HIGH BALL

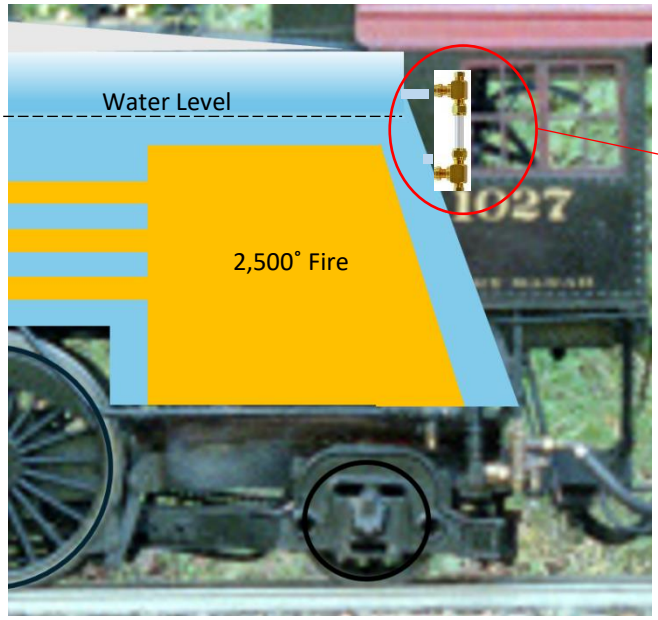
A Publication for the Mid-Michigan Railroad Club
March 2024

How Does a Steam Locomotive Work Part II

In February our locomotive was fired up and headed down the railroad. Whenever there is a fire in the firebox the engineer/fireman must keep a close watch of the water level. Each stroke of the pistons draws steam from the boiler lowering the water level.

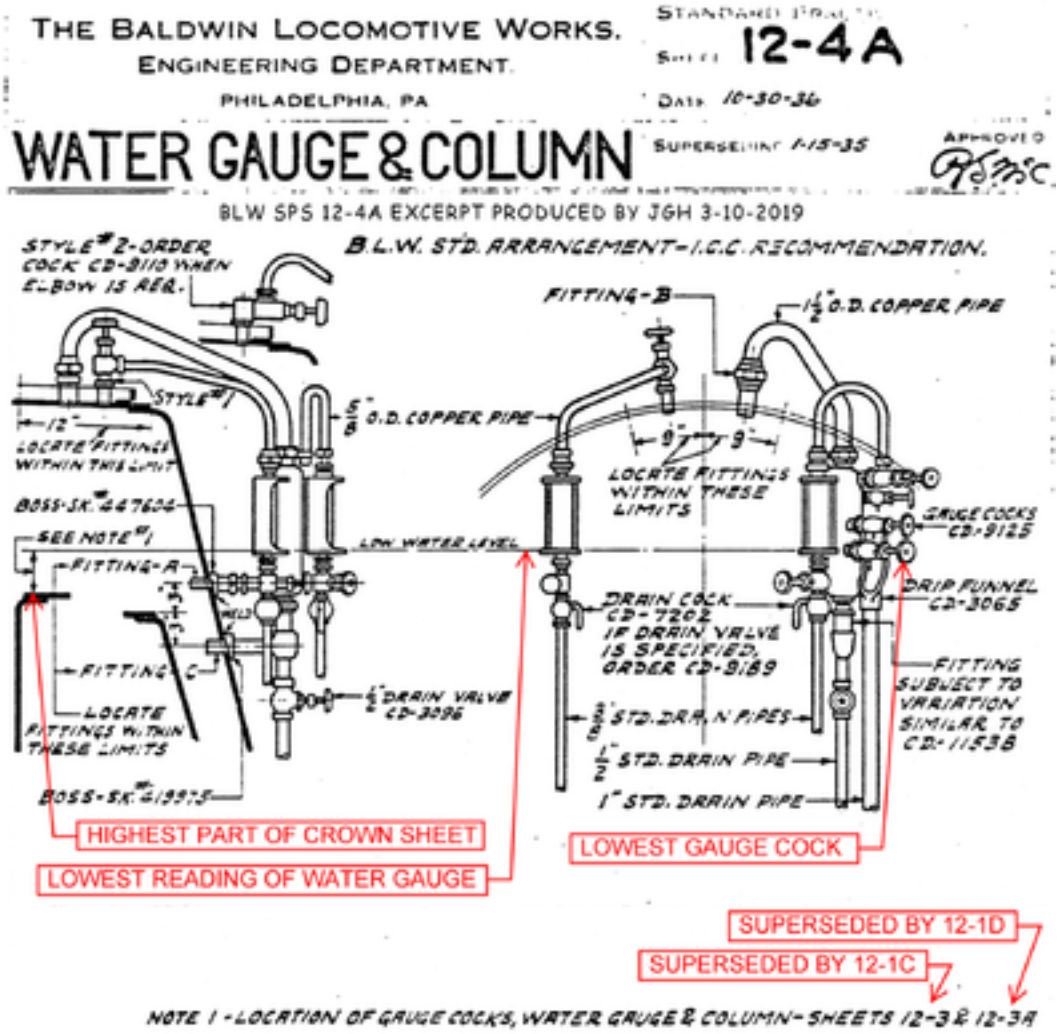
The fired surfaces (exposed to fire) must be covered with water at all times. A coal fire can burn as hot as 2,500˚F. At 1,000˚F steel will have lost 60% of its room temperature strength. With a melting point generally between 2,600˚ and 2,800˚F the firebox sheets will crack or collapse if they are left uncovered.

