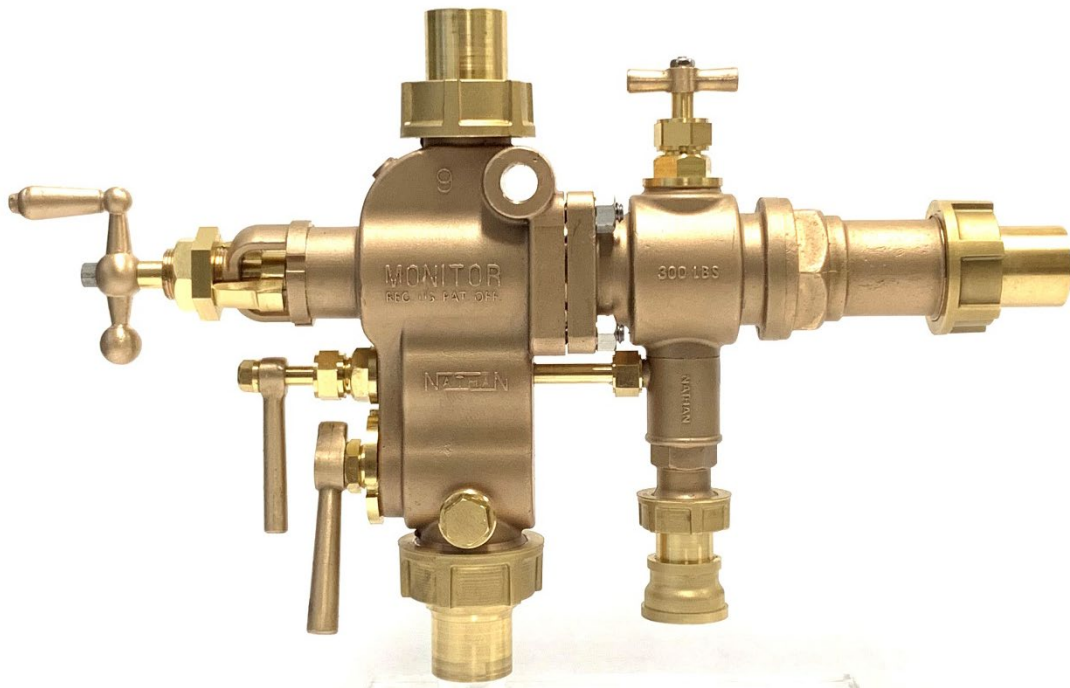


Eccentric Engineer
Nathan Monitor No. 9
In 2.5" Scale



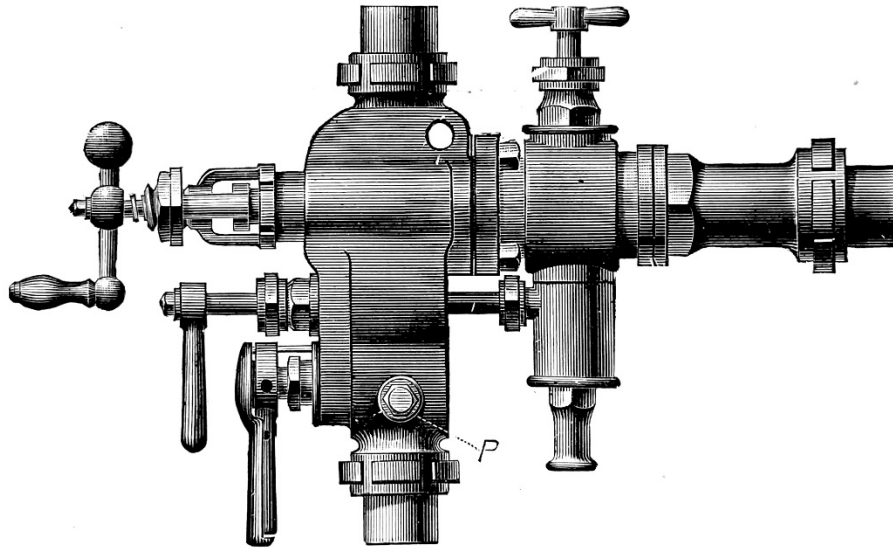
Installation, Maintenance, and Operation Manual

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Introduction

THE “MONITOR.”



EXTERIOR VIEW.

The “Monitor” Injector, exterior view.

From the Nathan M’F’G Co. 1892 Catalogue

Congratulations on your new 2.5” Scale Nathan ‘Monitor’ injector! Eccentric Engineer has recreated these injectors in miniature as accurately as possible from original Nathan blueprints.

