Boiler Fittings (Continued)

In my last jottings I started to discuss boiler fittings but did not get beyond the subject of feed clacks and non return valves in general. I promised (threatened?) to continue next time, so here goes!

A few months ago I was asked how I managed to make my injector steam valves completely steam tight when closed. I was rather surprised at the question at the time because it had never occurred to me that there might be a problem, but having now thought about it I can see where difficulties might arise. The basic design of the majority of steam valves incorporated in live steam models has not changed for best part of a century and consists of what might be described as a blunt needle valve – see figure 1. The diagram shows only the business part of the valve. We will worry about the rest of the device in a moment, but figure 1 serves to highlight the requirements for a guaranteed steam tight shut off. Clearly this will only be achieved if the conical end of the spindle locates exactly on the seating when the valve is closed. If there is any eccentricity between the axis of the thread on the spindle and the centre line of the cone on the end of the spindle or between the thread in the valve body and the valve seating a steam tight seal will not be achieved. It is, of course, possible to design valves with elastomeric sealing of some sort (the old style kitchen tap is an example) but in the small size valves we are usually dealing with it is more trouble to make such a valve then to make the traditional type properly.

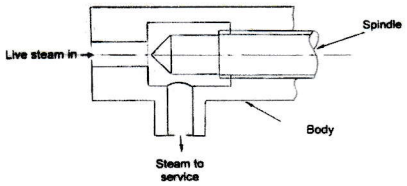


Figure 1
Basic Valve Geometry

Figure 2 shows details of the steam valves I have designed for my own locomotives. The dimensions shown are for a typical blower valve or injector steam valve but can obviously be modified to suit any application. The external dimensions of the body and bonnet are not shown and are not critical. If anyone would like a detail drawing a letter via Editor is all that is needed. The first and most important design feature to note is that the spindle is captive – i.e. the valve cannot be opened so far that the spindle screws out of the bonnet. The steam valve designs

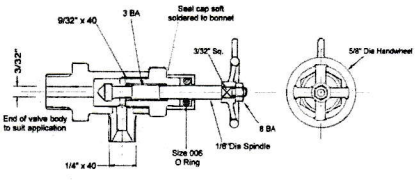


Figure 2
Steam Valve with Captive Spindle

promulgated by many of the famous designers of the past including such illustrious names as LBSC and Martin Evans, did not incorporate this safety feature which is now considered by most authorities as essential. The current edition (November 2008) of the British Model Engineering Liaison Group Boiler Testing Code is not entirely satisfactory on this matter and appears to leave the requirement to the discretion of the boiler tester. Most boiler testers will, however, insist on the requirement being met. Hopefully this situation will be clarified in future editions of the Code and captive valve spindles will be a mandatory requirement. Retrospective application of such a requirement will not be easy, bearing in mind the thousands of live steam models in service incorporating valves of traditional design with non captive spindles. It is interesting to note that the Australian Miniature Boiler Safety Committee current Code (which in my opinion is far superior to the British Code) does make the requirement for captive valve spindles mandatory, but the requirement is not retrospective to boilers registered before the introduction of the Code.

The second feature to note is the use of an "O" ring seal in place of the traditional packed gland. This is a personal preference and results in a smaller, neater configuration and a more reliable seal than a packed gland.

Another important feature of the design is the securing of the operating hand wheel / handle to the valve spindle. Many designs specify the hand wheel to be screwed onto the spindle and locked in place with a nut. Indeed, many commercially available hand wheels are supplied with a tapped hole. This is NOT a sufficiently positive method of securing the hand wheel. If the valve is closed too tightly or becomes tight as the temperature is raised from cold it is possible for the hand wheel and nut to unscrew together instead of opening the valve. I have seen it happen on one of the locomotives steamed regularly on our own track. The use of a square on the spindle engaging with a matching square hole in the wheel ensures a positive torsion drive. The nut only keeps the wheel in place. The British Boiler Test Code advises the inspector to check the security of valve hand wheels on their spindles whilst it is a mandatory requirement of the Australian Code referred to earlier that operating hand wheels and levers are positively secured to their spindles.