A water glass is the most common method in a model boiler to monitor the boiler water level. A simple water glass is a glass tube fitted at the water level.



The top of the water glass is connected to the steam space above the normal water level range. The bottom of the water glass is connected to the water space below the normal water level range. As the water level is the boiler rises and falls the level in the tube also rises and falls.

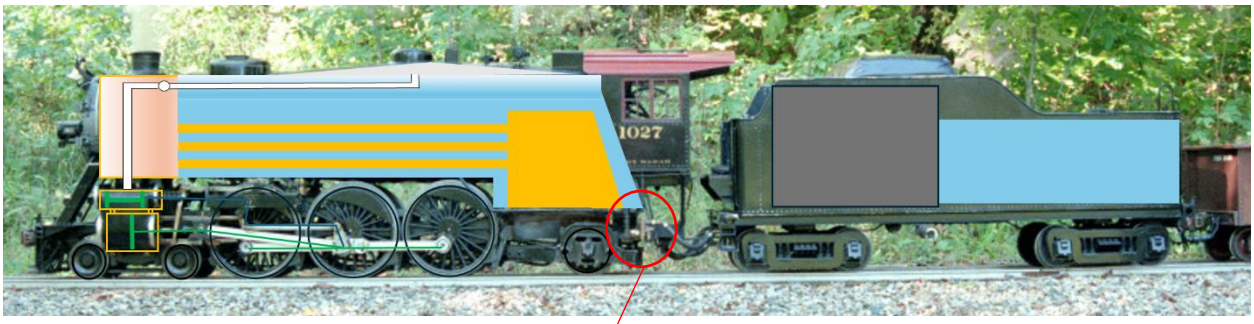
Some models are fitted with a water gauge or column which is a hollow metal column fitted with a glass lens on front side. A water gauge functions the same as a water glass giving a visual reference of the water level. Prototype locomotives were often fitted with two water gauges. This allowed the engineer and fireman to monitor the water level without leaving their side of the cab.