Nathan Manufacturing Co. was founded in 1862 just 3 years after the earliest attempts to manufacture injectors. A bit behind their competition, they didn’t introduce their first injector until 1880. The Monitor injector was their first offering and they were very warmly received. Taking feedback from their customers, Nathan Mfg. made many improvements to its injectors early on, and by 1888 the Monitor’s design was solidified into what we see today. Examples of the Monitor can be found on countless operational and display locomotives in museums, historical societies, and excursion railroads all around the world; clear evidence of its popularity and success!

With any injector, the quality of the installation is the greatest factor to its successful operation. In this manual, we will discuss the best practices for installation, operation, maintenance, and how to troubleshoot if the injector is not working correctly.

Installation

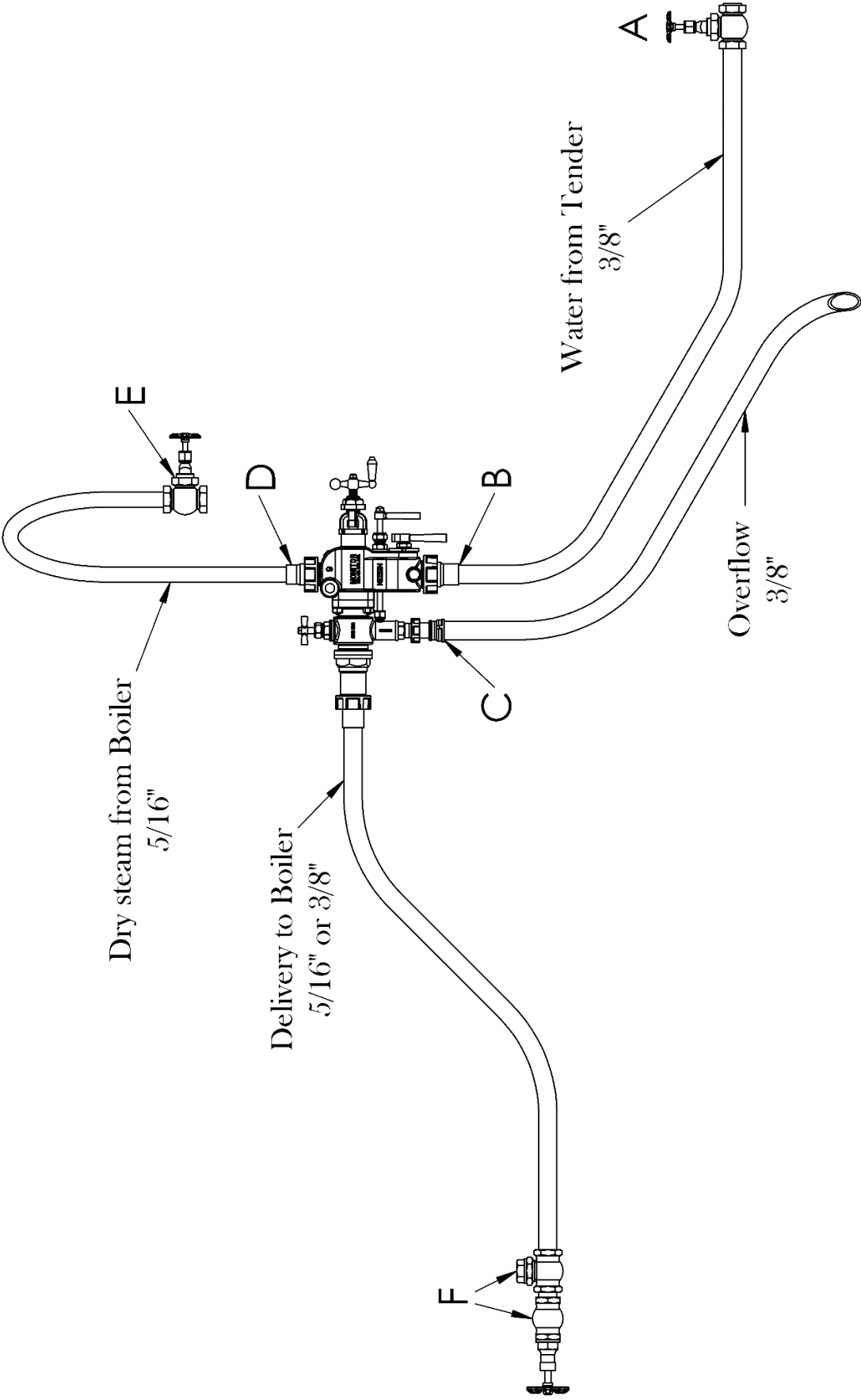


Fig. A, Water regulating valve

In order to alleviate casting issues, the water valve on the injector body is cosmetic only. A water regulating valve is still required to properly operate the injector, and there is a wide range of suitable valves. Ball or globe valves from 1/16" NPT to 1/4" NPT are both suitable, and it is typical to have the valve under the tender with an extended handle to be easily operated from the top of the tender. This valve can be placed anywhere between your tender and the injector, as long as it is easily accessible to the engineer.

