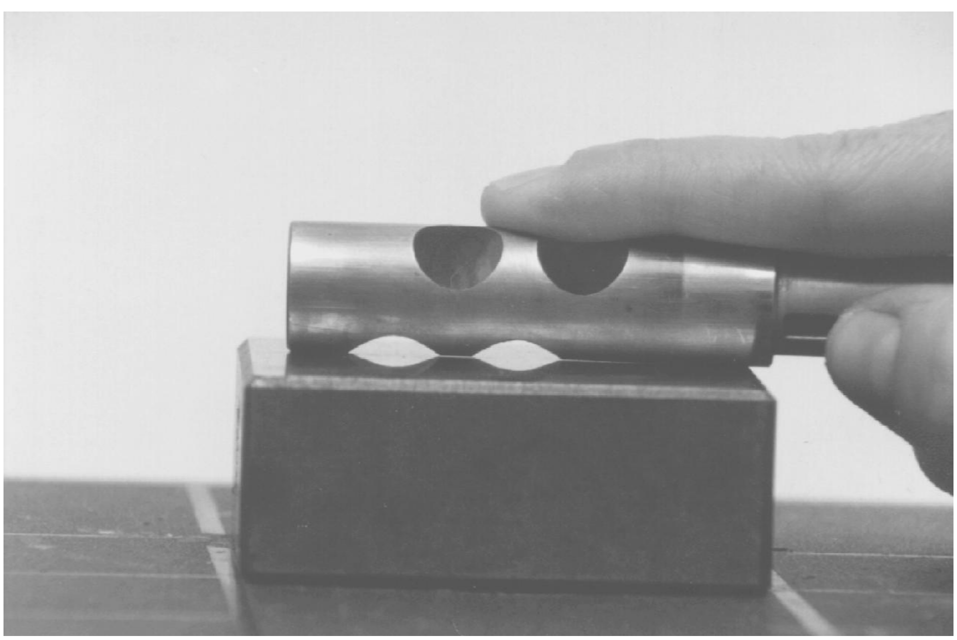
Piston bends are not nearly as common as casing damage, but it does happen. Most piston repairs will be simple straightening, but there are other problems which can occur through mishandling when oiling, cleaning or even through casing damage where the piston is affected as well.

It is good policy to inspect a piston if its corresponding casing needs repair - sometimes the piston will bend because of the casing dent, or through removal when trying to access the dent.

INSPECTING FOR DAMAGE

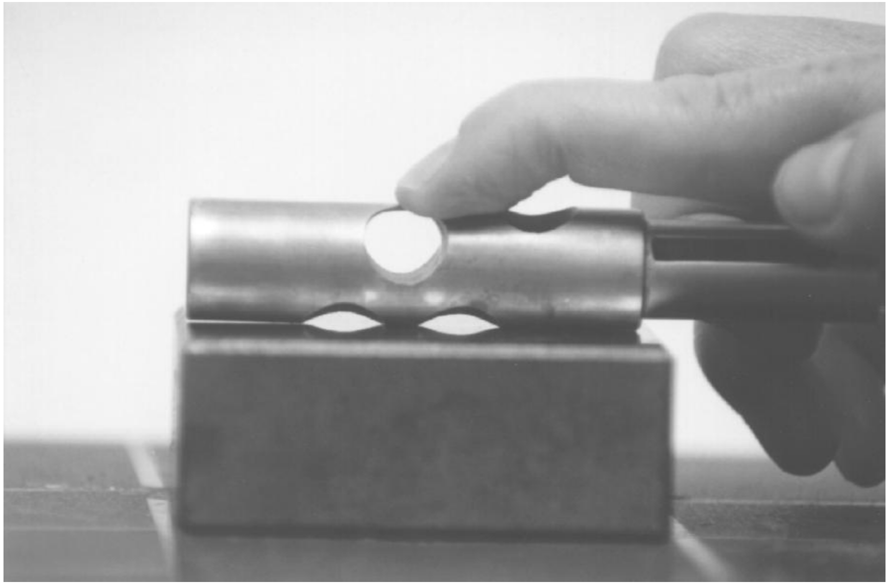
Any back-lit, flat surface will do. Some use an unmarred steel bench block, others use a trombone leveling stone, while some prefer glass - absolute flat is all that is required.

Roll the piston on the surface inspecting for gaps along the valve body. A bend will show as a cavity between the piston and the flat block, with a teeter showing when the valve is flipped 180° - the fulcrum of the teeter being directly opposite the crest that showed on the opposite side. Notice the light on either side of the port in the photo above - this valve is bent rather severely. With a bend, there will always be a cavity on one side and a corresponding teeter on the other. **If the valve is out-of-round with itself, you may have a teeter OR a cavity, but not both.**



Confirm the Bend

Flip the piston over so the bend is now opposite the flat block face - if the valve

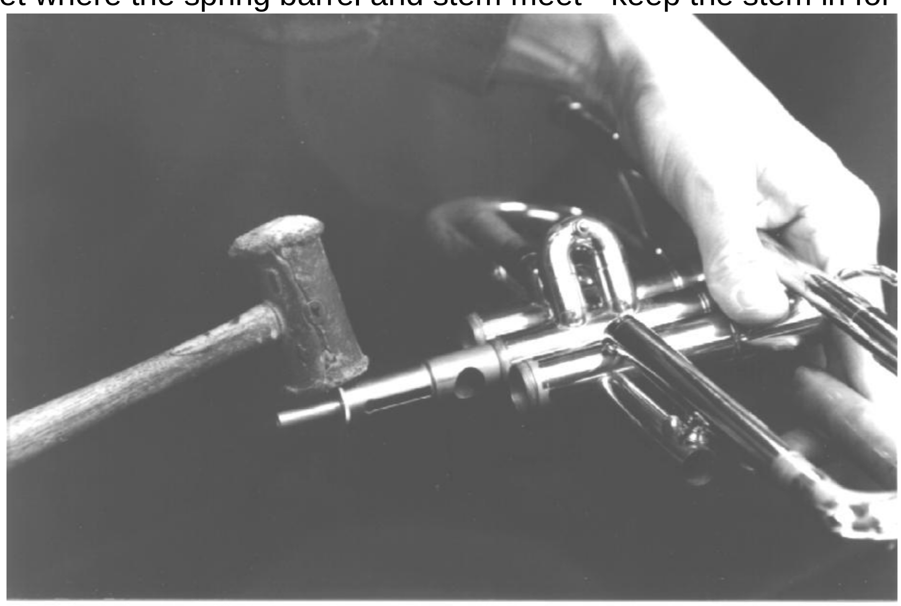


teeters on a fulcrum point at a point directly opposite the crest of the cavity, there is a bend. If there is a cavity but no teeter point, the piston is out of round, requiring a different repair approach.

In the photo above, the portion of the piston showing the cavity is now at 180° revealing a teeter with the fulcrum directly opposite the bend. This is a sure sign of a bent piston. If the piston did not show a teeter at 180°, it would indicate an oval or out-of-round piston, requiring different tools and techniques for repair.

It is most common to straighten the piston using the valve casing to gain leverage and to act as a fulcrum:

Place the piston into the casing up to the crest of the bend, tapping lightly with a mallet where the spring barrel and stem meet - keep the stem in for support.

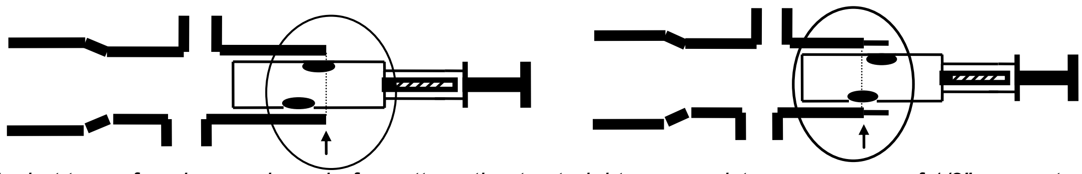


On bottom sprung pistons, tap on the very top edge - there is a large reinforcing brass disc inside which accommodates the stem threads. Often, just the weight of the mallet is enough force to straighten the piston.

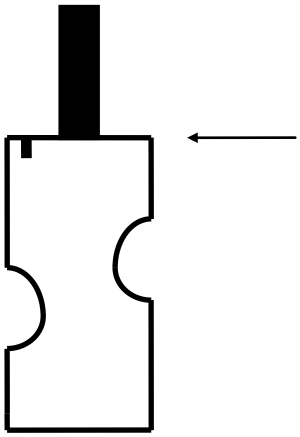
RE-INSPECT

Always re-inspect on your flat block to insure the piston is absolutely straight. Even though the valve may work, if there is a bend remaining, the action may be inconsistent with the other two pistons.

Note: some casings are counterbored - the edge of the casing bearing wall is your fulcrum for straightening, not the bottom of the casing.



Find out what type of casing you have before attempting to straighten your piston as an error of 1/8" or greater can result in extra work or, in the worst case, a new piston at your expense. The casing on the left is common with Bundy and Bach instruments, while most other manufacturers counterbore their casings at the bottom to allow for minor damage at the thread area. The arrows indicate where the edge of the casing bearing wall stops.



For bottom sprung pistons the procedure is exactly the same, the only exception being the point where the valve is tapped for straightening. Tap on the very top edge as there is ample support at that point. Don't tap on the stem directly as it may break off.

The above procedure will straighten a vast majority of bent pistons.

Truing Out-of-Round Pistons

Bends are relatively straightforward, but pistons do get out of round. The procedures for determining an out-of-round piston are the same as for bends – roll the piston on a flat surface. With a bend, there will always be a cavity on one side and a corresponding teeter on the other. **If the valve is out-of-round with itself, you may have a teeter OR a cavity, but not both.**

Ground Casing Sleeves

Available from Ferree's, the Ground Casing Sleeve is ordered specific to the size of the piston. Insert the piston completely in the sleeve – do not let any of the body extend out. Aggressively whack the exterior of the sleeve with a firm mallet made of delrin or acrylic (do not use steel hammers of any sort as the sleeve may dent, seizing the piston permanently in the sleeve. In many instances, the piston will be trued sufficiently enough to where a lapping block can be used to make the piston work.

Note: *the Ground Casing Sleeve does not straighten bent pistons - the repair tech must take care of that before the sleeve can demonstrate any effectiveness.*

A challenge in using a lapping block is that plating and proper diameter is sacrificed to make a piston work – this can result in unacceptable leaks between the piston and its casing.

Heating and Quenching the Ground Casing Sleeves – NOT recommended

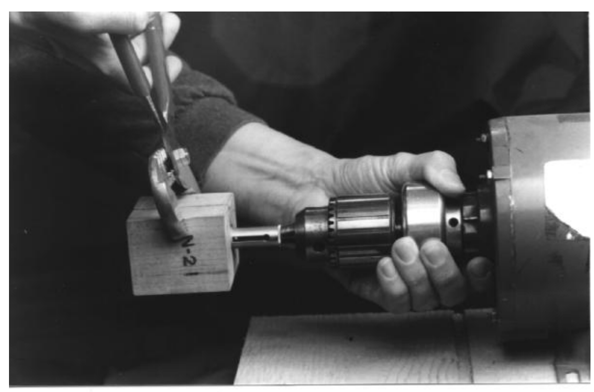
Some have found that by super-heating the ground casing sleeve then quickly quenching it in cold water is effective in getting a piston to work. While the piston may function, it is NOT recommended to do this because the piston is often shrunk .002" - .004" smaller than its proper diameter by this procedure. There is also the problem of the spring barrel falling off and the sleeve warping from repeated heating and quenching.

Slotting the Ground Casing Sleeve - Recommended

For trumpet pistons in particular, the performance of the Ground Casing Sleeve can be enhanced by slotting the sleeve lengthwise with a hacksaw. The Ground Casing Sleeves do not fit most pistons snug enough to completely true an out-of-round piston. Once slotted, the piston can be placed in the sleeve and trued by placing it in a bench vise, exerting light squeezes on the piston. Note – slotting may warp the sleeve some – it is best to slot the thinner sleeves made for trumpet pistons, as the thicker sleeves made for larger pistons may warp to the point where they may be unusable.

Slotted sleeves can also be fabricated on a metal lathe. They can be made of steel, bronze, brass, and even Delrin.