Turning now to the manufacture of the valve, the body is fabricated from phosphor bronze. The bonnet and seal cap may be phosphor bronze or brass and the spindle stainless steel. The need to achieve concentricity of the various features has already been mentioned. In the case of the spindle the best way to achieve an accurate result is to screw cut the thread, finishing to size with a die

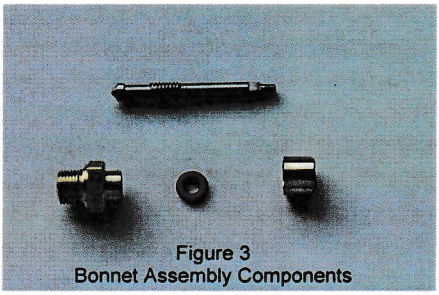


Figure 3
Bonnet Assembly Components

or die nut. If a BA thread is employed, and in my case it usually is, screw cutting presents a problem on many lathes, including mine! If the plain outer end of the spindle is machined to a couple of thou under the root diameter of the thread it will provide an adequate guide for a die and ensure a true thread. Machine the whole spindle at one setting, including the cone on the business end, leaving a small "pip" for final parting off – there is no need for a sharp point. The threads in the valve body and bonnet must also be cut with care but should not present a problem if sharp taps and dies are used with a tailstock die holder to present the die accurately to the job and the taps guided by a drill chuck in the tailstock. The seal cap is soft soldered to the bonnet and the "O" ring worked into its cavity through the spindle hole. Be careful to remove any sharp edges and burrs from the cap and the end of the spindle to avoid damage to the "O" ring during assembly. A smear of silicone grease helps. Should the "O" ring need replacement at some future date removal of the old ring is easily achieved by unsoldering the cap to facilitate removal of the debris from the old ring before re-assembly. A set of components for a bonnet assembly are shown in Figure 3. I make my own hand wheels, machining the profile on the end of a piece of bar and drilling to rough out the space between the spokes before parting off. The spokes are finished to shape with needle files and scrapers. Ideally the square hole would be produced with a small broach but I have never got round to making suitable tooling and do the job by hand with a square needle file. The appearance of the wheel is enhanced if it is dished slightly by pressing in the vice with suitable supports. A small hole is drilled in the rim and a suitable size piece of wire silver soldered in place and trimmed to length for the handle. Figure 4 shows opposite sides of a couple of typical 5/8" diameter wheels.

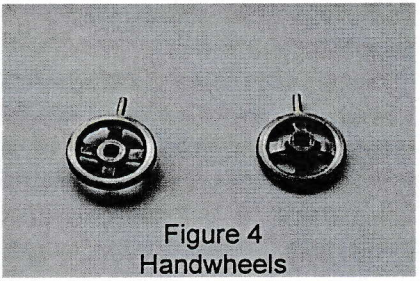


Figure 4
Handwheels

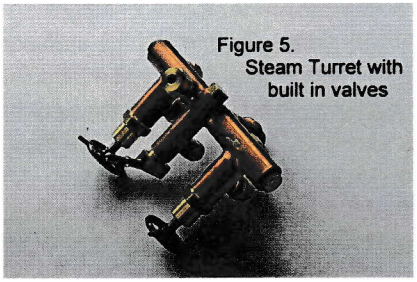


Figure 5.
Steam Turret with built in valves

The valve body may be made as a "stand alone" feature such as a blower valve screwed into the back head on the end of a hollow stay or may be made as an integral part of some other feature such as a steam turret as shown in Figure 5.

So much for steam valves. Let us now have a look at the design and installation of water gauges. The water gauge is arguably the most important fitting on the back head of any boiler and must be accurate and reliable.