Fig. B, Suction Line

The suction line is the most critical portion of the injector installation. It *must* be air-tight between the injector and the water regulating valve. Use as few fittings as possible to reduce the number of failure points where air leaks could occur. Red Loctite or soft solder work well as a sealant on threaded joints. Do not use thread locker or sealant on the union threads to the injector body.

Fig. C, Overflow Connection

It is strongly recommended to use the included reducer fitting to utilize 3/8" tubing for the overflow line. The reducer is designed to thread into the injector nipple and solder onto the 3/8" tubing.

Fig D, Steam Connection

The steam connection will be under constant boiler pressure and must be silver-soldered! Using soft solder can result in a failed joint during operation. Consider wrapping the steam line in fiberglass tape to prevent inadvertently burning your hands or arms on the line.

Fig. E, Steam Shutoff Valve

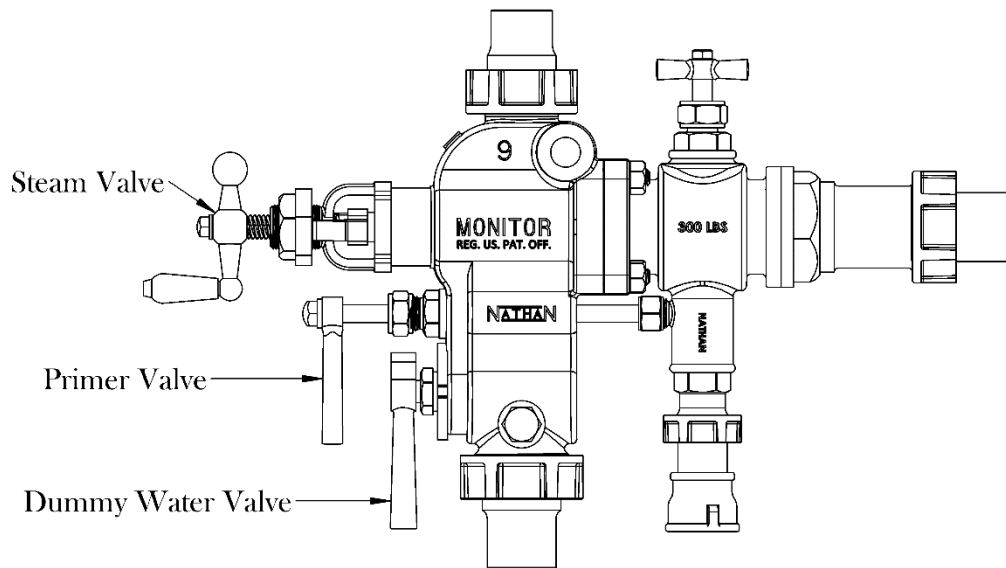
Even though the injector has a built-in steam valve, it is critical to have a main shutoff valve. If the injector needs to be removed or maintained while the boiler is under steam, this will only be possible if a main shutoff valve is installed.

Fig. F, Boiler shutoff & Check Valves

Eccentric Engineer recommends 1/16" NPT (5/16" MTP) check valves as a **BARE MINIMUM** for the Monitor injectors. Check valves from PM Research have been proven to work fine with the larger capacity nozzles. A shutoff valve between the boiler and check valve is strongly recommended but not required.

Operation

The model Monitor injectors feature a functional primer valve just the like the prototype and a quick opening screw type steam valve. Both the steam and primer valve feature triple lead threads for quick and easy operation. The primer valve offers the benefit of being able to draw water through the injector independently of the nozzles. No matter how hot the injector body gets, or even if the nozzles are completely clogged and inoperable, you will still be able to quickly prime the injector with cool water.



Follow this procedure to operate your injector:

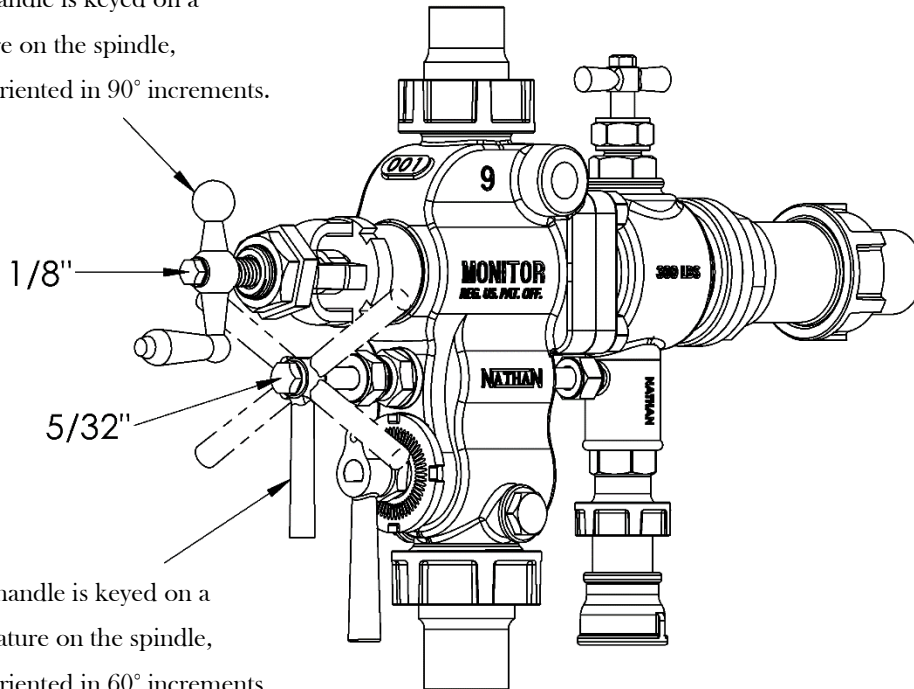
- 1) Open tender water valve *
- 2) Crack open primer valve. After 1-2 seconds the overflow will transition from steam to water.
- 3) Open the steam valve at least $\frac{1}{4}$ turn. The injector is now operating, however the overflow will still emit steam from the primer valve.
- 4) Close primer valve (not overly tight!)
- 5) Adjust water valve if necessary
- 6) When water level is satisfactory, close the steam valve. (not overly tight!)

*Since these injectors are designed to be mounted high, the water regulating valve can be left open if the injector is above the tender water level. Siphoning may occur after operation, in which case the water valve can be closed until the siphoning stops, and then reopened. At operating pressure, the water valve won't need to be regulated once it's set unless there are large fluctuations in boiler pressure.

Positioning the Handles

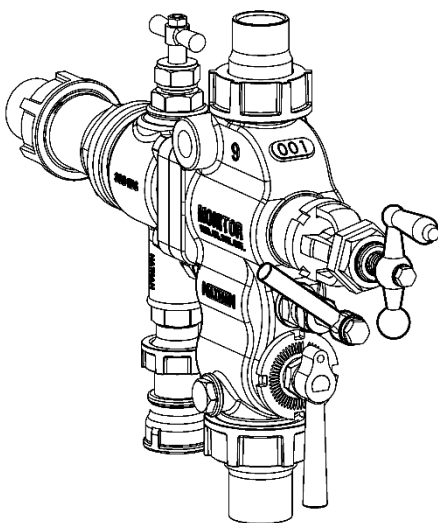
Depending on where your injector is installed, it may be inconvenient to open or close the handles. For example, if your injector is mounted close against the boiler jacket on the fireman's side (left side of the boiler), the primer valve may hit the boiler jacket when open, which would leave little room to easily close it again. The handles can be removed and re-positioned to the best possible orientation for your installation.

The steam handle is keyed on a square feature on the spindle, and can be oriented in 90° increments.

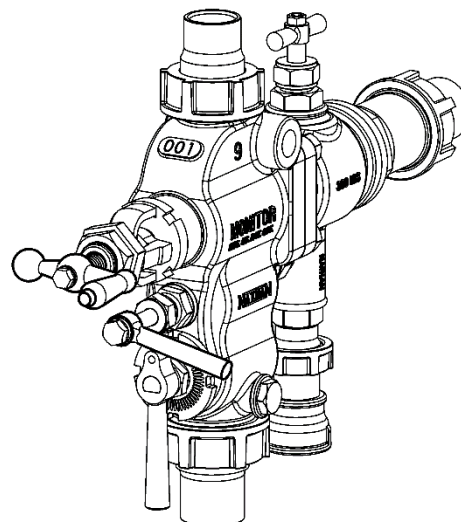


The primer handle is keyed on a hexagonal feature on the spindle, and can be oriented in 60° increments

Recommended "closed" handle positions
for Fireman's side:



Recommended "closed" handle positions
for Engineer's side:



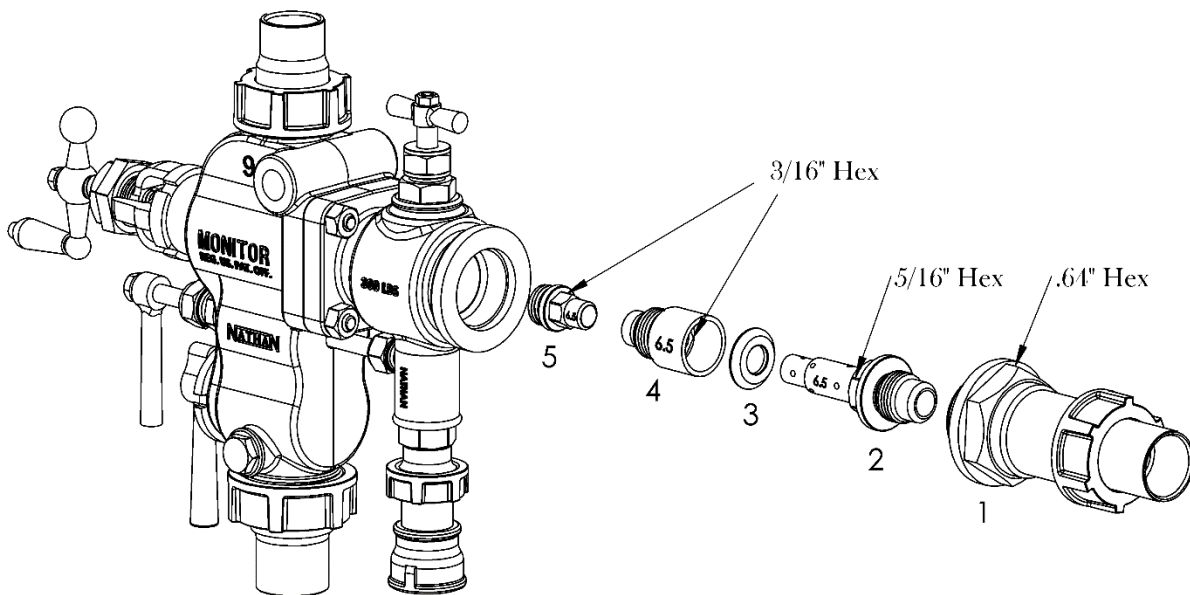
Maintenance

Preventative Measures

Your best defense against a problematic injector is to install a water filter in your water suction line. Dorman “Help!” glass fuel filters work very well, and spare filters can be purchased separately. They come suited for either 5/16” and 3/8” ID tubing.

Periodic cleaning of the nozzles can help to keep your injector operating at its best. An annual cleaning in an ultrasonic cleaner with 50/50 water and CLR for 5 minutes is all it takes. Unless you have reason to suspect that your nozzles are coated with scale or other substances (such as boiler treatment), anything more than once or twice a year is too much.

Removing Nozzles



- 1) Unscrew the in-line check from the injector body (not a functional check on the model). The best way to unscrew is to use two adjustable wrenches: one on the square body flange and one on the .64” hex.
- 2) Once unscrewed, the delivery nozzle and washer (3) will come out with the in-line check. The delivery nozzle can be unscrewed from the in-line check if necessary.
- 3) Be very careful not to lose this washer! Replacements are available.
- 4) The combining nozzle can be removed with a 3/16” socket.
- 5) The steam cone can also be removed with a 3/16 socket. It will come out easiest with the injector pointed down toward the ground.

For general maintenance, do not disassemble the injector body beyond what is illustrated here. The injector nozzle capacity is engraved into each nozzle to prevent mixing the nozzles (5.0 or 6.5 in pints per minute). Attempting to install mixed capacities will damage the nozzles.

Reinstalling Nozzles

When reinstalling, the steam nozzle should be tightened firmly. The steam valve comes in contact with this nozzle and it must be tight to avoid loosening during use. A bit of ant-seize or graphite lubricant is recommended. **DO NOT** use thread locker.

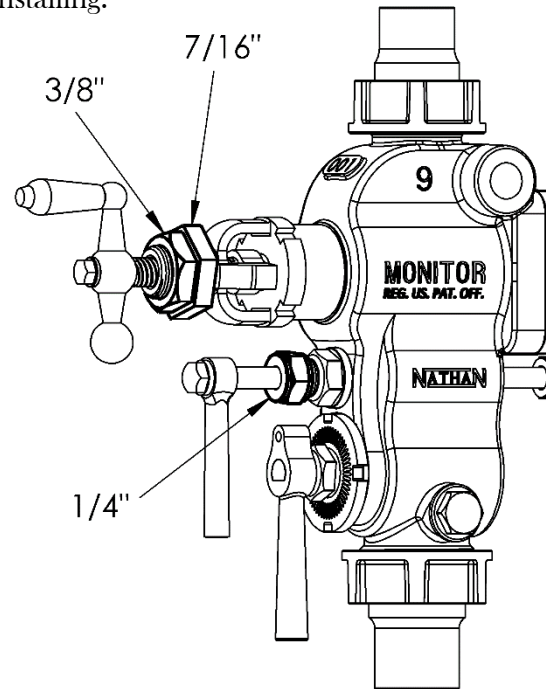
The combining and delivery nozzles do not need to be nearly as tight as the steam nozzle. Simply screw them in until you feel the nozzle stop. Make sure all metal to metal surfaces are completely clean of debris and/or anti-seize before reinstalling.

