

Suggested Bench-Check Procedures for a SPICA Injection Pump

First of all, unless you have a specialized and purpose-built test bench there really is no way to verify the complete functionality of an injection pump. However, you can inspect and test some of the functions of the pump. The pictures in this guide were taken on a pump with parts of the casting cut-away for use as a training device. This guide is written for the an owner with good mechanical skills and some knowledge of the SPICA system.

What you cannot home-check/test:

1. Balance of fuel delivery between plungers. This requires that the pump be “run” with an alternate motor/lube source as well as calibrated catch tubes to measure/compare fuel delivery.
2. Recalibration of the reference screw. Requires the pump to be run with an alternate motor source.
3. Check valve operation.

Things you can inspect and check on a home bench with ordinary tools:

1. Signs of fuel leakage past the plungers.
2. Functionality/adjustment of the Fuel Cutoff Solenoid Microswitch and wires. This microswitch is not accessible for R&R when the pump is mounted on the engine.
3. Functionality of the Fuel Cutoff Solenoid.
4. Functionality of the Cold Start Solenoid.
5. Visual inspection and cleaning of the Logic Section, and Pump lower sections.
6. Replacement of the front crankshaft seal, if needed.
7. Replacement of some gaskets.
8. Resetting of the pump gap with a dummy actuator.
9. Testing of the Thermostatic Actuator.
10. Cleaning of the injection pump base/oil filter housing areas.
11. Condition check of the Compensator Link Spring.
12. Cleaning of the Cold Start Solenoid hydraulic plunger well.
13. Cleaning of the Pump Section internal fuel manifold.
14. Check of the Fuel Outlet Restrictor.
15. Loosening of the Fuel Cutoff Solenoid Lock-ring and the Cold Start Solenoid Locknut.
16. Replacement of the Mounting Base to Engine oil O-Ring.

Items needed:

1. Pan to clean the pump body in.
2. Rags.

3. Spray carburetor cleaner.
4. Spray electrical cleaner.
5. Slot screwdriver.
6. Phillips head screwdriver.
7. Thin 24mm wrench (only if CSS needs adjusting)
8. Small hammer.
9. 10 mm wrench/socket .
10. .019" (.5 mm) and .040" (1mm) feeler gauges.
11. Makings for a dummy thermostatic actuator.
(see www.alfabb.com/bb/forums/showthread.php?t=5847&highlight=dummy)
12. Items for testing the Thermostatic Actuator (T/A) . . . Pot for heating water, thermometer, stove, mm ruler.
13. Electrical multi-tester or simple test light and 12v battery source.
14. Flashlight.
15. Replacement oil filter and gasket.

Owner-Mechanic Bench-check Inspection and Testing

First, try and rotate the pump with the pulley. Is it relatively smooth? There might be a slight clicking . . . that's ok. If tight or rough, it's likely that there's severe internal damage or seizures. If the pump has been badly stored and not "pickled" it's likely to be damaged. Have the fuel ports and fuel towers on top the pump been capped? If not, there could be rust in the check valves and very-close-tolerance barrel & plunger