Oval Piston Repair Option II - LAPPING BLOCKS



Lapping blocks should be used as sparingly as possible no matter the technique or application. They can be used two ways:

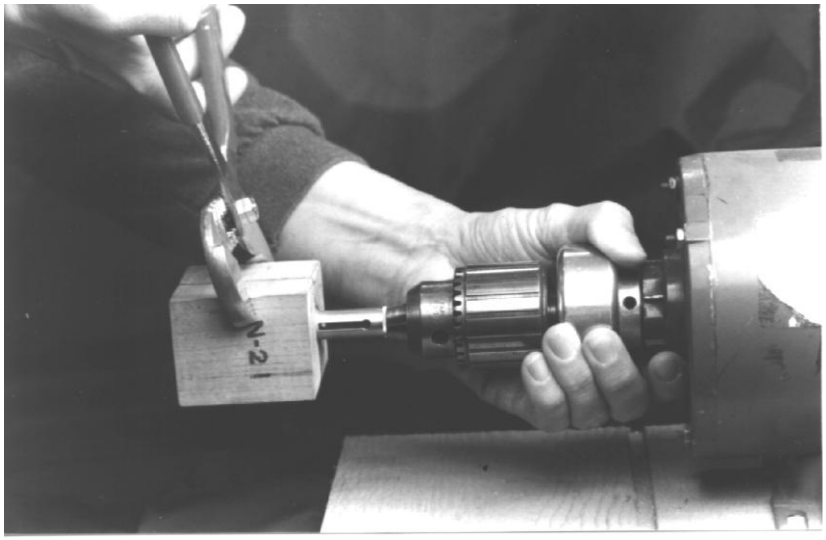
- With lapping compound to actually hone the piston face to where it is true.

OR

- With grease and pressure to burnish the piston true **(preferred).**

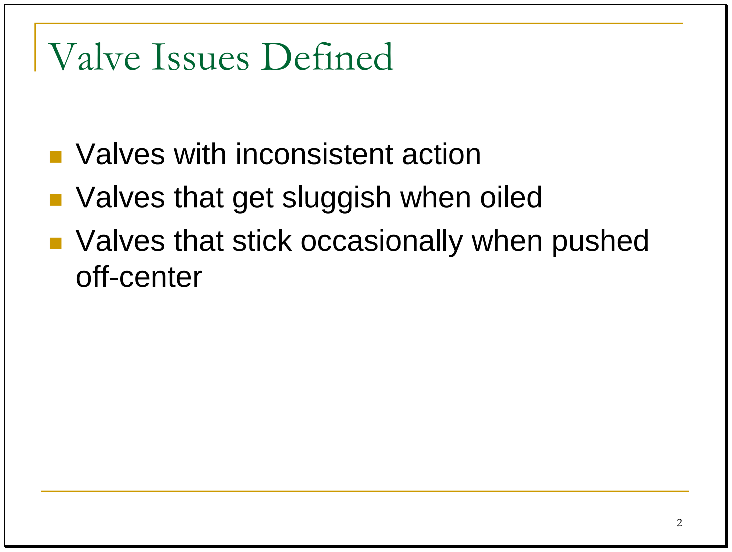
Burnishing the piston true

The lap block needs to be well greased for this procedure to be successful. The pliers exert pressure on the block which can burnish the piston round. **Turn the bench motor by hand**. Some polishing may occur on the valve face. Be cautious of breaking the stem off during this procedure.

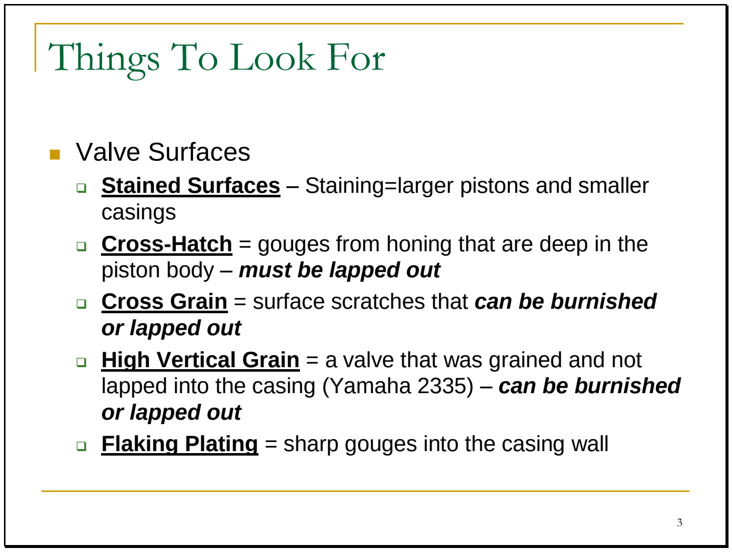


Slide 1

Slide 2


Valve Issues Defined
Valves with inconsistent action
Valves that get sluggish when oiled
Valves that stick occasionally when pushed off-center
2

Slide 3


Things To Look For
Valve Surfaces
Stained Surfaces – Staining=larger pistons and smaller casings
Cross-Hatch = gouges from honing that are deep in the piston body – must be lapped out
Cross Grain = surface scratches that can be burnished or lapped out
High Vertical Grain = a valve that was grained and not lapped into the casing (Yamaha 2335) – can be burnished or lapped out
Flaking Plating = sharp gouges into the casing wall
3

Slide 4

Valve Staining

Monel

4

Slide 5

Valve Staining

Nickel-Silver

5

Slide 6

Cross Hatch

Slide 7

<u>Cross-Hatch</u> = gouges from honing that are deep in the piston body – ***must be lapped out***

7

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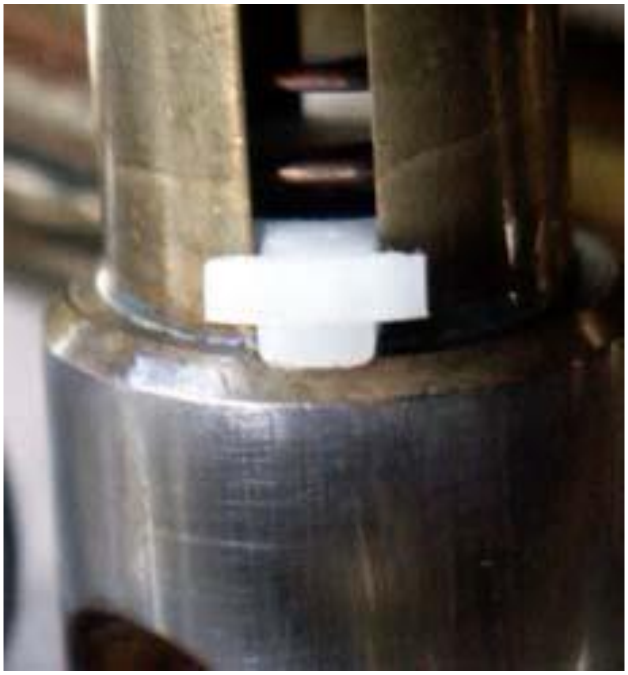
Slide 8

More Cross Hatch

8

Slide 9

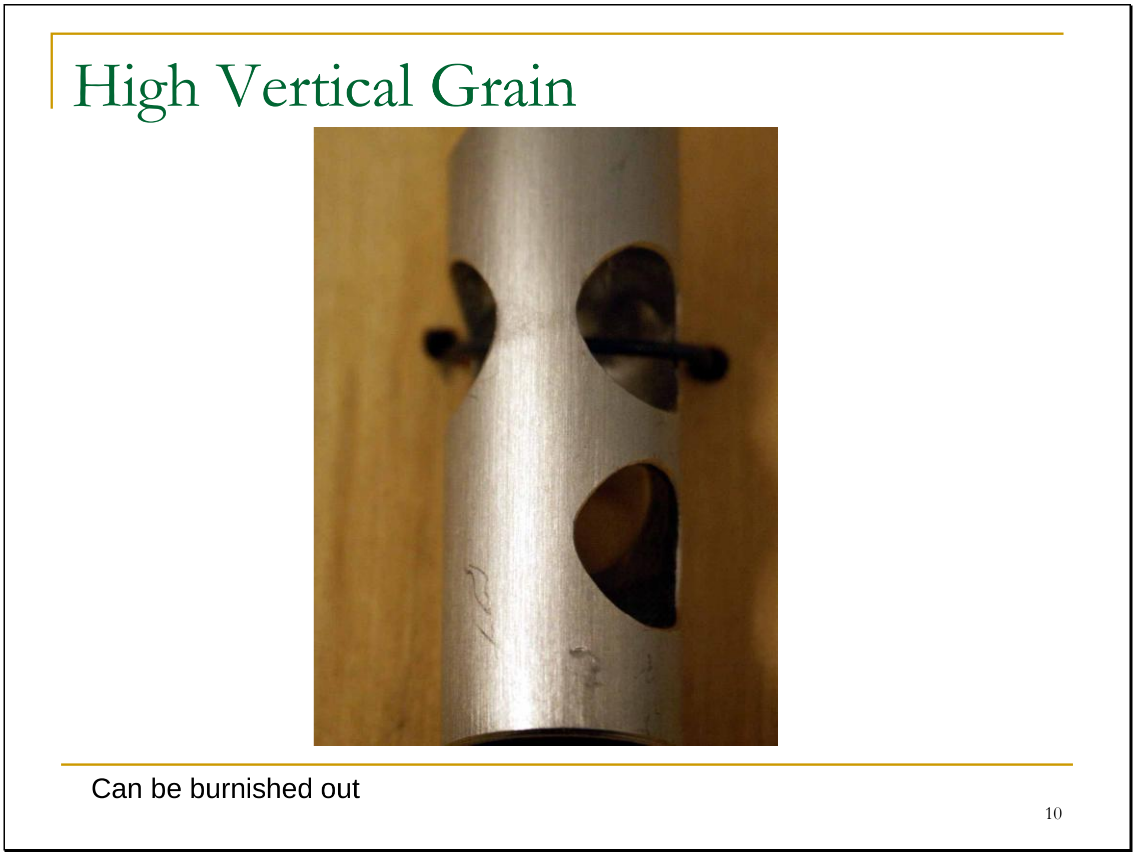
Cross Grain – from regular use



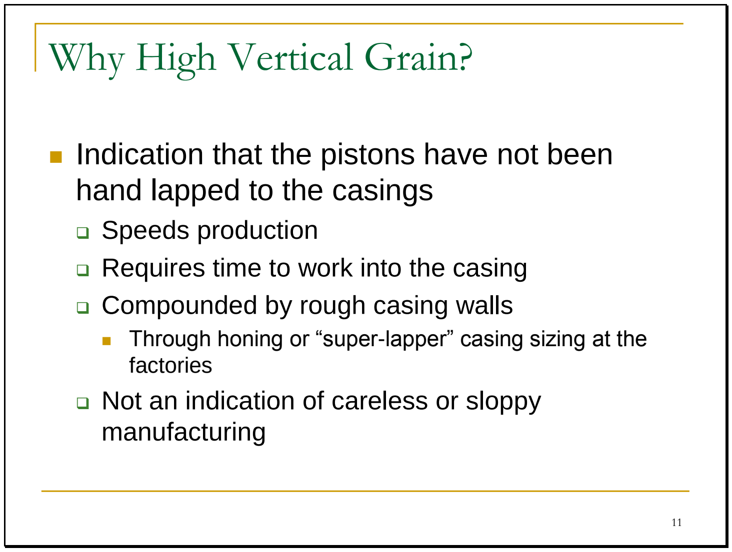
No Problem – can be burnished out or left alone if not a problem

9

Slide 10

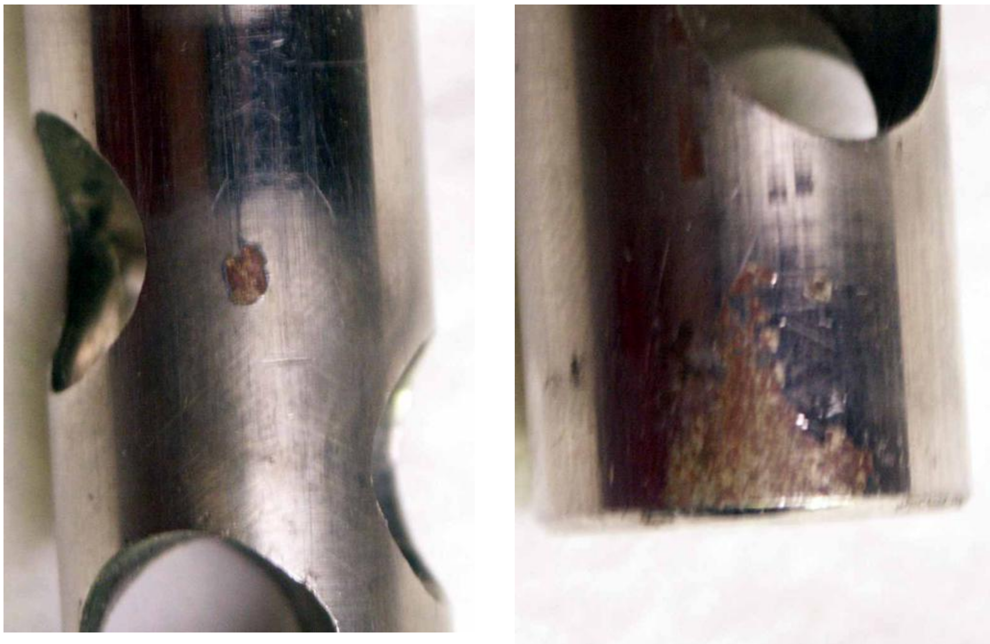


Slide 11


Why High Vertical Grain?
Indication that the pistons have not been hand lapped to the casings
Speeds production
Requires time to work into the casing
Compounded by rough casing walls
Through honing or “super-lapper” casing sizing at the factories
Not an indication of careless or sloppy manufacturing
11