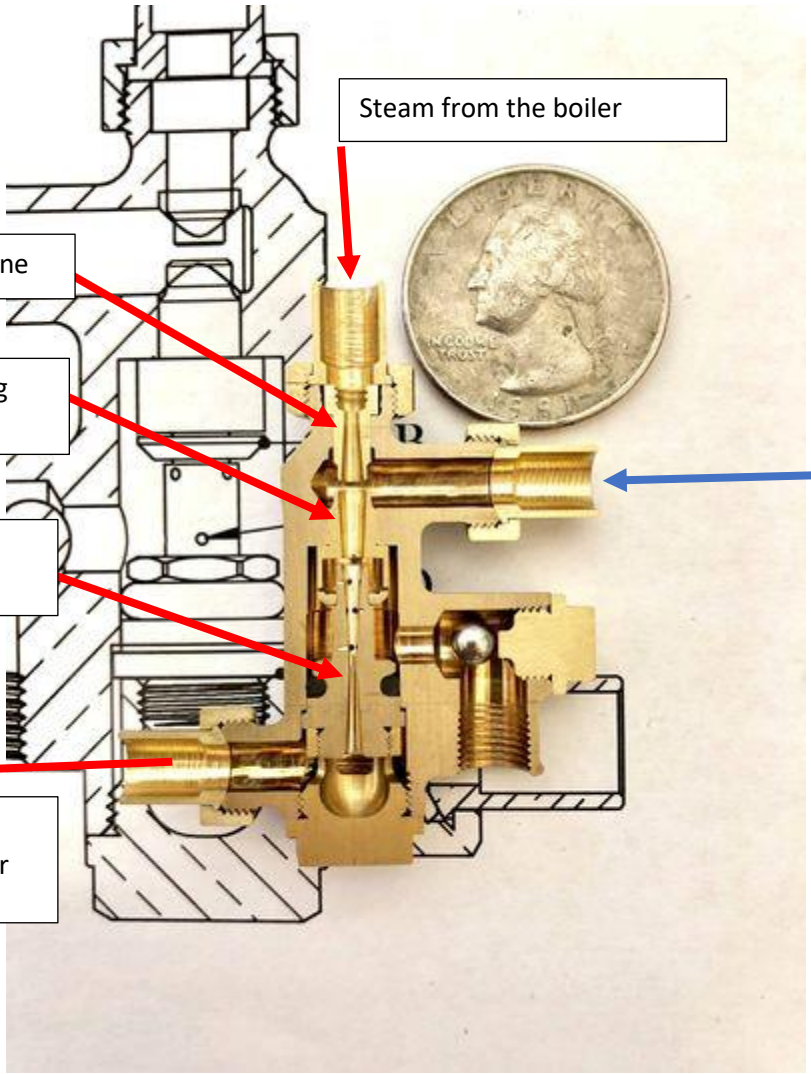


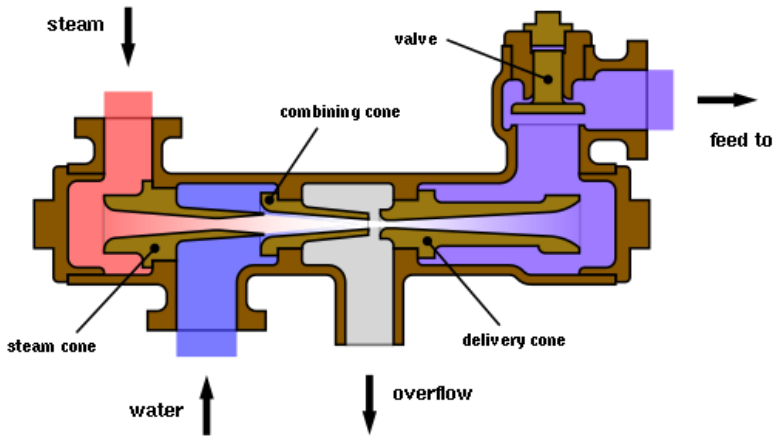
If a water gage connection to the boiler plugs the glass can give a false reading showing a level higher than the actual level. Large boilers were fitted with Tri-Cocks which is a set of three valves on the boiler at the same range as the water gauge. A fireman would briefly open each valve and observe if water or steam escaped. Water gauges provide a quick reference of the water level. Tri-Cocks provided a confirmation of the water level reducing the risk of a plugged connection.

With the fireman carefully monitoring the water level it is soon time to replenish the boilers water, This is accomplished with injectors and pumps.

The steam injector is an interesting device. With only one moving part the injector uses steam from the boiler, mixes the steam with water and produces a slightly higher pressure to inject the water into the boiler.







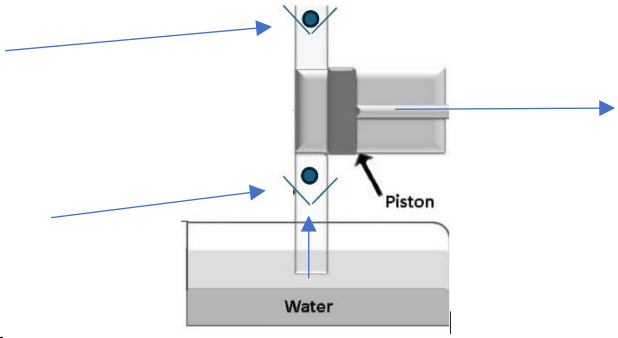
Steam is admitted to the delivery cone accelerating as it passes through the cone. The Venturi effect of the converging-diverging nozzle converts the pressure energy of the steam to kinetic energy. This high velocity jet of steam creates a negative pressure in the combining cone which draws water from the tender. The water mixture passes into the delivery cone where the diverging shape of the cone converts kinetic energy back to pressure energy. The pressure is higher than boiler pressure which causes the delivery pressure to lift and water to flow into the boiler.