The continuing integrity of any boiler relies on the maintenance of a covering of water over the heated surfaces. In the case of the locomotive type boilers we are usually concerned with this means ensuring that the firebox crown is always covered. Maintaining this situation is the driver's responsibility but he inevitably relies on the water gauge to achieve this and it is important that the gauge does not mislead him with erroneous information. Unfortunately the possible faults either designed into a water gauge or arising from its installation result in the gauge indicating that there is more water in the boiler than is actually the case. The most significant design feature leading to this state of affairs is the choice of gauge glass bore. We are all no doubt familiar with the capillary effect which causes water to rise inside a glass tube when it is dipped into a vessel of water. The effect is the result of forces occurring between the molecules of the water and glass at the interface and the surface tension of the water. The distance the water will rise in the tube can be calculated for any given tube diameter and is inversely proportional to this diameter. The water in our gauge glass behaves in exactly the same way and in consequence will indicate a higher level of water in the boiler than is actually present. So how significant is the error? I have calculated the capillary rise for a couple of pieces of gauge glass I had in the workshop and have measured the actual rise for the two tubes. The results are shown in the accompanying table. Fortunately the surface tension of most liquids decreases with increases in temperature and in the case of water at 150 deg. C (approximately the saturation temperature at 80 pisg) it is about two thirds of the value at room temperature. Even so, the effect is not insignificant and can easily lead to an error in indicated water level of ¼". Clearly, the larger the bore of the gauge glass the smaller the effect will be. It must be emphasized that it is the BORE of the tube which is significant. The first of the samples I used was a length of tube I had had for some time and which I have used for most of my own gauges. The second sample was a length of tube with a red stripe incorporated, purchased at a recent exhibition. The red stripe fired into the glass is magnified by the presence of water in the bore and provides a clearer indication of water level. A good idea in principle but in this case I consider the material quite unsuitable and it is destined for the waste bin. Although 0.5mm larger in outside diameter the bore is 1.5 mm smaller than the tube I usually use and could (would) provide a very misleading indication of water level in the boiler.

CAPILLARY RISE IN GAUGE GLASS

Nominal Tube Diameter mm	Tube Bore mm	Theoretical Rise mm	Measured Rise mm
5.5	4.32	3.5	5
6	2.84	5.2	8

My personal opinion is that the minimum bore of a gauge glass should be 4 mm. The current Boiler Test Code makes no reference to the size of gauge glass but the Australian Code referred to earlier specifies a minimum bore of 3 mm throughout the gauge.

Other sources of error arise from installation faults. The most serious of these is the sharing of the top fitting of the gauge with another fitting such as a manifold. This practice is forbidden by the Boiler Test Code. The reason for this is that if steam is drawn off from the manifold by a service (such as a blower of injector) the pressure in the manifold, and therefore the top of the water gauge if it is shared, will fall. The fall in pressure may well be very small – a few calculations for a typical manifold supplying an injector indicates a figure of 0.02 p.s.i. Not very much, but this translates to 5/8" rise in the level of water in the gauge glass. Theoretically the top fitting of a water gauge could be shared with a pressure gauge because no steam flow is involved – I saw such an installation at the Midland Exhibition – but it would be better to avoid the wrath of the boiler tester and stick with a dedicated connection for the water gauge!

The location of the connection on the back head is also of importance. In particular the clearance between the inner end of the lower fitting and the fire box must be sufficient to allow free flow of water to the gauge without entrained bubbles of steam. Bubbles entering the glass make a nonsense of the gauge reading. Our own Boiler Test Code is silent on this subject but the Australian Code requires a minimum clearance of 5mm. The location of the lower gauge fitting should be such that the minimum level indicated (i.e. when the water is just visible at the bottom of the glass) should still leave an adequate covering of water over the firebox crown. Our Boiler Test Code states that "*when no water is showing in the glass there is still a safe level of water above the crown sheet of the boiler*". Whilst we may understand the intent, this is an unsatisfactory statement since if there is no water showing in the glass there is no way of knowing where the level is – the boiler could be empty! Better to define the requirement as the bottom (visible) end of the glass being an adequate distance above the crown sheet. The Australian Code defines this distance as being 10% of the distance between the crown sheet and the outer firebox wrapper. This seems to be a reasonable rule of thumb but will not suit every boiler design. Whilst the positioning of the lower gauge fitting in this way may seem an obvious safety requirement some of our famous designers of the past did not consider it. The Martin Evans drawings for the boiler of my current project show the lower gauge fitting positioned such that the crown sheet of the firebox would be bone dry with water still showing in the glass. I raised the position of the bush ¼" to satisfy the code requirements. If you are building to a published design it is a point worth checking.