Slide 12

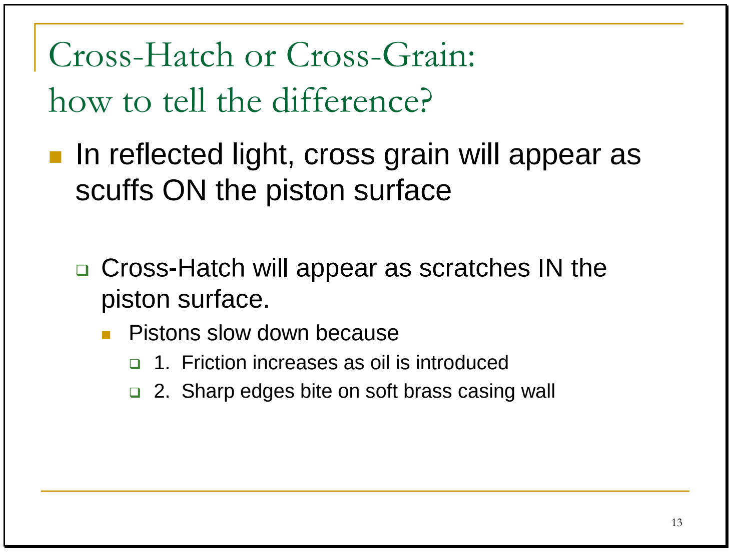
Flaking/Missing Plating



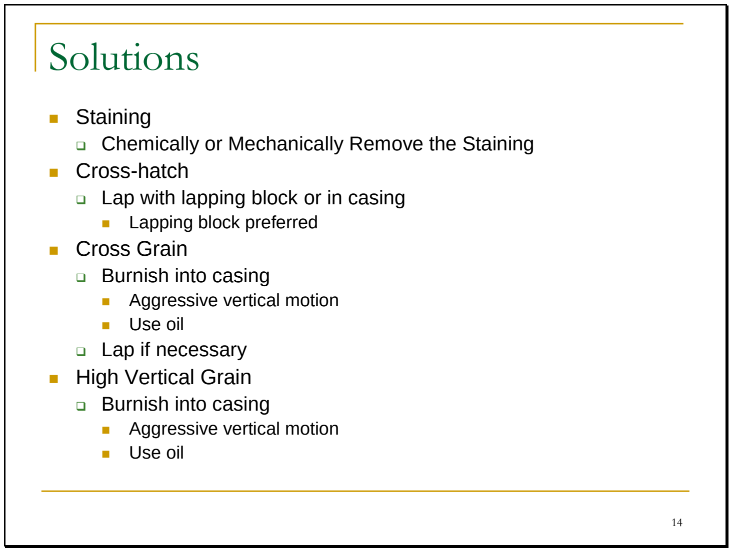
Three solutions: Replace the piston, buff the edges smooth, or re-plate/re-fit the piston

12

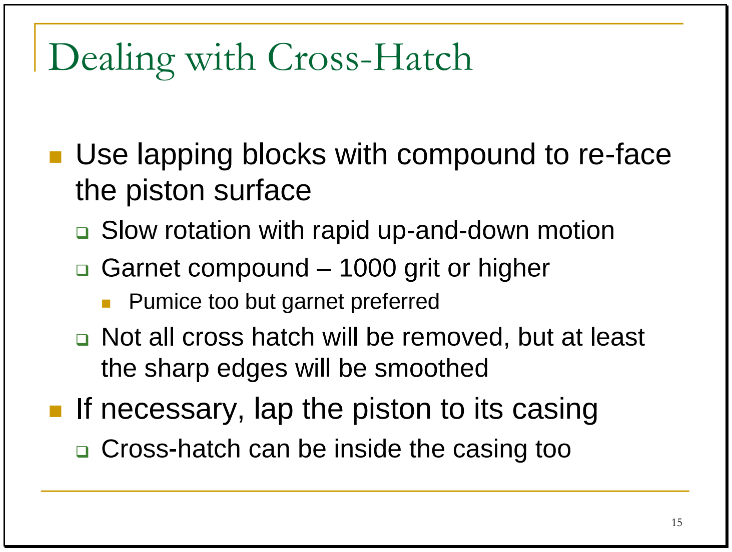
Slide 13


Cross-Hatch or Cross-Grain:
how to tell the difference?
In reflected light, cross grain will appear as scuffs ON the piston surface
Cross-Hatch will appear as scratches IN the piston surface.
Pistons slow down because
1. Friction increases as oil is introduced
2. Sharp edges bite on soft brass casing wall
13

Slide 14


Solutions
Staining
Chemically or Mechanically Remove the Staining
Cross-hatch
Lap with lapping block or in casing
Lapping block preferred
Cross Grain
Burnish into casing
Aggressive vertical motion
Use oil
Lap if necessary
High Vertical Grain
Burnish into casing
Aggressive vertical motion
Use oil
14

Slide 15


Dealing with Cross-Hatch
Use lapping blocks with compound to re-face the piston surface
Slow rotation with rapid up-and-down motion
Garnet compound – 1000 grit or higher
Pumice too but garnet preferred
Not all cross hatch will be removed, but at least the sharp edges will be smoothed
If necessary, lap the piston to its casing
Cross-hatch can be inside the casing too
15

Slide 16

Dealing with High Vertical Grain and Cross-Grain:
Burnishing a Valve Into Its Casing

- Best described as “breaking in” the valves
- Good to try before lapping
- Does not work well for cross-hatch
- Commonly needed on student and step-up King, Conn, and Yamaha student trumpets

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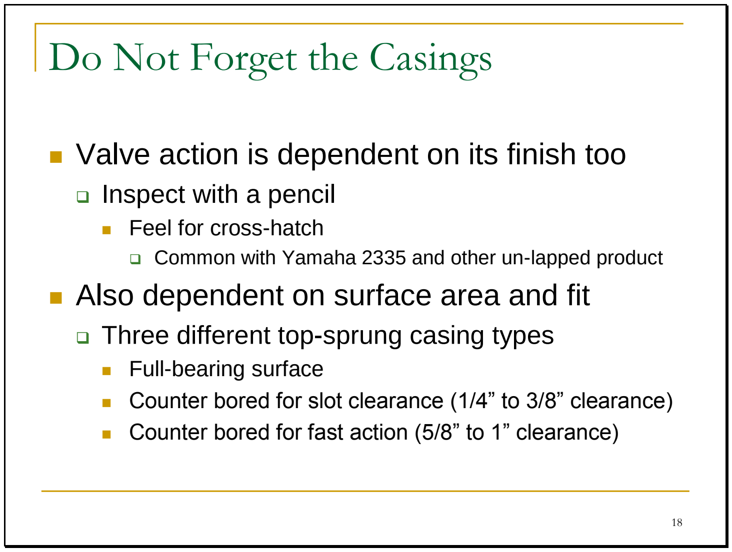
Slide 17

MPEG:
Burnishing a Valve Into Its Casing

Use Valve Oil – Burnish aggressively, pushing the piston off-center

17

Slide 18


Do Not Forget the Casings
Valve action is dependent on its finish too
Inspect with a pencil
Feel for cross-hatch
Common with Yamaha 2335 and other un-lapped product
Also dependent on surface area and fit
Three different top-sprung casing types
Full-bearing surface
Counter bored for slot clearance (1/4” to 3/8” clearance)
Counter bored for fast action (5/8” to 1” clearance)
18

Slide 19

A Honed and Lapped Casing in Good Shape

19

Slide 20

A Honed and Lapped Casing in Good Shape - mpeg

20

Slide 21

An Un-lapped Casing with Honing Cross Hatch

21

Slide 22

An Un-lapped Casing with Honing Cross Hatch

22

Slide 23

Casing After Honing on the "Super-Lapper"

23

Slide 25

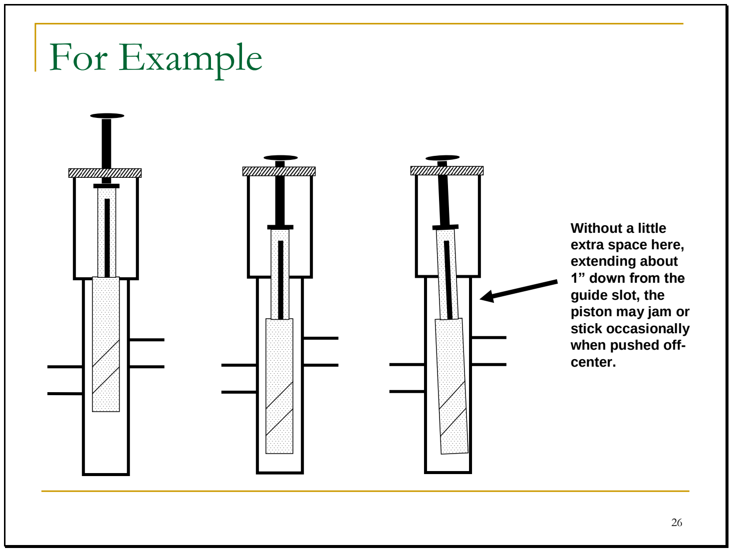
Valve Fitting:

Top-sprung valves need clearance at the top of the casing.

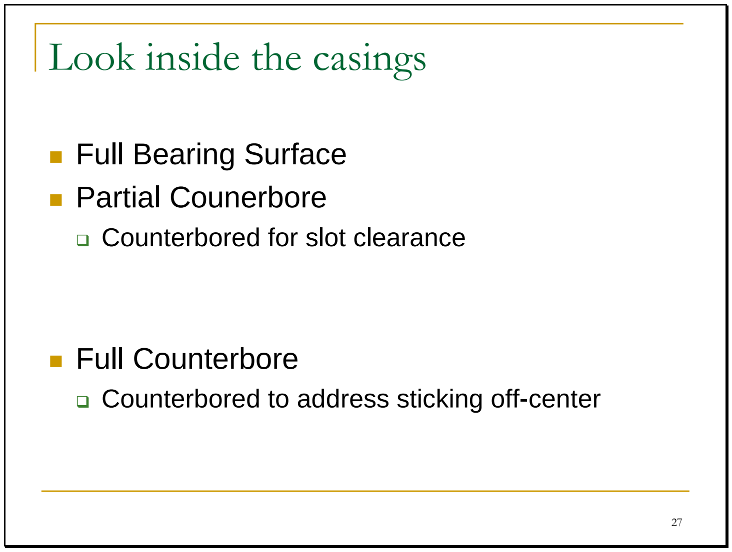
- A few ten-thousandths will do
- Without extra space at the top, the valve gets wedged into the casing when pushed off-center
- A common problem with easy solutions

25

Slide 26


For Example
Without a little extra space here, extending about 1” down from the guide slot, the piston may jam or stick occasionally when pushed off-center.
26

Slide 27


Look inside the casings
Full Bearing Surface
Partial Counerbore
Counterbored for slot clearance
Full Counterbore
Counterbored to address sticking off-center
27