The injector may seem to be a 100% efficient device. All of the steam drawn from the boiler is injected back into the boiler so it would appear no energy is lost. When water boils it is first raised to the boiler point. Then additional energy called the heat of vaporization is required to convert the water to steam. As water boils on the stove the water is at the boiling point and slowly converts to a vapor as energy continues to be added.

In the combining cone as the steam mixes with the tender water and condenses, the condensing steam gives up the heat of vaporization energy which provides the additional pressure needed to inject the water into the boiler. Without a steady flow of water to cause the steam to condense in the combining cone the inject would not work. Steam will pass through the steam cone into the combining cone. Since steam has not condensed and released the heat of vaporization energy pressure at the delivery cone is too low to lift the outlet check and the steam will exhaust out the overflow.

The second method to add water to the boiler is a reciprocating pump.

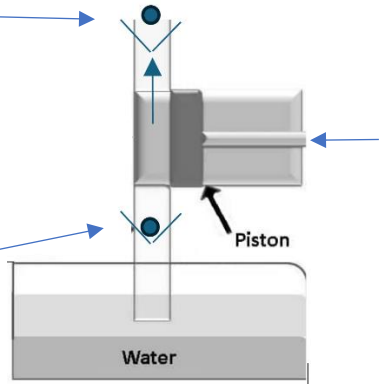
Boiler pressure presses the outlet check against its seat preventing steam from flowing into the pump.



In this figure as the pump piston moves to the right, the volume inside the pump cylinder increases. This creates a negative pressure (vacuum) inside the cylinder.

Atmospheric pressing water against the inlet check valve causes the check valve to lift (open). Water flows into the pump cylinder.

When pressure inside the pump cylinder rises above boiler pressure, the outlet check lifts (opens) and water flows into the boiler.



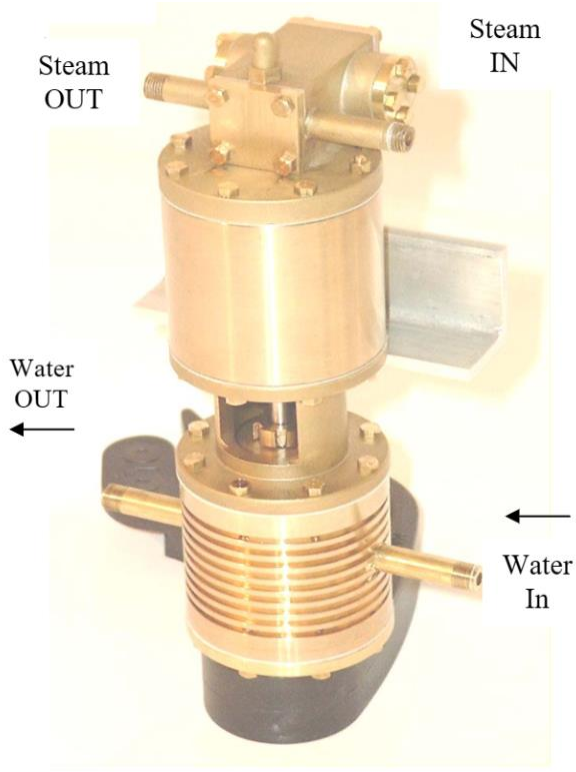
In this figure as the pump piston moves to the left, the volume inside the pump cylinder decreases. This creates a positive pressure inside the cylinder.

The positive pressure presses the inlet check against its seat and preventing water from flowing back to the tender.

The reciprocating feed pump can be driven by hand, by adding a steam piston to the pump or mechanically connecting the piston to the steam engine. On the model locomotive injectors and axle mounted pumps are most common.

