



**Federation of Model
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Check valves design and making

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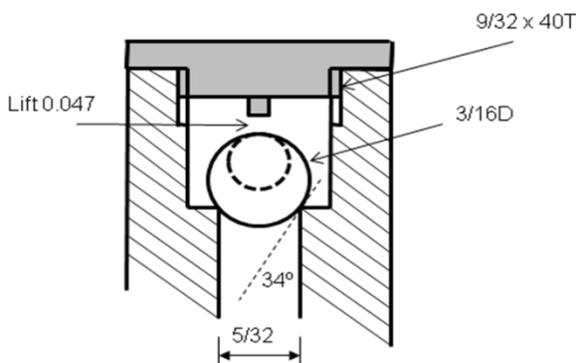
As part of the preparation of an engine for its summer outings I found myself dealing with a leaking check valve. Check valves, or clack valves as they are often known, are a necessary and important fitting since we need to supply feed water to the boiler without the contents being expelled by the steam pressure within, so, clearly, they must work well. Unfortunately, they are not for life in the sense that you can fit them and ignore them thereafter as they do need attention according to the life they lead. Top feed clacks have a charmed existence way up above the water line but life is tough for the valves fitted somewhere around the foundation ring where they are exposed to very hot water with dissolved and suspended salts. Low mounted clacks should be avoided like the plague but I know it is easier said than done, after all every boiler will need at least three water feeds, two for running use plus the emergency hand pump, so the doorplate is likely to end up a bit crowded and at least one clack usually has to live in the depths of hell. Oh, fortunate are they the modellers of ye oldies where the clacks go alongside the boiler, also they with "modern" top feed prototypes, for they shall inherit clack free boiler fronts.

A leaky check valve spells trouble in almost all cases as bleed-back to an injector can easily raise temperature beyond the pickup point, while blow-by to the axle pump will produce a steamy tender (not quite the same thing as Stirling's Steam Tenders on the GNR) which sounds a good idea for a cold day but which will cause cavitation in the pump. Either way you're stuck without water! The central heating in my tender was caused by a clack located at foundation ring level and I assumed that sediment had built up. On inspection it did not look furred up (neither did the ball) and I just twiddled a D-bit by hand on the seating face to give a light clean, wiped the ball, replaced it and tested. No way! The ball was not seating. Perhaps I should describe the test procedure. Equipment required: about a foot of rubber tube, one set of lungs and a tongue; Procedure: wring the tube on to the input connector thread, hold the clack vertical, suck to produce vacuum and try to hold the vacuum by putting tongue tip over open end of pipe. The suction will maintain itself on a perfectly sealed system but it will leak off past a ball, however the ball should seat well enough to give the feel of some vacuum if the clack is to be of any use. I inspected the seating with a glass under a bright light and saw that it was pitted, evidently the extreme conditions had taken their toll. I managed to chuck the valve concentrically and took about 10 thou off the face, tidied up the hole with a reamer, burnished the seat and reassembled. Now I was able to suck a vacuum which held for a short while, job done.

So how do you make decent clacks? Thinking about how they work gives us a clue: a rustless ball sits on a seat formed by the edge of a round hole, when the pressure underneath the ball exceeds that above it lifts allowing water to flow, when the feed water stops the pressure from the boiler pushes the ball back on the seat and it seals, it's that simple. Simple it may be but it does require a number of things to be done correctly if it is going to work. The essential things to watch are: 1) the ball must be spherical, 2) the hole must be truly circular in a flat plane if the ball is to seat all-round

the circumference, 3) the ball must be in a position to re-seat when the feed stops, 4) the lifted ball must not obstruct the free flow of water.

The shape of the ball is in the hands of the supplier, generally they are good but I have heard of instances where bronze balls were not true, stainless seem to be satisfactory. Control of the ball when lifted is taken care of by putting a pintle on the underside of the valve cap of length to limit the lift of the ball to $\frac{1}{4}$ it's diameter, at this lift the open area is equal to the cross section of the seat (trust me, I'll spare you the maths) and the ball will not be forced into the delivery hole (yes, I have seen this happen, the injector picked up and immediately went into full overflow). Requirement No. 2) for a circular seat is the one to watch: it is only achieved when the seating surface is perfectly flat and when the hole is round and perpendicular to the seat, a round hole at any other angle produces an ellipse on the surface so obviously the ball will not seat. The manufacturing sequence must be to sink a ball chamber and finish it off with a D-bit (flat surface) then without disturbing the body in the chuck to drill the hole and finish with a reamer (circular & perpendicular). For a good seal it is beneficial to burnish the seat, so as a final operation glue or force fit a ball of the same diameter on to a brass rod, coat with polishing compound or Brasso, and rotate heavily against the seat.



The dimensions of a typical clack for a 5" G engine with $\frac{3}{16}$ " pipework are Seat D $\frac{5}{32}$ ", Ball D $\frac{3}{16}$ ", Cap thread $\frac{9}{32}$ " x 40T. The angle of seating is 34° , this is fine as it allows the ball to sit well inside the seat without being too far in and risk jamming. A ball lift of 0.047" leaves an area below greater than that of the seat hole (and supply pipe). If the chamber is made to the tapping diameter of the cap thread the area between wall and ball is also greater than the seat so free water flow is assured.

What are the alternatives? I experimented with nitrile balls at one time in an attempt to improve seating as the slight softness of the material assists the ball in sealing against an imperfect seat, but at high temperature and pressure there is a risk of jamming. Also, the ball tends to float when not held by back pressure: if you fill your boiler with special water before leaving home you get a free internal car wash on the way to the track. Full size check valves are taper plugs lapped in against a taper seat, I think this would be a bit beyond the ability of Mr AV Modeller, but there is an alternative in using O-rings to form the seal. This has been done successfully by several people and I am told that reliability is high which I do not doubt as I have used a similar arrangement in

push-pull steam valves which operate under fairly harsh conditions. As usual in engineering there is always a trade-off, in this case it is size. For the above valve the seat diameter would need increasing a bit to compensate for the area which is obstructed by the "wings" of the guide spindle, a $\frac{3}{16}$ hole (which is not required to be round or perpendicular in this case) needs a $\frac{5}{16}$ OD ring and the valve chamber would be about $\frac{3}{8}$ ID so it's not easy to get a valve that looks appealing. An O-ring check valve was described in ME (2006) where the valve body was guided by an extension into the cap, so that the diameter did not increase, however the height was extended and the "look" suffered, I have no information about performance.

Finally, some men are born pessimists and resort to belts and braces. The check valve equivalent is putting one clack in the normal position and having another hidden away in line between the injector and the "official" clack. For this use the usual 90° valve is sometimes not convenient and an in-line alternative is easier to arrange, Laurie Lawrence's excellent design on page 392 of ME October 1986 is highly recommended. Now just a minute, exactly who are those double clack chickens?!