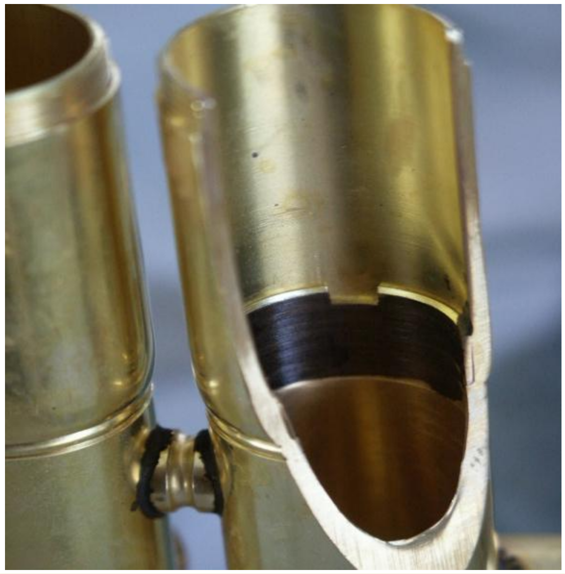
Slide 28

Full Bearing Surface

28

Slide 29

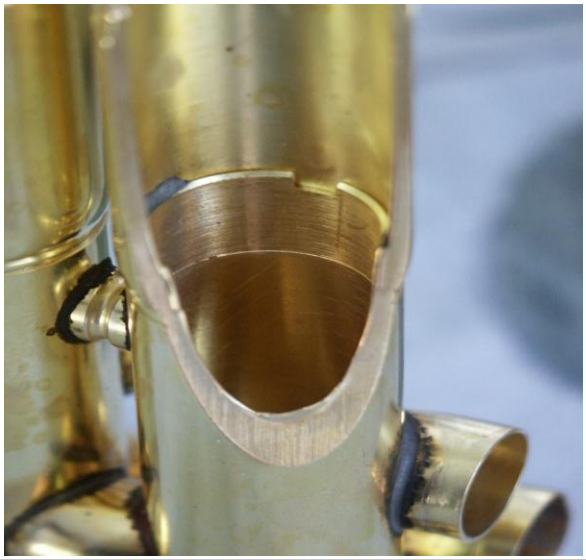
Counter bored for slot clearance (1/4” to 3/8” clearance)



29

Slide 30

Counter bored for slot clearance (1/4” to 3/8” clearance)



30

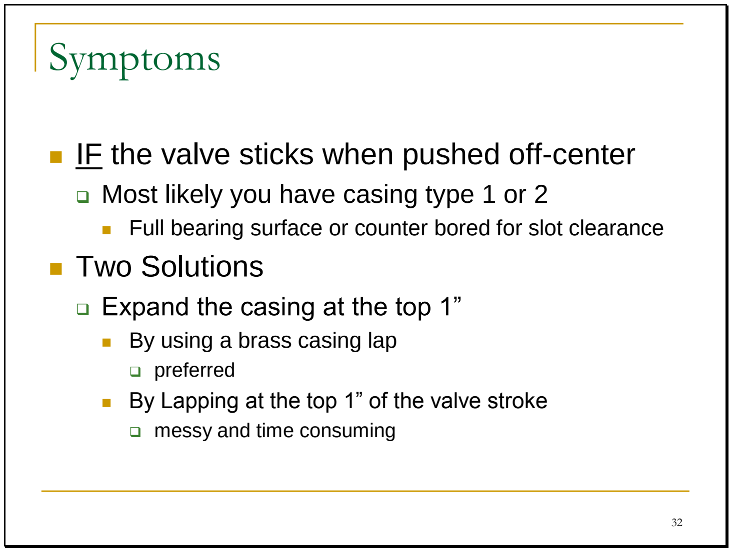
Slide 31

Counter bored

3/4” to 1” clearance=length of valve stroke

31

Slide 32

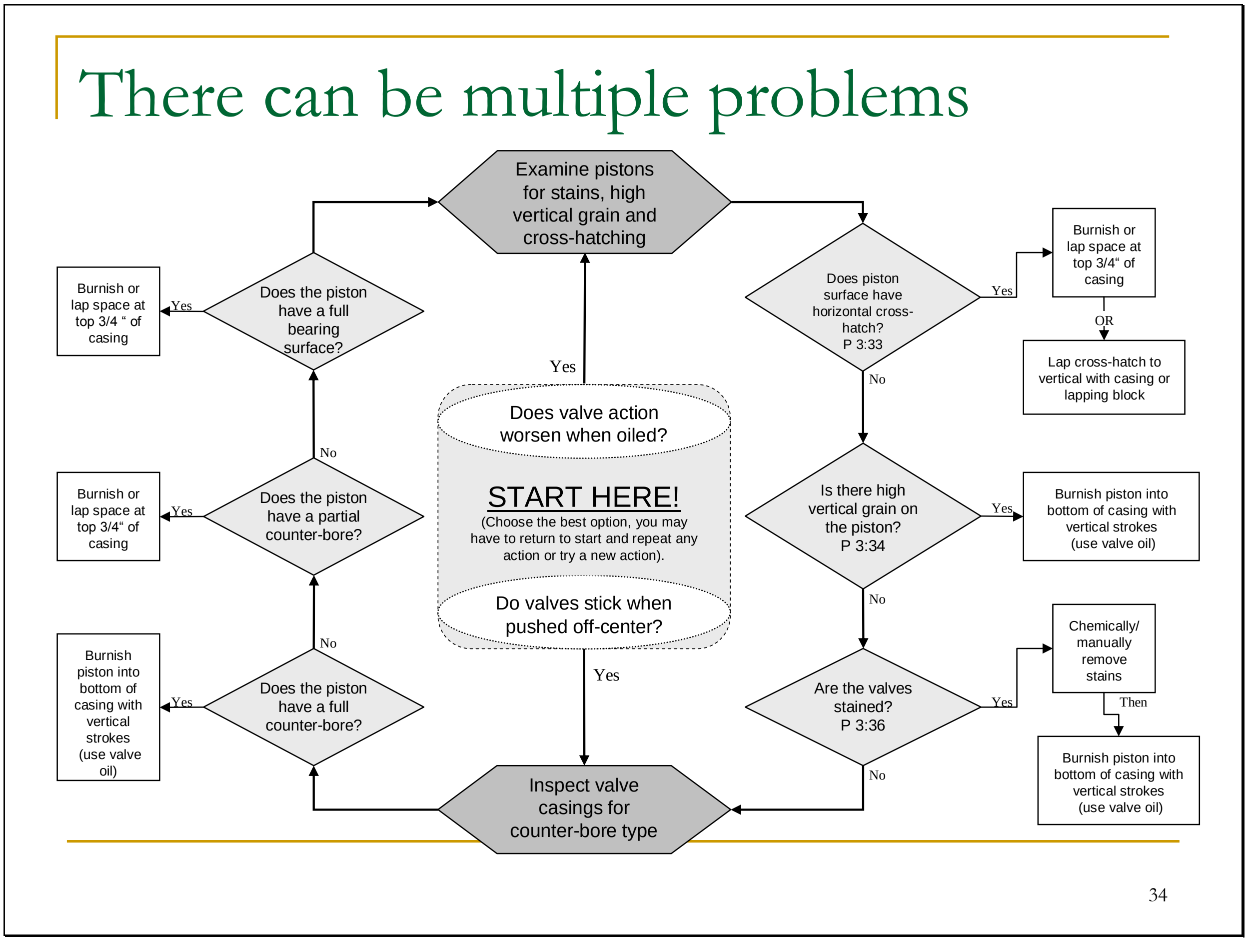

Symptoms
IF the valve sticks when pushed off-center
Most likely you have casing type 1 or 2
Full bearing surface or counter bored for slot clearance
Two Solutions
Expand the casing at the top 1”
By using a brass casing lap
preferred
By Lapping at the top 1” of the valve stroke
messy and time consuming
32

Slide 33

MPEG:
Expand the casing at the top 1”

33

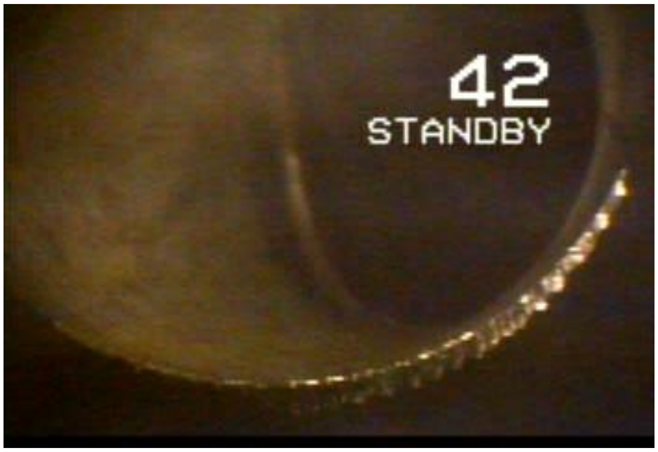
Slide 34



There can be multiple problems
Examine pistons for stains, high vertical grain and cross-hatching
Burnish or lap space at top 3/4 " of casing
Yes
Does the piston have a full bearing surface?
Does piston surface have horizontal cross-hatch? P 3:33
Yes
Burnish or lap space at top 3/4" of casing
OR
Lap cross-hatch to vertical with casing or lapping block
No
Yes
Does valve action worsen when oiled?
START HERE!
(Choose the best option, you may have to return to start and repeat any action or try a new action).
Do valves stick when pushed off-center?
Yes
No
Burnish or lap space at top 3/4" of casing
Yes
Does the piston have a partial counter-bore?
Is there high vertical grain on the piston? P 3:34
Yes
Burnish piston into bottom of casing with vertical strokes (use valve oil)
No
Chemically/ manually remove stains
Then
Burnish piston into bottom of casing with vertical strokes (use valve oil)
No
Yes
Does the piston have a full counter-bore?
Are the valves stained? P 3:36
Yes
No
Inspect valve casings for counter-bore type
34

Slide 35

Other Things to Consider: Burred Port Edges



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Slide 36

Other Things to Consider: Burred Port Edges

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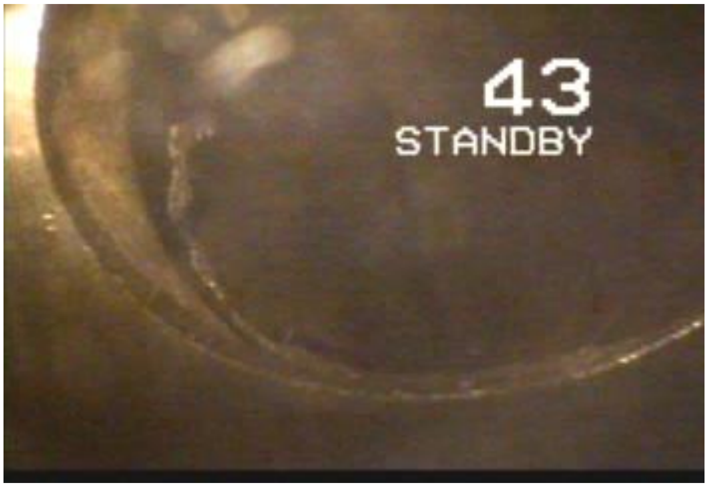
Slide 37

Other Things to Consider: Burred Port Edges



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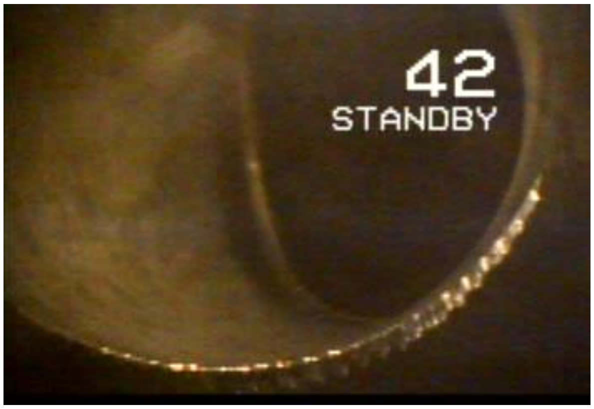
Slide 38

Other Things to Consider: Porting – Radial Alignment



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Loosening Stuck Aluminum Valve Stems

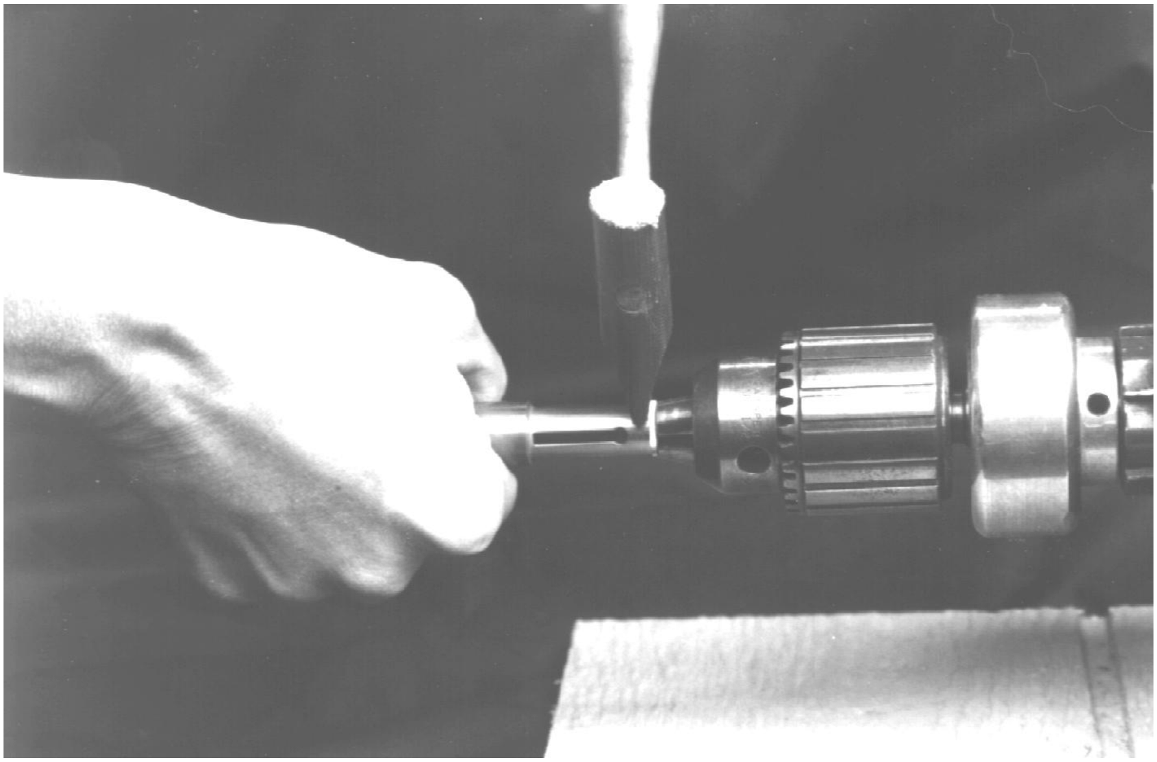
> Stems will seize on both top and bottom sprung pistons, but the problem is much more common on top sprung pistons where aluminum stems are very common.