Hand pump from PM Research

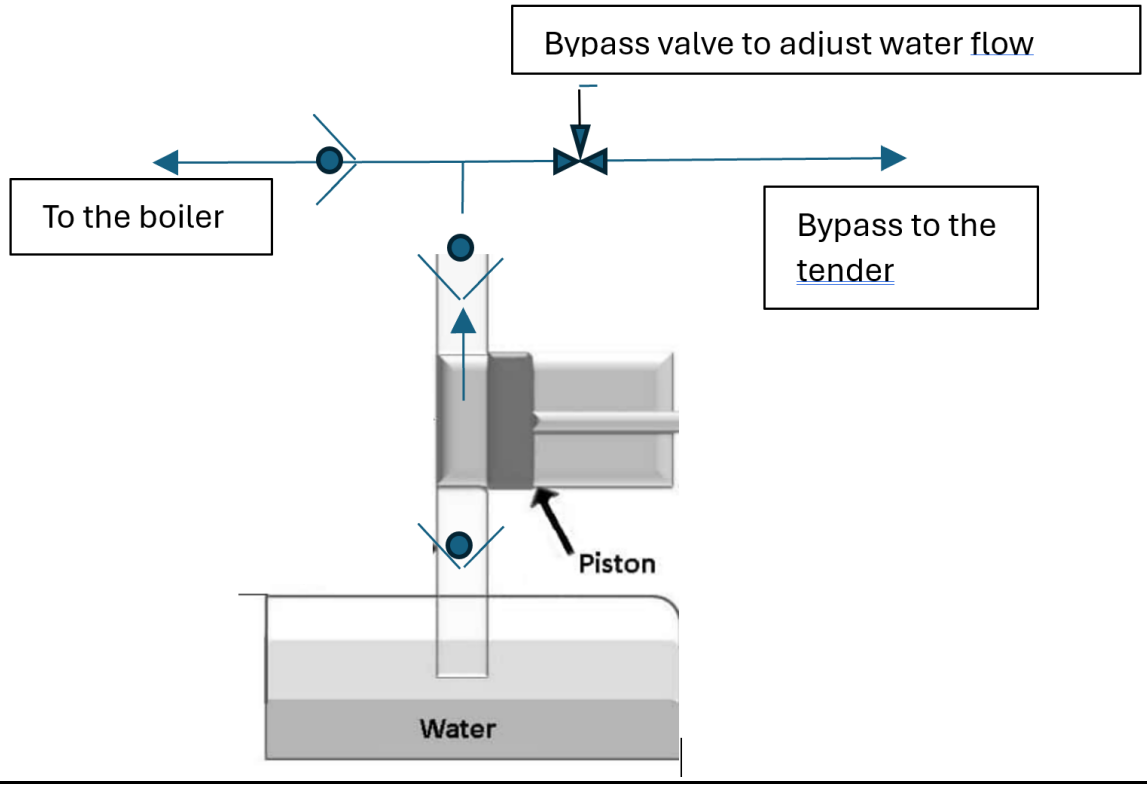
https://pmmodelengines.com/



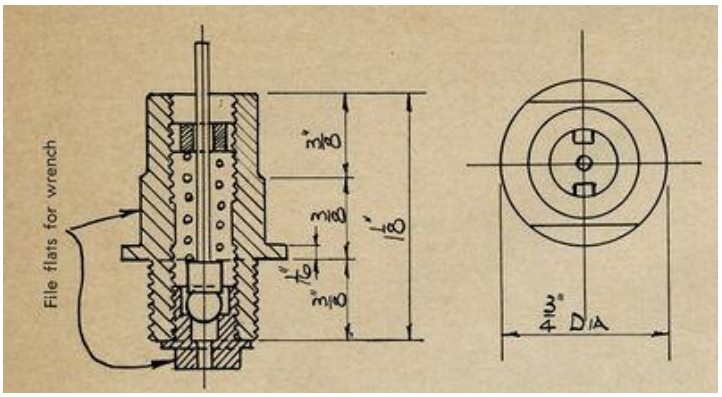
Steam driven pump from Keim Steam Pump

https://keimsteampump.com/home-page

Axle mounted pumps are most often fitted with a bypass valve. The bypass allows some of the water pumped to flow back to the tender and "bypass" the boiler. While not prototypical this allows the pump to be set to provide most of the water needed making the locomotive easier to operate. The balance of the water being supplied by an injector.