Steam & Primer Valve Packing

The packing for your steam and primer valve may periodically need to be adjusted. The Teflon packing will swell when the injector is under steam, so *only* adjust the packing when the injector is hot.

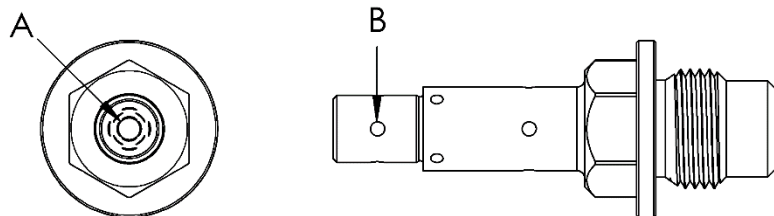
To adjust the main steam valve, tighten the larger 7/16" nut until leaking stops, but not so tight that the handle is difficult to rotate. Once in place, tighten the 3/8" hex against the 7/16", holding the 7/16" in place with a wrench to preserve your adjustment.

To adjust the primer valve packing, simply tighten or loosen the 1/4" packing nut on the valve bonnet.



Obstructed Nozzles

Even with reliable water filters, sometimes debris can enter from the boiler and clog your nozzles. If your injector was working fine and suddenly stops, a clogged nozzle is the most likely culprit. To check, remove the in-line check to inspect the delivery nozzle. This has the smallest inner diameter and is the most likely to be clogged. Be sure to look straight through the nozzle (A), and through all 12 cross-drilled holes (B) to make sure there are no obstructions. You should be able to see light clearly through these holes. If the hole pictured in Fig. A is obstructed, use 17 gauge wire to push out the obstruction. **ONLY** push from the threaded end of the nozzle back toward the cross-drilled end of the nozzle. Failure to do so will lodge the obstruction deeper. Use 21 gauge wire for the holes shown in Fig. B. The nozzles are machined from 316 stainless. You **will not** damage the nozzles by using copper wire or steel wire with caution.



Troubleshooting

The Monitor injector should prime promptly after opening the primer valve, and should begin injecting water as soon as the steam handle is opened at least ¼ turn. With the water valve correctly adjusted, the overflow should run completely dry after the primer valve is shut off. If there is any variance from this described performance, then something is wrong with the injector or the installation.

Symptoms:

1. Will not prime / slow to prime - See A, B, F, G, J
2. Primes but will not inject - See A, C, E, H, I, M
3. Injects, but overflow will not run dry - See A, B, D, I, K, M
4. Overflow sputters water and steam during operation - See A, B, C, H, I, J, M
5. Water dribbles consistently during operation - D, K, M
6. Steam coming from overflow while injector is not in operation - See F, L

Potential problems:

- A. Leak in water suction pipe
- B. Obstruction in suction pipe or clogged water filter
- C. Clogged delivery nozzle
- D. Restricted delivery line
- E. Check valve shutoff closed
- F. Check valve leaking / stuck open
- G. Restricted overflow
- H. Wet steam into injector
- I. Feed water too warm
- J. Water tank empty
- K. Worn out nozzles
- L. Steam valve and/or seat worn or damaged
- M. Water valve improperly adjusted

Solutions

A. Leak in Water Suction Pipe

Tighten every joint or fitting between the injector and water adjustment valve, including the union in the injector body. Start the injector. If the problem persists, start the injector and run a water hose over every joint between the injector spanner nut and the water tank shutoff valve including solder joints. If water runs over a leak, it will effectively seal the leak and the injector will begin to inject or run dry. If the leak cannot be located this way, it is possible there is more than one leak.

B. Obstruction in Suction Pipe or Clogged Water Filter

If the suction pipe is clogged, either in the line or in the filter, this can act the same as having the water valve closed too far or shut entirely. If possible, first clean out the water filter to rule out that potential issue. Blow out the water lines with steam or air and be sure water is flowing freely out of the tender with the lines disconnected.

C. Clogged Delivery Nozzle

To check if the delivery nozzle is clogged, loosen a fitting on the delivery line where water can safely be discharged into the atmosphere. If the installation includes a deck hose or auxiliary line that operates off the injector's delivery, open that valve to check delivery pressure. If the injector is working properly, there should be a very forceful jet of water. If the discharge is unimpressive, then the delivery nozzle is most likely clogged. If the delivery is unimpressive and there are visible air bubbles in the water, then refer to section A.