The major reason aluminum stems get stuck is through fusion of the brass barrel and aluminum stem, particularly when the anodizing is broken down on the stem threads through abrasion or non-neutralized flux.

Solutions proceed from most common to increasingly aggressive:

1. **Chuck the valve stem in a bench motor as shown. Grab the hand brake and piston and attempt to loosen the stem- the bench motor gives ample purchase**.

2. **Tap on the barrel just below the stem base to loosen any debris and repeat step one**.

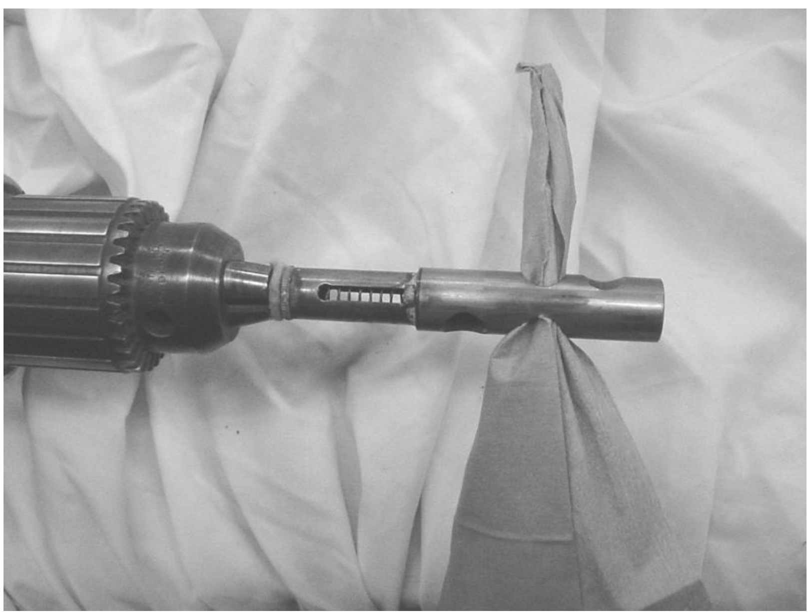


3. Heat the barrel just below the stem base, repeat step 2 and step 1.

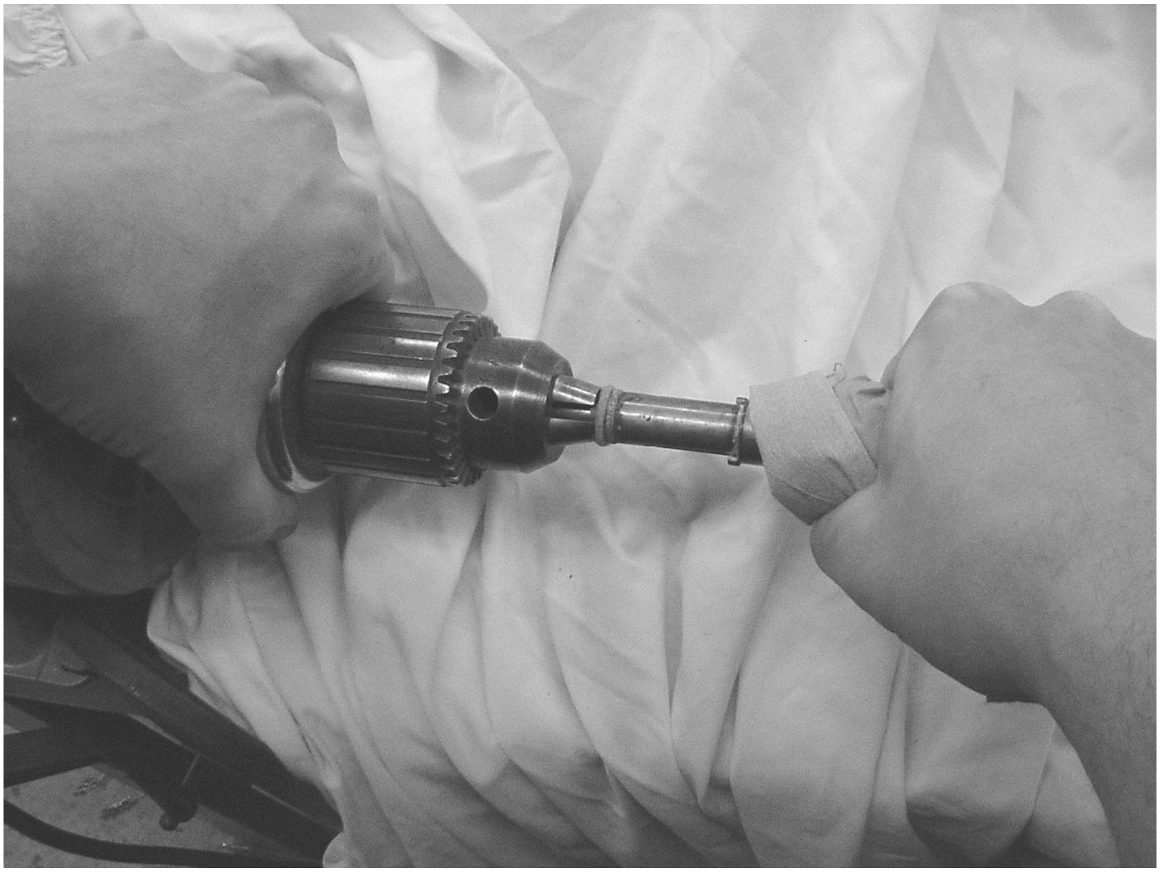
4. Apply penetrating oil, repeat steps 3, 2 and 1

   (**Note:** *when heating any part with penetrating oil applied, it is best to limit the heat used as once the penetrating smokes and/or burns, the joint may actually bond together more)*

For added purchase on the piston, a steel pad slick can be placed through the spring barrel slot. Watch carefully for stress on the spring barrel, however.



Another means of increasing purchase on the piston is to run a rag through one of the ports, then turning the piston clockwise to wrap the cloth around the piston body.



Heat and tap between steps. Also give the penetrating oil time to work!

5. Heat and quench in cold water repeatedly - two or three times should suffice.
(This is as suggested in the Allied catalog)

Note: *The above will loosen a vast majority of valve stems. The following procedures assume that the stem will not budge, necessitating sacrificing the valve stem.*

DISSOLVING THE STEM

Assuming the valve stem threads have fused with the barrel and will not loosen at all, the next step is to break or saw off as much of the stem as possible and by either

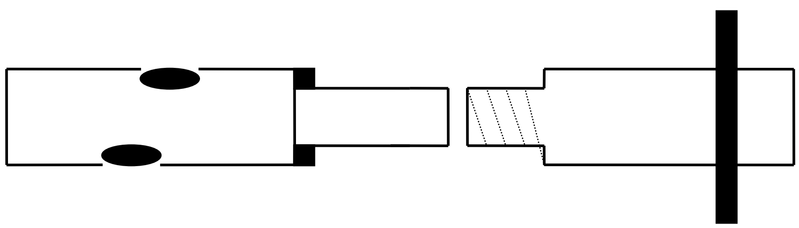
- soaking in diluted muriatic acid or
- heating and fluxing the area (zinc chloride flux is fine)

Dissolve the remaining stem base/threads. Both options require adequate ventilation and appropriate safety precautions.

With either method, it is possible to then pick out any remaining stem pieces relatively easily with a needle spring.

CHASING CLOGGED THREADS

Whenever a fused stem requires dissolving for removal, there can remain ample debris which prohibits the replacement stem from threading properly. Suppliers now offer thread chasers specific to spring barrels by brand.



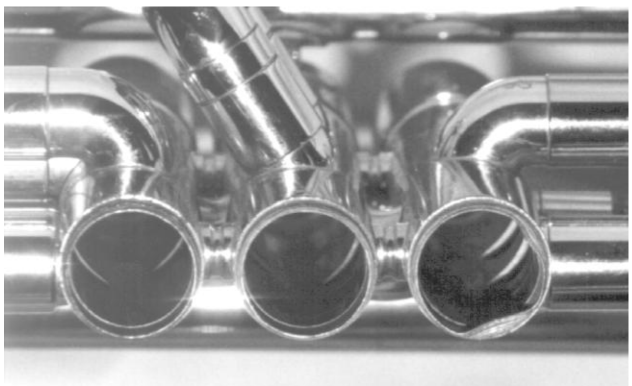
Valve Casing Thread Repair

Preserving the threads without resorting to chasers is the goal of repairing any damage to the casing thread area.

Casing Distortion at the Threads

Most valve casings are counterbored at the bottom, though there are exceptions. Damage to this area can be repaired by using barrel-shaped dent balls and doweling to re-shape the area back to round.

The type of damage shown at the third valve casing is typical in repair work. The counterbore –



the area larger than the casing bearing surface – at the bottom of the casing requires the use of barrel shaped dent balls. To select the proper ball, size the dent balls off of one of the undamaged casings.

Correct ball size is determined by using a nearby-undamaged casing. If the damage is severe, under-sized dent balls can be driven through the area from the top of the valve

casing to get started. If the repair shop uses Ferree's ground casing mandrels for casing repair, these will also suffice in opening the severe damage.

To get started, a dent ball smaller than the casing diameter (bearing surface) can be dropped through the top to move some of the extreme damage outward. This saves a lot of time and reduces the chance for error.

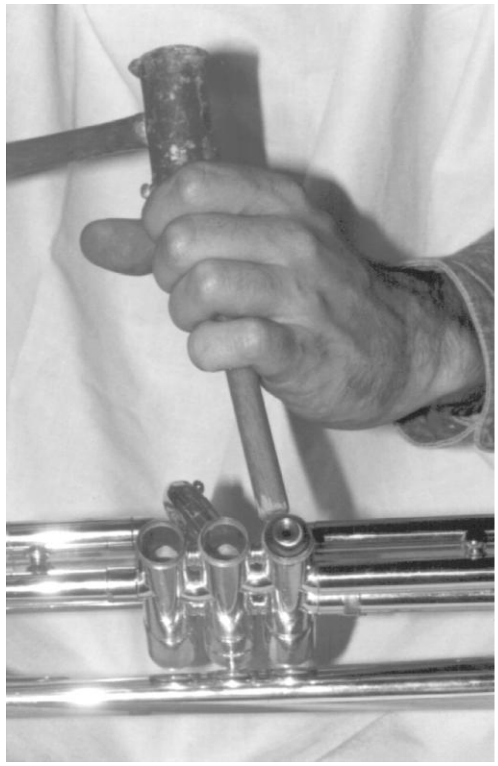
Continuing from the photo above, drive the under-sized dent ball through the valve casing from the top to force the damage out – this will hasten the repair.

When inserting the proper sized dent ball into the casing counterbore, tap the ball so that the tapping force is driven into the damage as it is seated – often the damage is strong enough

where, if the technician taps straight downward to seat the ball, the opposite side of the damage is flared open. See below.

Tap the dent ball so that it is driven downward and into the damage at the same time. The damage can often be strong enough to blow open the opposite side of the valve casing.