The build up of scale around the inner ends of either of the gauge fittings is possible and will result in sluggish movement of the level in the glass.

This is readily checked by blowing down the gauge and observing the speed of recovery of the level. This procedure is called for by the Boiler Test Code during the steam test but the check should be made every time the boiler is steamed. Provision should be made in the gauge fittings for access to the internal passages via removable plugs to enable these passages to be cleared should this become necessary.

The matter of blowing down the gauge glass raises the subject of the blow down valve which should, if of the screw down variety, comply with the same rules as all other screw down valves and employ a captive spindle. This valve may, of course, be a "plug" type valve if preferred. This type of valve has the advantage of opening and closing the flow passage very quickly with only 90 deg. movement. For some reason these valves do not seem to be used very often in model practice although they were normal in full size.

One of the hazards associated with water gauges is, of course, the risk of a broken gauge glass whilst the boiler is in steam. Full size practice employs isolating valves in the top and bottom fittings and many models follow the same practice. The disadvantage of incorporating isolating valves is that, unless the fittings are rather bulky and over scale the passages are very restricted. Unless built to scale the majority of models are only fitted with a single water gauge and if a glass is accidently broken it is inevitable that the boiler must be shut down as quickly as possible. My own philosophy is that if the glass is broken, put the injector on and dump the fire immediately!

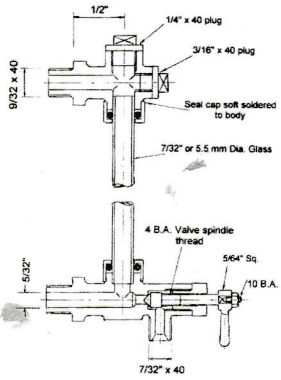
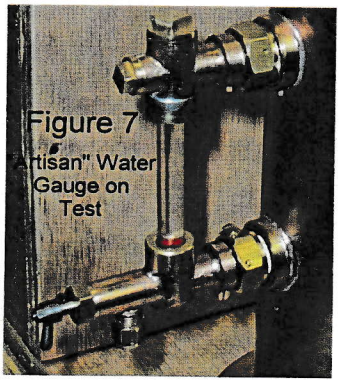


Figure 6
"Artisan's" Water Gauge

Figure 6 shows details of the water gauge design I have adopted for my own locomotives whilst figure 7 shows an example of a gauge to this design undergoing pressure testing at 200 p.s.i. The design incorporates "O" ring sealing for the glass and a screw type blow down valve with captive spindle. I have not bothered with a gland or seal on the blow down valve spindle since the valve is only open for a few seconds occasionally. There is no reason why a gland should not be fitted but it increases the size of the fitting and the outstand from the back head unnecessarily. A removable plug is incorporated opposite the top (steam) passage to facilitate cleaning if required.



The "O" ring seal housings for the glass are of similar design to the seals described for the steam valve spindles, employing seal retaining caps soft soldered to the body of the fitting. The seal groove could be machined from the solid if preferred, there being plenty of room to insert a small boring tool in this case. The advantage of this seal configuration is its relatively compact nature compared with a screwed seal retainer. This helps to achieve the greatest possible visible length of glass within a given space. I consider this important. Significant changes in water level can occur due to ascending and descending gradients and surging due to irregularities in the track. If a short glass is employed management of the water level in the boiler can be difficult and lead to anxious moments!

I am sure that I have taken up more than my fair share of space in this edition of LINK so had better close before our editor complains! There is still a great deal that can be said on the subject of boiler fittings but I think it might be time for something different in my next jottings. Watch this space!

Editors grovelling time

As mentioned in my general comments, the 2nd article by "Artisan" did not include Fig 4 referred to in the text on page 8 and is herewith reproduced below.