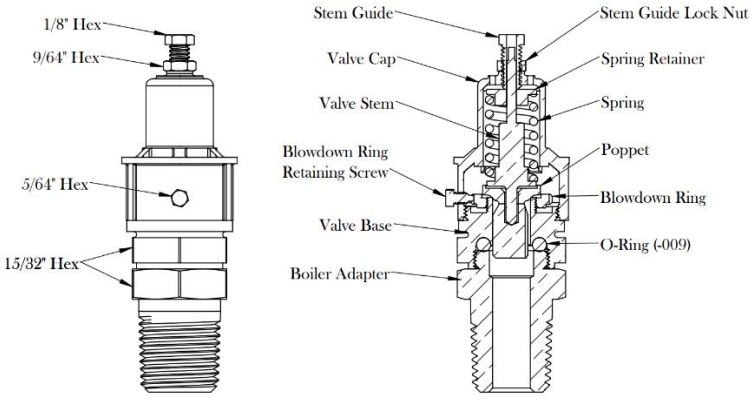
With the engineer/fireman maintaining a safe water level and good fire, one more important device is the safety valve. Safety valves limited the maximum pressure in the boiler.



November-December 1954 *The Miniature Locomotive*

A simple home shop made safety valve. This is essentially a check valve with a spring and an adjusting screw to vary the spring pressure. When the force of the boiler pressure pushing upward is greater than the spring force the ball lifts (opens) and vents steam to atmosphere.

Ball type safety valves while simple and inexpensive tend to chatter and buzz valve when open. Many locomotive owners prefer safety valves from Super Scale and Eccentric Engineer. These valves are smoother operating poppet types and include an adjustable differential meaning the span between open and close pressures can be adjusted.



Eccentric Engineer safety valve https://www.eccentricengineer.com

In a coming month we will look at some of the other devices used on a steam locomotive.

Think Safety

- Equipment Inspections. Spring is a few days away and the railroad opens soon. If you have not inspected your equipment now is a good time to do it.
- The track needs to be walked before all run days. Look for debries on the track and damage due to things like golf carts.
- PLEASE NOTE: It is up to EVERY MEMBER to remain alert and proactive to the cause of safe operation and good personal conduct at ALL TIMES. This is a club rule and expectation. Unsafe train handling and/or poor personal conduct cannot be tolerated at the club. Please speak up if anything is amiss as far as safety and/or conduct is concerned and remember to do so respectfully and calmly to all parties involved. Safety is our NUMBER ONE PRIORITY and should never be taken for granted.

Projects

- The new pavilion needs to be finished. The framework has been erected. We still need to install the used steel panels on the roof and hook up the electrical line to the structure.
- The old pavilion, which is now our riding car and lawn maintenance storage building, still needs Lexan (clear) panels installed along the top of the ends and sides to let natural sunlight in.
- Existing mainline trackage. We can replace individual ties here and there BUT there are complete track panels that may need to be replaced. Some sections of our mainline is original to the club. We have a good supply of new wood ties on hand as well as a large quantity of plastic ties that we purchased last year from an individual in Indiana.
- The bridge decks are still in need of a coat of weather sealer.

2024 Run Schedule

March 30

April Saturday Work Days (weather permitting)

May 4-5, 11-12, 18-19 Arts & Crafts Show

June 8-9

July 6-7, 20-21

August 3-4, 17-18

September 14-15, 21-22 Flea Market and Antiques Show

October 5-6, 12-13, 19-20, 26-27

2024 Dues are due.

Annual dues are due. Please send them to Chris Morris 421 N Shelson St. Charlotte MI 48813-1224.

MMRC Facebook Page

Facebook Likes and Followers have increased quite a bit in the last 10 months (38% growth rate in Likes, and 52% in Followers). Many people use social media and we want to continue to leverage that. Looking for four volunteers at a minimum who run a train on the MMRC to share more about how their engine works (and some pictures of the internal workings along with the exterior of the engine). Goal is to increase knowledge to the public and retain interest on how trains operate. Would love a steam, electric, gas, hybrid. Contact Tina Pritchard, Membership Secretary if you can help.

For Sale Items for the newsletter?

Send details to Pat Patton, patpatton@ymail.com

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