To protect the threads when re-shaping, use the end grain of a piece of doweling to shape the threads around the dent ball. To shape threads between casings, the dowel can be



sanded to a wedge shape for access. See photo.

The endgrain on a piece of dowel will serve to protect the threads as the bottom of the casing is brought back to round.

For working distortion between the casings, a dowel sanded to a wedge shape will allow access while still protecting the integrity of the threads.

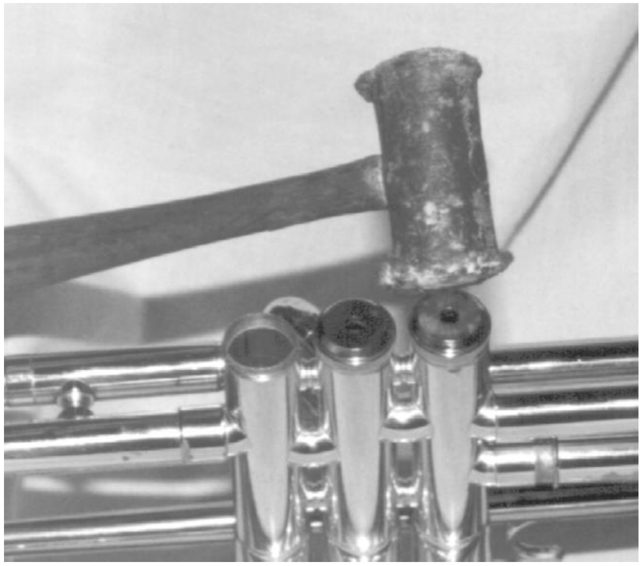
The dent ball can then be driven out from the top of the casing as shown above.

INSPECTION:

The piston should pass freely through the bottom of the casing. There should also be an equal amount of space showing between the piston and casing counterbore.

For techs with an eye for absolute accuracy, a telescoping gauge can be used to determine consistency of both wall diameter and wall squareness. It can also help determine where problems hidden from the eye may lie.

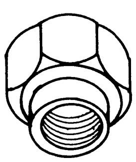
Working the Threads



With many repairs of this type, the valve cap can serve a thread chaser if the cap will start square without cross threading. If there is a good lead thread, a steel thread chaser is not necessary. Get the valve cap started square – inspection is critical, for if the cap is cross threading permanent thread damage may result.

If the valve cap can be started square thread chaser is not necessary for repair. In this instance, the valve cap can be tapped to re-set any distorted threads, assuming it has been started square. Even if the valve cap fits tightly, tapping around the perimeter of the cap should re-set the threads. Notice the neighboring valve cap installed for protection of the #2 casing threads.

The valve cap may bind as it threads on. With a mallet, tap the valve cap around its perimeter using a wedge to tap the cap between casings – this often reforms distorted threads on the casing.



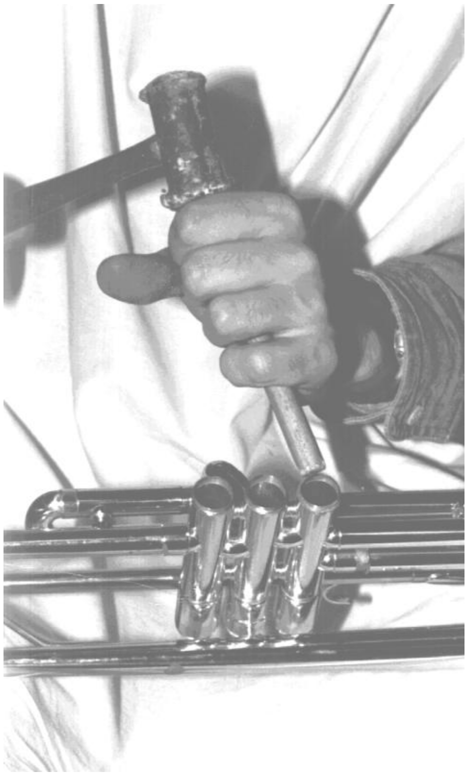
USING THREAD FORMING TOOLS

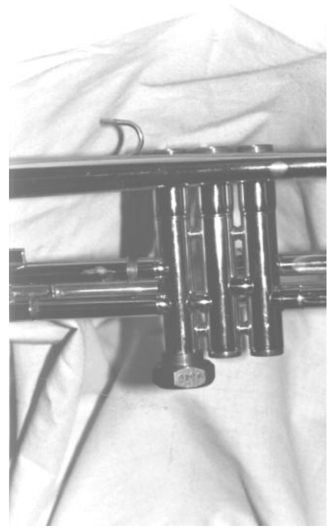
When the lead thread on the valve casing is no longer useful (the valve cap will not thread at all or cross-threads), a chaser is the appropriate tool for repair. There are two styles of thread chasers available: Those from Ferree's and those from Allied Supply. The Ferree's style chasers act more as a burnisher while those from Allied act more like a thread die – cutting the threads.

It is always recommended to do as much thread repair as possible with the valve cap – if the cap will start square, a thread chaser is not necessary.

Ferree's Thread Forming Mandrels

Ferree's has taken a rather unique approach in designing their chasers – they have discerned the most common thread pitches (e.g. 32 tpi) and made thread forming mandrels in incremental diameters. This allows the tech to purchase oversize mandrels to repair/restore worn or missing threads.



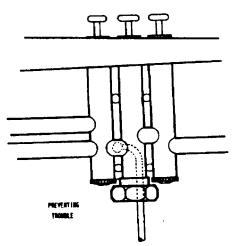


The Ferree thread mandrels are not cutters, they are burnishers. To use it, the technician must actually roll in the bottom of the casing to allow the tool to find a useable thread on which to grab. Use a softened rawhide mallet or doweling end-grain for this purpose.

> ***The only instance to use any thread mandrel or thread chaser is if the lead thread will not allow the valve cap to thread square or not allow the cap to thread at all. To use the Ferree's thread forming mandrel, roll the bottom of the casing inward using a piece of dowel. This will clear the damaged lead thread out of the way allowing the chaser to grab undamaged square threads.***
>
> ***The tool may be difficult to thread up the casing, but if it's threading square use whatever force is necessary. Thread the tool fully on the casing.***

Once the thread forming mandrel is threaded to base, a barrel shaped dent ball or tapered mandrel can than be used to bring the casing back up to size. As the tool is threaded off, it will restore the damaged lead thread. Some tapping of the valve cap may be required if it is too tight.

The threads that were rolled in to allow the chaser to thread can now be pushed out to meet the thread mandrel with a barrel shaped dent ball. When the chaser is removed, the formerly damaged lead thread will be repaired. Some tapping of the valve cap may be required to complete the job. Always inspect the bottom of the casing for clearance of the piston.



The Ferree's mandrels are also handy in protecting the threads when removing knuckle dents.

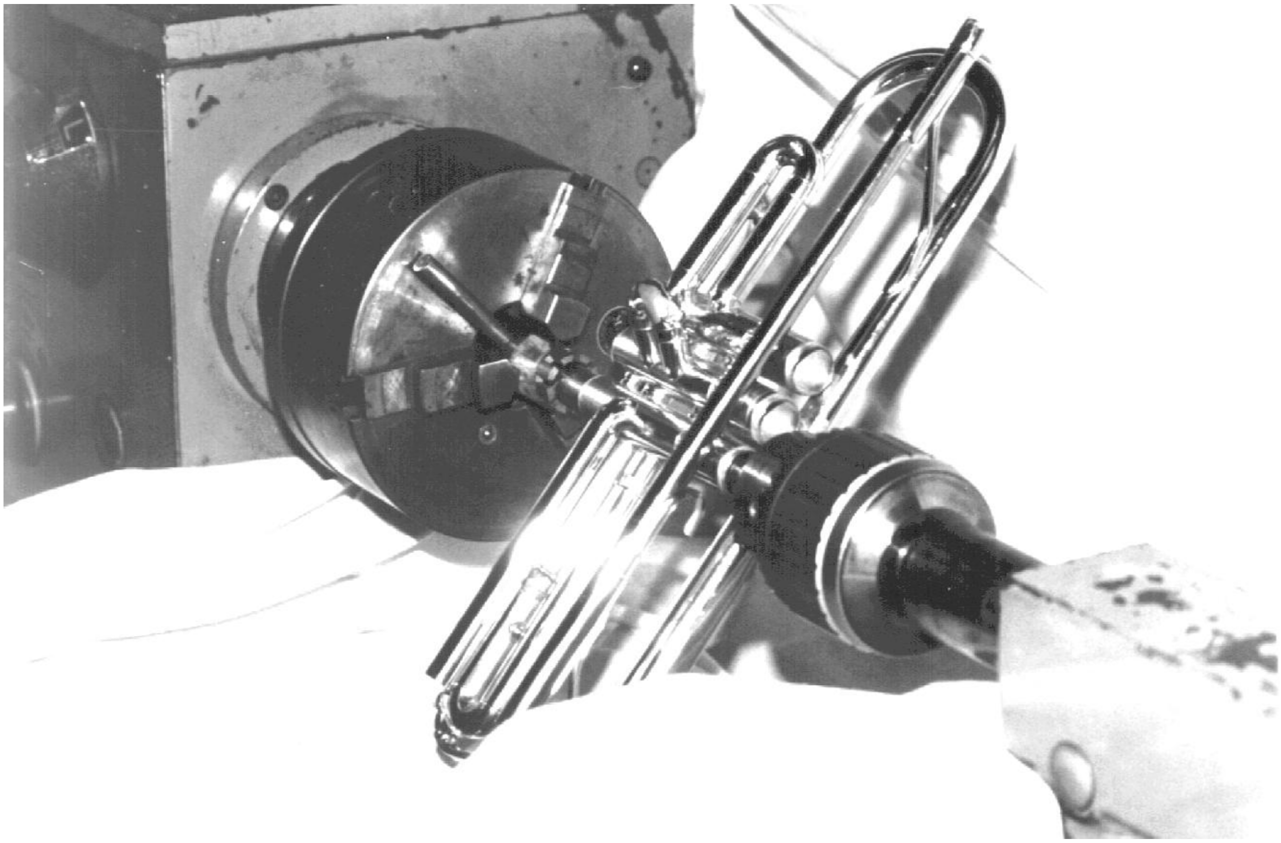
Allied Thread Chasers

The chasers available from Allied act as a die would – actually cutting threads into the brass. The greatest challenge in using these chasers lies in getting them started squarely. It is very common for the chaser to actually cross thread its way up the existing thread. While the supplier now provides plastic pilots to help center the chasers, some techs find the pilots ineffective or marginally effective in centering the chaser. We offer the following alternatives.

Lathe Method of Chasing

If the shop has a lathe and Ferree's ground casing mandrels, chasing resulting in square threads can be simple. This idea was learned from the repair techs at Marshall Music in Lansing, MI.

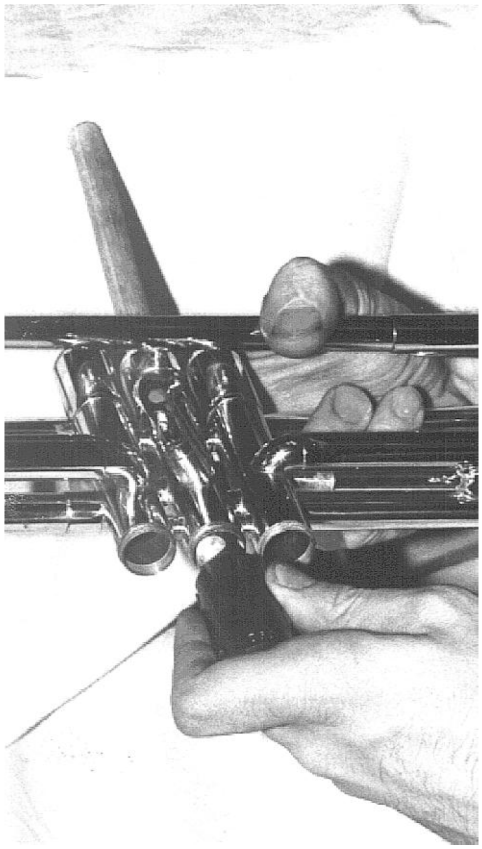
With the chaser held in the chuck and the mandrel in the tailstock, the chaser will remain absolutely square for re-cutting the threads. The chuck can be turned by hand. The only dangers lie in running the chaser too deep or banging the instrument on the lathe bed.



The chaser is chucked in the lathe headstock. The Ferree's ground casing mandrel (.664" for Yamaha) is chucked in the tailstock. With the chuck in 'free spindle" it can be turned by hand to repair the damaged threads on the trumpet. This will insure no cross-threading common with this type of chaser.