D. Restricted delivery line

If water flows from the overflow no matter how the injector water valve is adjusted, then it is possible that the delivery line is too restrictive. This could be due to restrictive fittings, pipe with too small of an I.D., a check valve that is too small, or a shut off valve with excessively small passageways. Be sure that all fittings and pipes in the delivery system have a minimum I.D. of 1/4" to ensure optimal performance.

E. Check Valve Shutoff Closed

Make sure the shutoff to the boiler check valve is open.

F. Check Valve Leaking or Stuck Open

If possible, close the check valve shutoff and maintain the check valve. The injector should be able to operate normally if the leak is not severe, however if it is so severe that the injector will not operate, or boiler water loss is significant and there is no secondary injector, follow this procedure:

Close the shutoff to the check valve. Start the injector as normal, and set the water valve to its normal operating position. Its delivery will discharge out the overflow with the check valve shut. Slowly open the check shutoff until the injectors overflow runs dry. If the injector breaks while opening the shutoff valve, close the valve and restart the process with the water valve open slightly more than before. When the water level is satisfactory, close the check valve and shut off the injector. If the leak was due to debris, this may fix the leak. If there is a more serious problem with the check valve, this procedure will keep your boiler full until you can safely shut down your locomotive.

G. Restricted Overflow

The overflow line should be at least 3/8" and have as few fittings as possible. Any small or sharp fittings can result in a backflow of steam into the injector, preventing priming.

H. Wet Steam into Injector

If the steam line taken from the boiler is not from a dry pipe, water can be sucked into the steam line. Move the line to a point where it can only receive dry steam. If the boiler water is too high, or contaminants are causing foaming, this can cause priming as well.

I. Feed Water Too Warm

For optimal performance, the feedwater temperature should be 60-80 degrees Fahrenheit. The injector will work with hotter feedwater temperatures, but efficiency and performance will decline. If the feedwater tank is too warm, top off the tank to bring the temperature down. If the tank is full and still too warm, partially drain the tank before adding cool water. Adding ice to the tender will get you by, too!

J. Water Tank Empty

Be sure to check water tank level frequently to avoid a low water emergency.

K. Worn Out Nozzles

If overall performance has declined, it may be time to replace the nozzles. However, with the frequency the typical hobbyist runs, it should be many decades before the stainless nozzles wear out. Eccentric Engineer keeps extra sets in stock should you wish to replace them!

L. Steam Valve and/or Seat Worn Out

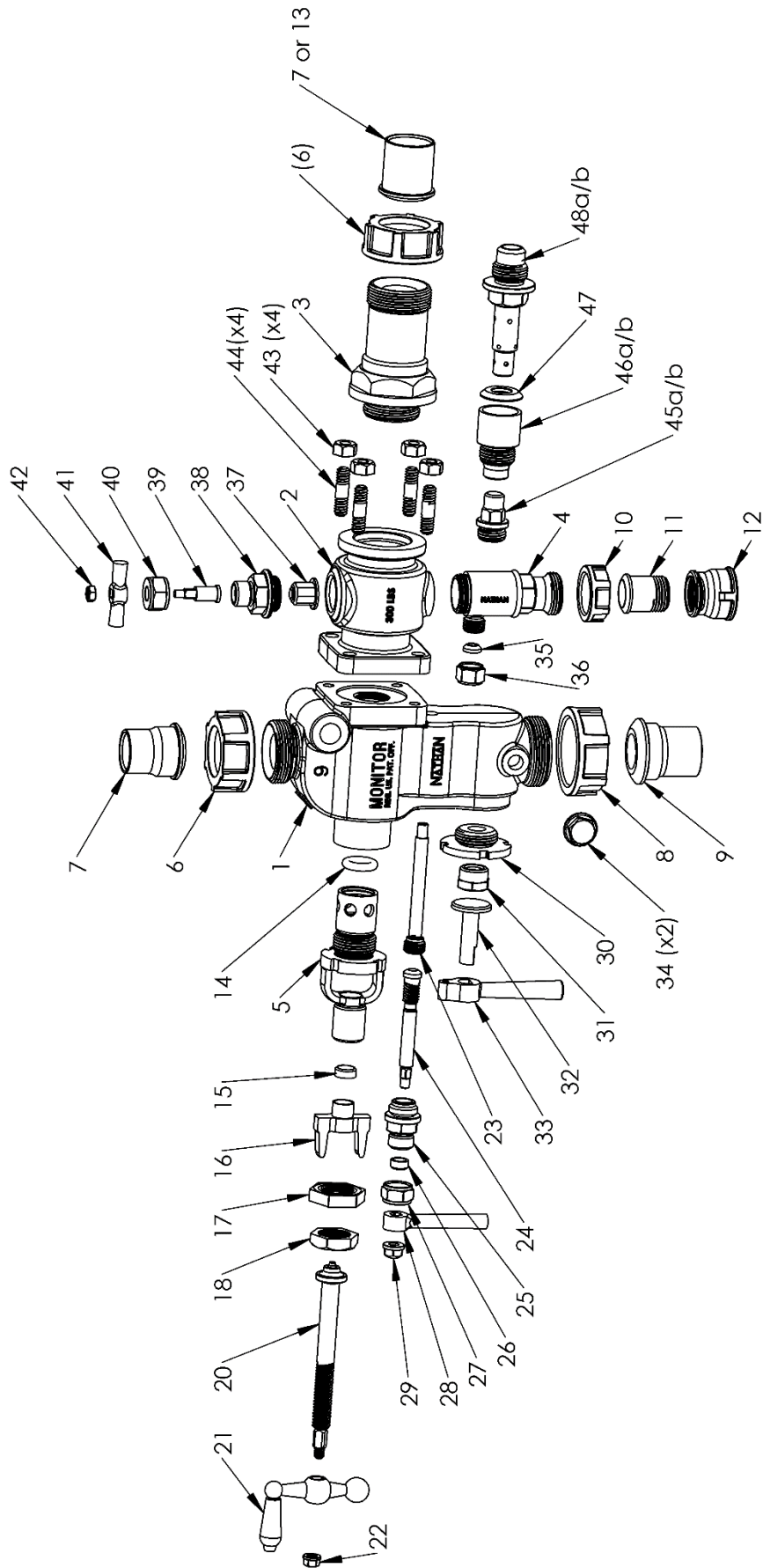
First, you must determine which valve is leaking. Check valve, steam valve, or primer valve?