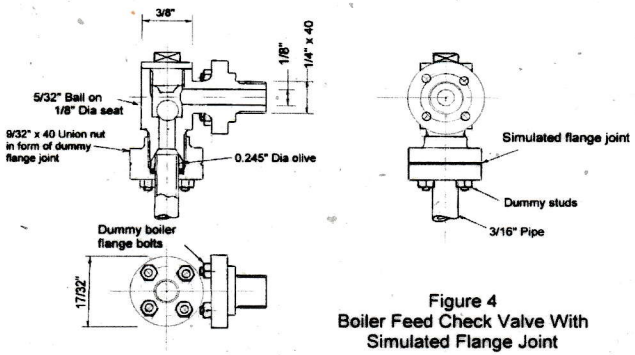


Figure 4
Boiler Feed Check Valve With Simulated Flange Joint

Again I must apologise as the 3rd article on the preceding pages has not reproduced exactly as written. Text has been regrouped after seeking guidance from so called experts which failed to give answers to the problem nor overcome the positioning of fig 7. **Ed**

Space filler: A newly appointed prison chaplain was leading his first prison service. He reduced the congregation to gales of laughter when he began his sermon saying: "Peter was a man who had real convictions".

Following the 3rd of the series Jottings from the workshop by 'Artisan' this is an appropriate place to include this important announcement up date from the boiler testers for all to duly read and note.

BOILER TESTING RULES UP DATE **BOILER TESTING RULES UP DATE**

A recent need for clarification regarding very small boilers resulted in a phone conversation (1st Feb) between Gordon Ross and the Southern Federation boiler inspector for clarification.

The opportunity was also taken to clarify the outstanding issue regarding captive valves and their application. There has been an ongoing issue with Southern fed to clarify the current legislation on captive valves which has been unclear.

The inspector advises that the matter was discussed at a recent Southern Federation meeting and they have advised that the decision is that ALL boiler valves must be captive and that there is no retrospective immunity. Confirmation of this is expected to be published by the Southern fed in due course.

Discussion between the clubs appointed boiler inspectors has confirmed that they will continue to enforce this policy on the boiler blowdown and gauge glass blowdown valves. Boilers put forward for test without these valves being captive will be refused a certificate.

The legislation is understood to apply to all boiler valves. However the club inspectors agree that some latitude will be given to other isolating valves on the boiler. It will be expected that all other valves should be modified before presentation at the next boiler test (ie: 12 months grace)

Health check

To ensure you remain fit and ready for the above summer programme carry out the following test:

How smart is your right foot? This will confuse your mind (if it's not already Ed) and you will keep trying over and over again to see if you can outsmart your foot, but, you can't. It is programmed into the brain.

1 While sitting at your desk in front of the computer lift your right foot of the floor and make clockwise circles.

2 While doing this draw the number '6' in the air with your right hand. Your foot will change direction.

There is nothing you can do about it.

Dr Ripper Health clinic manager

Events organiser

The summer running season will soon be with us and I have started on the summer running programme. Hopefully we will be visiting Leicester and Peterborough Societies if things work out okay. They will be coming to us but no dates have been fixed as yet so keep your eyes on the notice board for when dates become fixed I will put them up.

Dates already fixed are:- 4th April, 2nd May, 4th July, 1st August, 3rd October as Club steam up days. Family days 6th June and 5th September. Finally we are hosting a GL5 weekend 7-8th August when members will still be able to attend the site and use the raised track. The ground level will be intensively used by the GL5 members and if you are interested in seeing what they get up to then this will be the golden opportunity.

Other trips are in the pipe line which will probably be on a Friday evening. I intend to try and sort out a visit to Thorrington tidal mill, you may recall the talk we had last winter, hopefully if things work out we will be able to see it in operation, keep an eye on the notice board for details.

Late last year I attended the Model Engineering Exhibition at Sandown Race Course and was disappointed. There were few trade stands and those that were there tended to deal in new tools etc as opposed to the type of trader we are used to at places like the Midland and Alexandra Palace exhibitions. Rumour has it that this exhibition will remain at Sandown for the next 2-3 years and will hopefully improve so then I may try and organise a coach.

Finally can I appeal to those members who are good at catering to come and speak to me as I need a bigger pool of helpers. We also need a bigger pool of members to run things when we have visitors i.e. steaming bay marshals, bridge operators, persons to check boiler tickets and make tea etc etc.