Bench top Method of Chasing

For those without lathes, using the Allied chasers needn't be a problem. The piston can serve as a pilot (much sturdier than the plastic pilots) using a dowel for extension as shown in the photo. This idea came from Nathan Bickhart, Red Wing graduate.



Block up against the edge of the workbench, setting the piston in the center of the chaser. From there, the chaser should remain square as it re-establishes threads.

Shown at right, another method of repairing threads is to silver solder a valve cap to a long nose pliers (ground back a bit to insure a large solder joint), sawing the valve cap in half with a jewelers saw. An extremely effective means of repairing casing threads!

Valve Jobs

A "valve job" implies a restoration or improvement of tolerances between the pistons and casings by enlargement of the piston through copper, then nickel, plating. The process involves honing (truing) both the plated (enlarged) piston body and corresponding casing to the same dimension, followed by hand lapping to achieve proper valve action and tolerance - usually five ten-thousandths (.0005) to one thousandth (.001) of an inch on diameter.

Indications that a valve job is necessary:

- Sagging of pitch during extreme crescendos
- Poor response in all registers - most notably in the lower octave
- Unfocused/uncentered pitches
- Exaggerated intonation deficiencies
- All the above problems are alleviated or minimized when the valves are heavily oiled

Tests to confirm the need for a valve job:

- Measurement of both piston and casing - dimensions differ by more that .0015" to .002" or greater.

- Discerning leaks in the piston/casing by removing a valve slide, pressing the corresponding piston to its downstroke, blowing vigorously through the instrument & plugging the valve slide tube which stops the air flow. There should be no leaking with the valves oiled and infinitesimal leaking with the valves/casings dry

(see below).

- Extreme lateral slop with the valve in the down-stroke position. View the piston through the bottom of the valve casing - the piston should show little if any side movement with lateral (side to side) force applied (see below).

Instruments which are candidates for valve jobs:

> Large brasswinds (baritones, euphoniums and tubas) which are to be overhauled (complete reconditioning with new finish). Reason: For most large brasswinds, the casing assembly must be removed so it can be internally honed - it is much less expensive to make the valve job part of an overhaul than otherwise.

> Professional piston brasswinds where the player intends to use the instrument for many years to come.

> Historical or older brasswinds where it will be used and appreciated.

> Older Yamaha brasswinds where the alloy "Yamalloy" was used to manufacture the pistons and corrosion build-up is causing the valves to consistently drag. **Note:** *Yamaha has not used Yamalloy for many years. It looks similar to Monel, but stains and corrodes very rapidly.*

Instruments which are not candidates for valve jobs:

> Most student line trumpets and cornets, especially when the cost of the valve job exceeds or matches the value of the instrument.

> Professional instruments where the instrument has sustained serious damage which inhibits performance and negates any improvement the valve job would provide.

Steps involved in a valve job:

(sequence dependent on instrument, condition and technician)

a) The pistons and casings are measured to determine if a valve job is necessary and to determine if there is any residual damage which must be addressed, such as body and slide alignment, casing or piston repairs, etc.

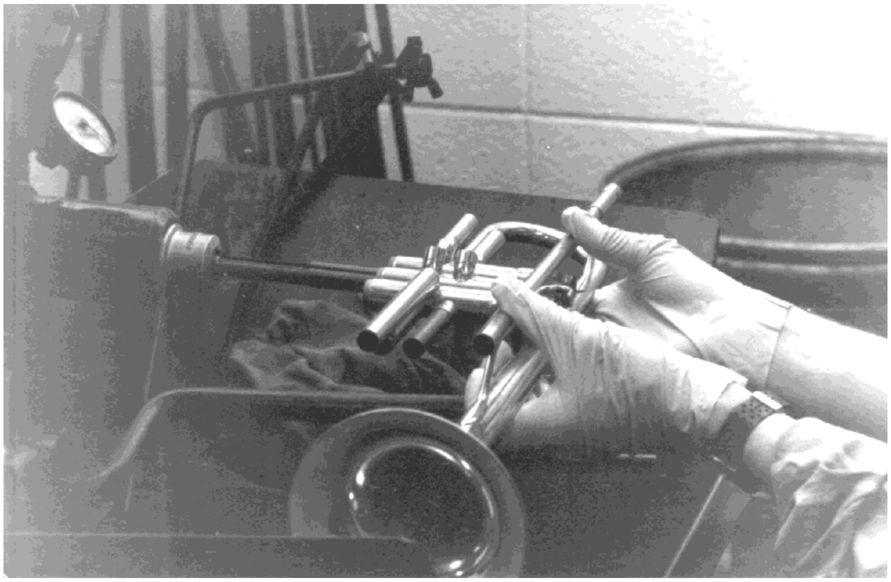
b) Nickel plated pistons are stripped.

c) Both piston and casing are honed true (accurate dimension top to bottom, and absolutely round).

d) Pistons ports as well as top and bottom edges are beveled. Ports are scratch-brushed.

e) Piston and casing are re-measured to determine required plating thickness.

f) Piston is copper plated to within .001" to .002 thousandths of needed diameter. It is then honed true once again.



g) Piston is nickel plated to just slightly above casing dimension, then honed true and grained for final matching to the casing.

h) Casing is honed to match piston diameter. The valve at this point is so tight that it must be forced through the casing.

i) Valve is hand lapped to appropriate fit. Valve guides and guide slots are deburred for smooth action.

External honing of the piston. Stones held within the holder are passed over the rotating piston body. The holder can be opened and closed during the honing process to control the amount of material removed. The purpose is to make the piston absolutely round as well as accurate in dimension from top to bottom. Even a difference of one or two ten-thousandths of an inch disparity can negatively effect the outcome of a valve job.

The casing is trued and enlarged with an interior hone, which has a stone mounted within the body of the expandable mandrel. The diameter of the hone is controlled at the honing machine (the dial can be seen in the upper left hand corner of the photo), which is adjustable in thousandth-of-an-inch increments. Like the piston, the casing must be perfectly round and consistent in diameter from top to bottom.

The piston and casing are honed to the exact same size - actually fit so tight that the valve will pass through the casing only with considerable force. Hand lapping from there affords greater control over creating the proper tolerances and bearing surface for a successful valve job.

COMMON CONCERNS SURROUNDING VALVE JOBS

Can Monel pistons be nickel plated, and will the plating last?

Yes to both questions.

Nickel plating will adhere to Monel just as well as it does to brass or nickel silver. The copper used to build up the piston and improve adhesion of the nickel. The nickel plating will be as durable as any other nickel plated piston, and perhaps even more so because the tighter tolerances reduce friction.

Why nickel plating as opposed to copper or chrome?

Nickel plating is an extremely hard coating which is an ideal bearing surface. It is highly resistant to wear (casings wear much faster than pistons) and can be honed to amazingly precise tolerances. Copper by itself is much too soft and would result in a very sluggish piston which would burr and scratch too easily - that is why it is used strictly to build up the valve close to final dimension. Chrome's hardness makes it to too difficult to true accurately and fit with the same precision as is possible with nickel.

Will the valve action or "feel" change?

Yes, especially if the valves are made of Monel or Yamalloy.

The action will become more buoyant or lighter for three reasons: The slop has been removed thus reducing friction; nickel plating's surface hardness is greater than Monel, meaning less drag between the piston and casing; and the grain of both the valve and casing is smooth and vertical due to the hand fitting.

Will the plating shrink the port diameters?

Yes, but generally not enough to effect performance.

When any instrument or instrument part is plated, the greater amount of plating will build up on the "open" surfaces where current is greater. For example, the amount of plating on the inside of a valve port will be much less then that on the valve body itself. Most pistons are enlarged anywhere between two to five thousandths of an inch with plating - this translates into somewhere between .0005" and .001" closure of the port (on diameter). To further alleviate port closure, the edges of the ports are beveled with a scraper to reduce build-up at that point. For those players who demand no plating inside the ports, the ports can be plugged at added expense.

There are those who speculate that the plating inside the port could conceivably be considered an advantage, given that nickel plating is a harder, less porous material than the high copper brass used in manufacturing the ports, perhaps positively effecting instrument response. Something very difficult to prove, but conceivable.

How long will a valve job last?

Most likely longer than the original factory fit, though maintenance is a factor.

In a majority of cases, the tolerances after a valve job are better than the original factory fit. This is because more time can be spent in all the stages of preparation and execution of the valve job where mass production is not an issue. This means that the valves have a longer time to wear to the same state. Proper maintenance can insure a valve job lasting ten years or longer.

Are there disadvantages to a valve job?

The tighter tolerances mean less room for debris that would not have affected the valve prior to the valve job.

Also, some players are shocked at the differences in their instrument's performance after a valve job. Response, center and intonation are all affected and, while most players appreciate the changes, it can cause dismay for some. Players who bend pitches a lot do not always favor tighter valves.

What equipment is required for performing valve jobs?

Optimally, a honing machine with both interior and exterior honing stones, and corresponding mandrels and holders. In addition, lap wrenches and valve mounts must be made for each brand of spring barrel (barrel threads are not standardized) - usually these are handmade on a lathe.

Sunnen is the most common manufacturer and supplier of honing equipment. For internal honing of the casings, they offer a tool called a "porta hone" which eliminates the need for the actual honing machine. Exterior honing of the pistons can be done on a lathe or gear motor with an oil feed attachment - though one still must have the appropriate stones and holders. Some shops use the porta hone to enlarge and true the casings, and then purchase over-sized replacement pistons from the manufacturers - a good compromise, especially if one is concerned about maintaining port diameter.

Purchasing honing equipment, new or used, is not recommended for most play-condition repair shops. To justify the expense, one would have to make valve work a full-time job. And there are plenty of places that do quality re-fit work.

Why not just plate the valve to dimension and stop there?

Plating doesn't adhere evenly to any part being plated. For example, on a piston valve, if .003" of plating is required, there may be as much as .005" on all the edges (top, bottom and port edges). Without proper honing equipment it is next to impossible to true the valve top to bottom - vital in achieving a tight fit (Anderson Plating has a good description of this in their price list).

Some shops have tried honing a piston with lapping blocks and lapping compound, only to find that the lapping blocks work laboriously slow and do not provide any control over diameter or roundness. While the "porta" equipment described above is a good alternative for internal honing, lapping blocks are no substitute for proper external honing equipment.

What if a player can't afford a valve job, or can't be convinced that it is necessary?

For some instruments, a valve job is a vital necessity. For most it is not. For those who are waiting to afford a valve job or can't justify the expense, it is recommended that they increase their frequency of oiling and select slightly heavier oil which will better fill the space between the piston and casing.

John Huth

Special thanks to Don Miles of Miles Trumpets and Band Instrument Repair - Cincinnati, OH, Ken Cance, Greg Beckwith, and the present and former students of the Band Instrument Repair Program at Red Wing Technical College.

Porting Piston Valves

There is little disagreement on the need for accuracy when porting piston valves, both up and down stroke. When one considers that a difference of as little as .003" can determine whether a trumpet's bore is considered medium or large bore, it can be a logical conclusion that inaccuracies in valve porting can make a profound difference in instrument performance.

Rules to Remember:

1. Never assume that the bumper thicknesses on the instrument are correct – measure and mirror in every horn.
2. **Never Stack Felts** – use cork or Valentino brand synthetic washers underneath a single felt.
3. Port each valve individually on professional instruments.

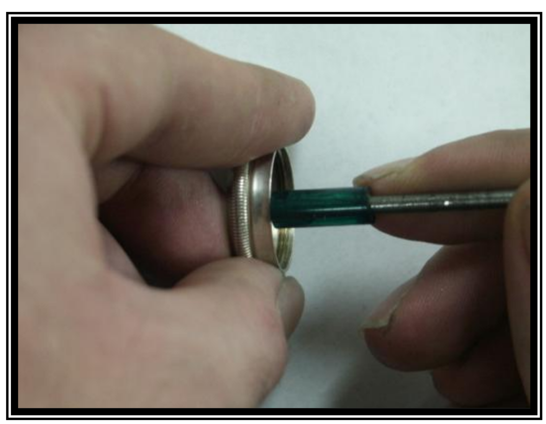
Simple measuring tools have been used for years by many repair technicians in determining the proper amount of bumper material for the valve stem (up stroke). While valve casing mirrors can be used, many prefer the convenience and accuracy of the measuring tools available through most suppliers. It is recommended to do both – measure to get a sense of how much bumper material is required, and then use the valve mirror to confirm those measurements.

There are custom shops that specialize in "precision valve alignment". The information that follows does not enter into how precision alignments are performed, though there is little doubt that such alignments are beneficial for top professional players.

Simply described, valve porting can be described as attaining the proper alignment of the valve port and casing knuckle when the piston is either in it's up or down position.