If the steam leak stops while the injector is operating, it could be originating from either the main steam valve or the check valve. Close the main shutoff to the injector so the body is not under pressure. If the leak persists, then the check valve is leaking. If no leak is present, then the leak is likely coming from the main steam valve. Replace the O-ring seat.

If steam emits from the overflow while the injector is operating, then the leak is coming from the primer valve. A replacement primer tube and primer spindle may be necessary if they are damaged.

M. Water Valve Open Too Far

If water is pouring from the overflow during operation, the first thing to try is slowly close the water valve. If the overflow does not dry up, and instead goes from pouring water to sputtering steam, then there is another issue that needs to be addressed. See A, C, H, I, or K.



Parts List

1 - Body	27 - Primer Valve Packing Nut
2 - Overflow Body	28 - Primer Valve Handle
3 - In-line Check	29 - Primer Valve Handle Nut *
4 - Primer Body	30 - Water Valve Bonnet
5 - Steam Valve Bonnet	31 - Water Valve Packing Nut
6 - 9/16" Spanner Nut *	32 - Water Valve Stem
7 - 5/16" Steam Connection *	33 - Water Valve Handle
8 - 5/8" Spanner Nut *	34 - Water Valve Inspection Plug
9 - 3/8" Water Connection *	35 - Primer Tube Packing *
10 - 3/8" Spanner Nut *	36 - Primer Tube Packing Nut
11 - Overflow Connection *	37 - Overflow Check Valve
12 - Overflow Reduction Fitting *	38 - Overflow Bonnet
13 - 3/8" Delivery Connection *	39 - Overflow Valve Stem
14 - AFLAS -008 O-ring	40 - Overflow Packing Nut
15 - Steam Valve Packing *	41 - Overflow Handle
16 - Steam Valve Packing Follower	42 - Overflow Handle Nut
17 - Steam Valve Packing Nut	43 - Body Mounting Nuts
18 - Steam Valve Packing Lock Nut	44 - Body Mounting Stud
20 - Steam Valve Spindle	45a - Steam Nozzle 5ppm *
21 - Steam Valve Handle	45b - Steam Nozzle 6.5ppm *
22 - Steam Valve Handle Nut *	46a - Combining Nozzle 5ppm *
23 - Primer Tube	46b - Combining Nozzle 6.5ppm *
24 - Primer Valve Spindle	47 - Washer *
25 - Primer Valve Bonnet	48a - Delivery Nozzle 5ppm *
26 - Primer Valve Packing *	48b - Delivery Nozzle 6.5ppm *

*Replacement parts can be ordered from www.EccentricEngineer.com/spare-parts

If you need a replacement part that is not on the website, let us know how we can help!

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