Ian Pryke

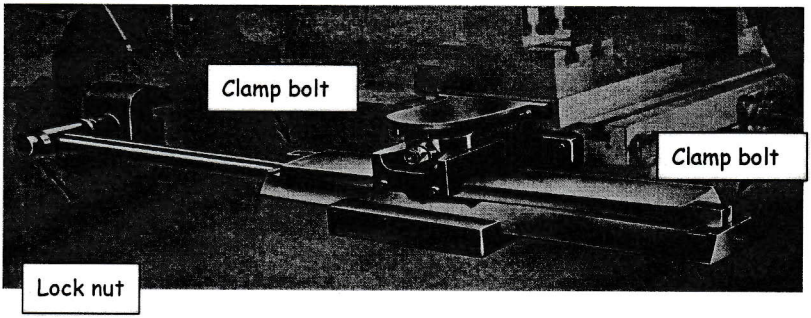
Taper Turning in the Lathe

Recently Paul Beeby and I had a need to turn some wagon axles with the traditional taper towards the centre of the axle which most wagons have.

Having to do a reasonable size batch it was going to be a long job to do with the compound slide set-over method you might normally use for tapers. The distance to the axle centre being over two inches (each end) conjured up thoughts of the lots of handwheel turning necessary there and back, even if you could accomplish the cut in one pass. Invariably the finish by this method is not very good either.

Paul happened to mention he had a taper turning device for his Colchester Bantam lathe and this seemed the answer to our prayers. Little did I know when he said he had an attachment he meant in a box in a cupboard!

Investigation and reading the manual more than once resulted in a days work getting it fitted to the lathe. A few bits were missing and had to be manufactured but by the end of the day all was working.
He popped around next morning having completed the whole batch in less than an hour and the finish was superb.
You might wonder where this is leading but for those in the know the club Colchester Student lathe also had an almost complete taper turning device fitted to it. To cut a long story short this has been completely stripped and rebuilt and the missing part (the long ¾" diameter beam) made from some material I had at home. The club lathe is now capable of turning tapers easily and quickly with long lengths and good finish easily achieved.
Why would I need to use it I hear you ask I am not making any wagon axles?
Well certainly the number of instances for its use whilst building an engine is small but there are some occasions when it might prove very useful. The long internal bore of the chimney is one obvious candidate, also its mating adaptor for the blower. Morse tapers are also sometimes handy to copy.
For those not familiar of its workings the following notes are intended to remove the mystic and give members the confidence to use it.
The picture below shows what you see when you now look at the back of the club lathe.



This is permanently fitted and in no way detracts from the normal parallel turning that you may need to do. If you wish to use the taper device however it is a simple job to bring into use.
Firstly set the adjustable back slide to the taper required. The calibration is show in both degrees and inches per foot. (These refer to inclusive angles so if you want to turn a taper of 2°set it to 1°) There is a small clamp bolt at each end, an allen key will unlock/lock once the setting is made.
To bring the unit into operation only requires the locking of the bolt at the end behind the tailstock to clamp the ¾" bar to the anchor bracket. Now when you wind the saddle handwheel the cross slide will traverse slowly over following the taper you have set.

To go back to parallel turning release the locknut – it's as simple as that!
Note: - the maximum angle possible with this attachment is 20° (Included)

Mike Gipson

Extra auction

A reminder from ***Mike Gipson***- there will be a third auction this year to be held on Friday 9th April which is included in the secretary's Friday events list below.

Secretary's programme of events

March

5th Rev. Lovell. A light hearted talk about the Essex Scene - rearranged from 18 Dec - **Please note this has now been CANCELLED Ed**

12th Julian Garrett: The early days of the Welshpool and Llanfair Light Railway

19th Models Night. Members display their current work.

26th David Cleveland - A programme of vintage films using a recently restored antique projector

April

2nd Auction viewing

9th The Annual Auction - Night Three

30th Annual General Meeting

Mike Gipson's Paxman talk is deferred until October

5 June Families Day
7/8 August GL5 Rally and AGM
5 Sept Families Day

Publication deadline for July edition 6th June 2010.
Please submit articles by E mail as an attachment if possible. Also acceptable on disc, hand written or typed and photographs by post to Link Editor, 52 Valley Road, Ipswich IP1 4PD

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