Casings with External Threads

For casings with external threads, it is common to measure from an "open" knuckle (a knuckle that has sound traveling through it with the valves in the up position) to the top edge of the casing, transferring that measurement from the corresponding piston port to the valve stem – giving the proper amount of bumper material. This is sound, but fails to take into account any gap that may exist between the flat underside of the top valve cap and the edge of the valve casing. Instructions are below:



1. Measure the depth of the valve cap.

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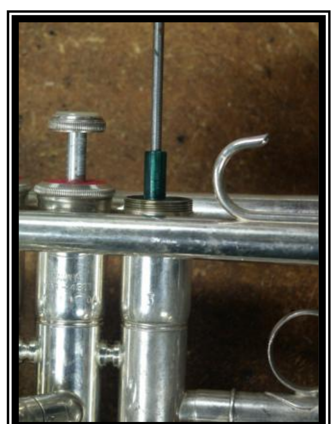
2. Compare this measurement with the depth of the valve casing threads. Note difference (if any) with caliper or ruler. *It is this gap that is often excluded in setting the up stroke.* In the photo below, there is approximately 1/32" gap showing –

meaning that the underside of the valve cap is that far from the casing edge. This gap is common on older, domestically manufactured instruments.

3. Using the valve casing knuckle connected to the main tuning slide (or any "*open*" knuckle), measure from the knuckle to the top of the valve casing. An "*open*" knuckle implies those that are in use whether the valve is up or down, such as the bell knuckle or the main tuning slide knuckle.



Shown above is just an exterior view – of course measure from the casing interior. *Measure from a knuckle that is always in use with the valve in the up position, such as the bell knuckle or the knuckle off of the main tuning slide*.

4. Transfer this measurement to the piston at the corresponding port to the valve stem. ***In addition, add the difference between the valve cap depth and the thread depth (steps 1 & 2)***.

5. For downstroke on trumpets, flugelhorns, and other brasswinds where port/knuckle alignment can be view through a valve slide tube, view for proper alignment, adjusting the felts as necessary. Figures 1 and 2 below demonstrate both improper and proper port/knuckle alignment on the downstroke.

Figure 2 - Misaligned Valve Stroke

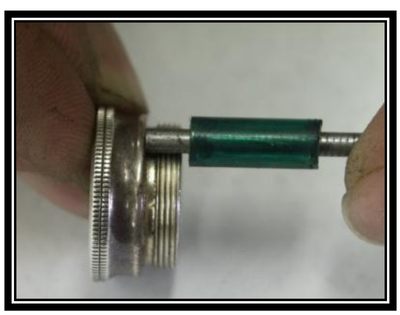
Figure 1 - Proper Aligned Valve Stroke

6. For the down stroke, if it cannot viewed through a valve slide, measure the "open" valve ports with a caliper as shown, and use this measurement to set the amount of bumper material in the valve cap or button. Make certain upstroke of the piston is set before setting downstroke

INTERNALLY THREADED CASINGS

For valve casings with internal thread design such as trumpets and cornets from Getzen and Bundy, we must still account for a space disparity. The measuring tools, in this instance, will be used in a slightly different manner.

1a. ***With internally threaded casings, what matters when porting upstroke is determining where the flat underside of the valve cap is relative to the valve cap's stopping point: the exterior shoulder of the valve cap that rests against the edge of the valve casing.*** Measure the depth of the valve cap underside, comparing that to the depth of the cap external threads to knurled shoulder. If the depth of the underside is ***greater*** than the thread depth measurement, add the difference to the knuckle/casing measurement. This is shown in the sample pictures below.



1b. If the depth of the underside is ***less than*** the thread depth, subtract the difference from the knuckle/casing measurement – this has to be done on Bundy trumpets and cornets.

Valve Stem Witness Marks

With some older brasswinds, manufacturers scribed a witness mark on the valve stem to assist the technician in porting valve upstroke. The goal was to place enough bumper material on the valve stem to set the inner edge of the valve cap even with the witness mark. While effective, it is always best to inspect porting with a valve mirror for greater accuracy.

Using Valve Mirrors

Valve Mirrors are valuable tools when porting piston valves. With them, the technician is able to view both up and downstroke alignment of the valve ports to the casing knuckles. There are lighted valve mirrors available that make the difficult job of viewing inside a valve casing much easier.

Difficult-Access Casing Repair

On some large brasswinds, accessing casing damage with mandrels or laps can be next to impossible because of the wrapping of branches directly above the valve casing. This is a common problem with Euphoniums and Tubas.

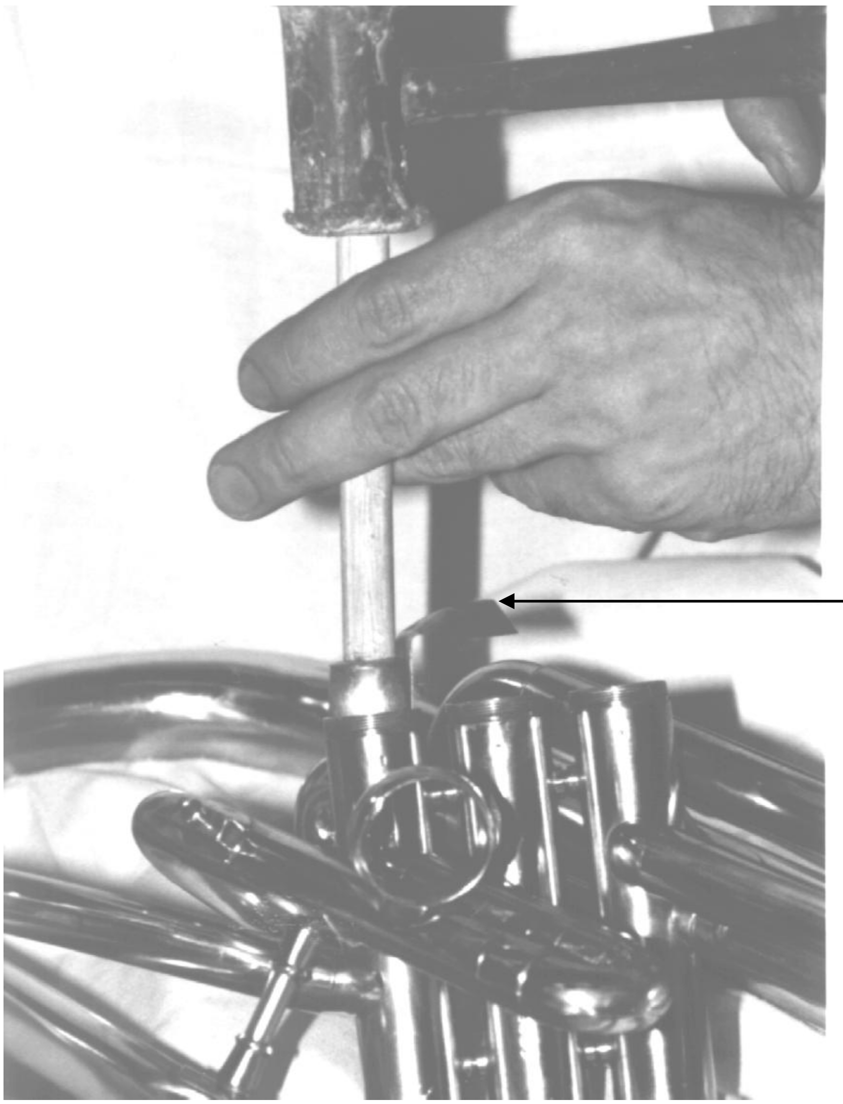
An option which has proven effective is to use large barrel shaped dent balls, which are gently forced through the top casing, wedged off-center by a long strip of brass shim stock.

The photo above shows shim stock of approximately .008" thickness and 3/8" width, a barrel-shaped dent ball from the Ferree's N62A dent ball set, a mallet and dowel.

Brass shim sheet stock can be purchased through machine shop suppliers. One can purchase a pack containing the multiple thicknesses required for this repair task. The shim stock is inexpensive and can also be used to make repair patches.

Select the largest size barrel shaped dent ball that will pass through the valve casing without jamming. Cut a 3/8" wide strip of shim stock approximately ½" longer than the valve casing (the shim will be used to force the dent ball into the casing damage, pushing the damage back out of the way). Place the shim opposite the dent and gently tap the dent ball through the casing. Note: The dent ball should be snug against the casing wall but not so tight that the casing diameter is expanded at the contact point. As the ball is nudged down through the casing, it should jam on the damage, pushing it out of its path as it is nudged through. This repair is particularly effective where there is knuckle damage.

In this instance, we are attempting to remove damage from the mouthpipe knuckle protruding into the casing wall. Our shim is placed opposite the knuckle, the dent ball fitting snugly into the casing but not so tight as to create damage. The dowel will be tapped to nudge the dent ball through, pushing the damage out of the way as the ball draws downward into the casing.



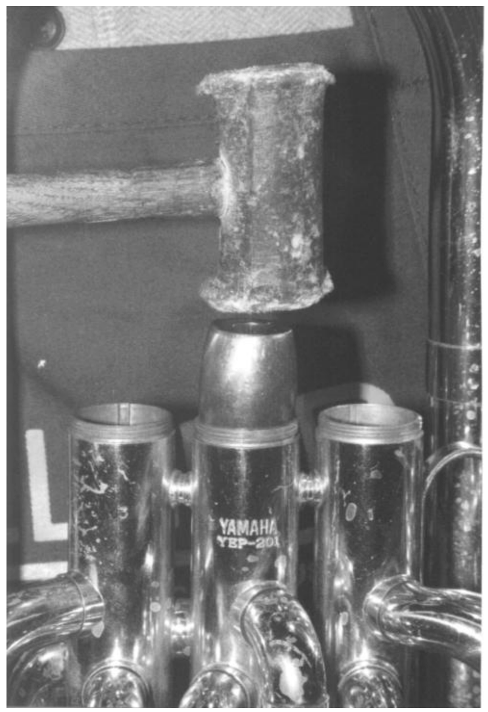
While difficult to see, the shim is placed in the casing opposite the damage. In this instance, the shim stock is .004" thickness, 3/8" width annealed so it will conform to the casing.

Yamaha Large Brass Casings

Problem: <u>Valve Cannot Be Removed from the Valve Casing</u>

A common problem on Yamaha large brass occurs when the top edge of the valve casing becomes rolled in. While it doe not effect the actual valve action, it can make removing the piston from the casing quite difficult.

Unlike most manufacturers, Yamaha does not counter bore the top ¼" of the valve casing. This creates a situation where the brass at the thread begins to roll in, often requiring the technician to remove the valve guide and send the piston out the bottom of the casing.
The solution begins with taking a barrel shaped dent ball (from Ferree's N62 set), tapping the



ball lightly to restore proper casing diameter (see above). This will allow the piston to pass through the top of the casing once again.

The next step is create space at the top of the casing with a sharpened solder scraper, following with sanding as shown. This should allow the valve to pass and assist in preventing the problem in the future.

Yamaha Valve Guide Slots (Keyways)

Problem: ***<u>Plastic Valve Guides Do Not Last</u>***

Common on bottom sprung Yamaha large brass, the problem is that the valve guide slot or keyway is not properly de-burred when the instrument is manufactured. In most instances the valve guides begin to wear prematurely from the slot cutting into the guide. The problem begins with the valve slowing intermittently then the valve slips out of its slot altogether. This process can take as little as three months.

One solution is to de-burr the slot with a hook-type solder scraper, followed with crocus cloth. If the problem persists, inspect the top edge of the casing to insure it is not rolled in, as that problem can also begin to chip away at the valve guide.

Valve Oils

Valve oil must do the following:

- **Lubricate Effectively**

Reducing friction is obviously what a player expects out of oil. Some oils are heavier than others and some valves respond better to one oil than another.

- **Fill the Space Between the Piston and Casing**

Sound fills all space – even space as small as .0015". Instrument performance can be enhanced when valves are oiled regularly because sound energy is not getting lost in the valve section.

- **Clean**

Oiling the valves regularly and applying the oil at the top of the valve body aids in flushing debris and surface saliva down to the bottom caps.

- **Prevent Corrosion**

Corrosion prevention is a major concern, particularly with Monel pistons. Saliva can quickly cut through many valve oils, particularly those that use paraffinic solvent as their base. Many players are finding that both kerosene-based oils and synthetic oils do a better job at preventing corrosion.

Recommendations: Regular application of valve oil is critical in the prevention of corrosion and in reducing piston/casing wear. Make certain that players place the oil at the top of the piston body, allowing the oil to flush down the piston face. Be generous with valve oil – ½ teaspoon per piston every day that the instrument is played is entirely reasonable.