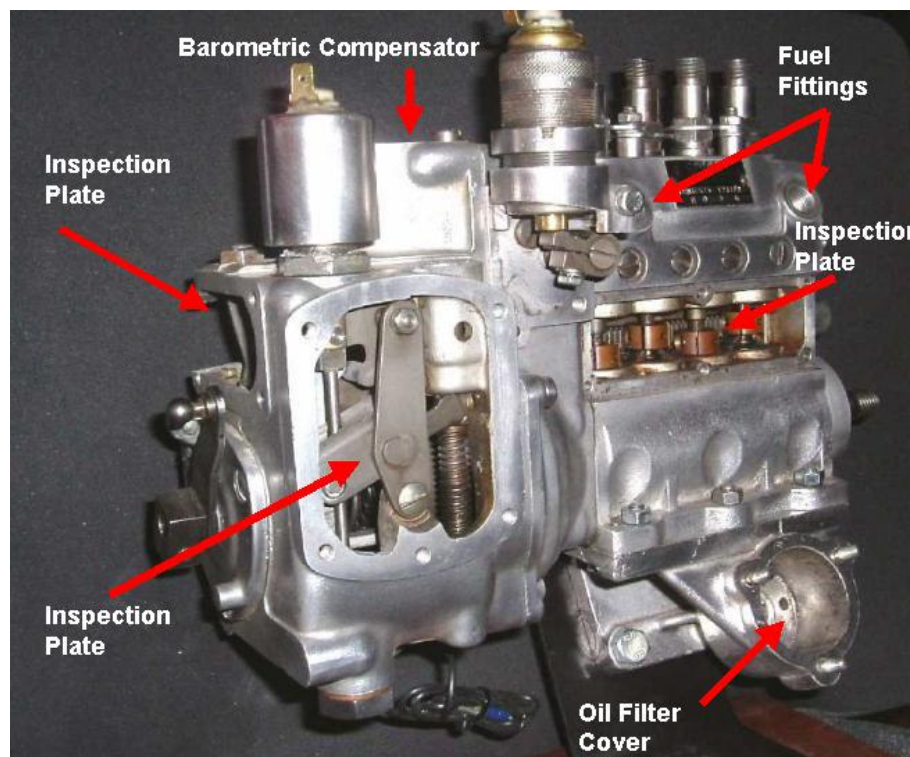


Fig 1. Items to be removed for bench check

assemblies. Rust will almost certainly ruin the pump. Next, you should completely clean the outside. Be sure to cap the fuel inlet and outlet, as well as the four fuel towers on top. You DO NOT want dirt to get into the fuel areas. The best way to clean it is to carefully scrape off the hardened grease, then use some spray carb cleaner to get the stubborn stuff out of the nooks and crannies. Wipe with a clean rag. I'd also clean and shine-up the electrical tangs on the CSS and FCS.



Fig 2. T/A hole

Clean out the cavity where the lower end of the TA went (see Fig 2), and install your dummy T/A set to either 27 mm or 29 mm, depending on the year of your pump.

Prepare the pump for internal cleaning & inspection by removing the large inspection port on the side of the logic section and on the rear. Remove the long rectangular inspection port on the side of the pump section. Remove the Barometric Compensator, the large brass plug on the bottom, and pump base from the main body of the pump.

The Barometric Compensator (BC) simply lifts out of the logic section casting after removing the 3 machine screws (see Fig 3). *Smell the BC. If it smells like stale gasoline instead of engine oil,*

it's likely the pump is severely worn, is leaking and requires rebuild. Be very careful with this semi-fragile unit. Set it aside on a soft rag in a safe place.

The pump base comes off after removing the six 10mm nuts attaching it to the pump body. Be careful to preserve the thin gasket between the pump casting and the base.

Remove the oil filter cover plate (three 8mm nuts) and remove the old oil filter. Clean out the oil filter cavity with carb cleaner spray.

Turn the pump body over and inspect the crankcase section (see Fig 4). Carefully scrap out the caked grease. Try and keep any crud out of the front or rear bearings. Carb



cleaner is ok, but be sure to finish up by spraying-out the bearings from any grit. The connecting rods are splash lubricated and will seem fairly loose around the crankshaft journals. That's ok. Re-lube with WD-40

Fig 3. Removing the Barometric Compensator (BC).

Remove the three countersunk screws and lift out the BC. Smell the BC for traces of stale gasoline which would indicate a severely worn pump. Set aside in a safe place. '75 and later models do not have the adjustment lever on the top.

Next, move up to the rack and pinion section of the pump. Clean this area well with carb cleaner and re-lube with WD-40.

Do the same cleaning process with the logic section. Clean it out as best you can with spray cleaner. Pay particular attention to the area indicated in the picture below (see Fig 5). This is the hydraulic plunger of the cold start system. Do not dig around with a screwdriver or other probe because you may damage or misalign some internal components. When finished, re-lube with WD-40 to prevent rust.

INSPECTING THE INTERNALS

Pump Section:

As you rotate the pump's crankshaft the action should be smooth and free. Rotate the throttle lever on the rear of the pump and watch the toothed rack move towards the rear (increased fuel delivery) while it turns the four small plunger pinions. It won't move much. Full throw of the rack is only about $\frac{1}{2}$ ". The pinions should move smoothly and in unison.

Logic Section:

1. Checking the Compensator Link Spring.

Look into the BC cavity and you will see a vertically mounted spring (see Fig 6). Make sure it is attached at both the top and bottom and is not seriously rusted. Poor pump maintenance and/or storage can allow moisture into the logic section and rust this spring. If the spring breaks, the engine will run very poorly at best, and may not run at all.



Fig 4. Crankcase



Fig 5. Cold Start Solenoid hydraulic piston bore

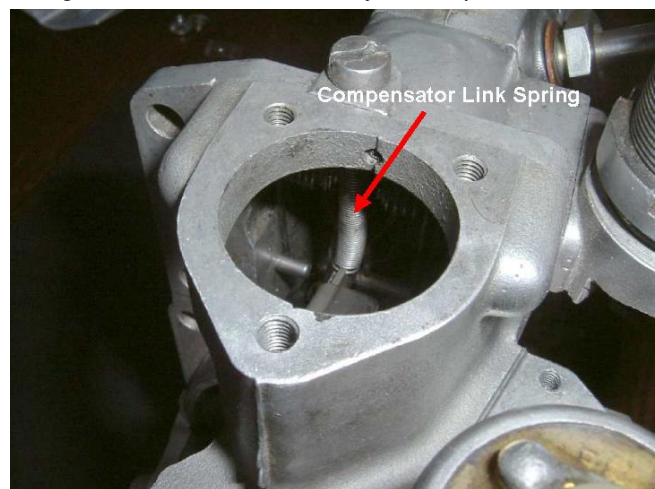


Fig 6. Compensator Link Spring. Look for good attachment at top and bottom and rust.

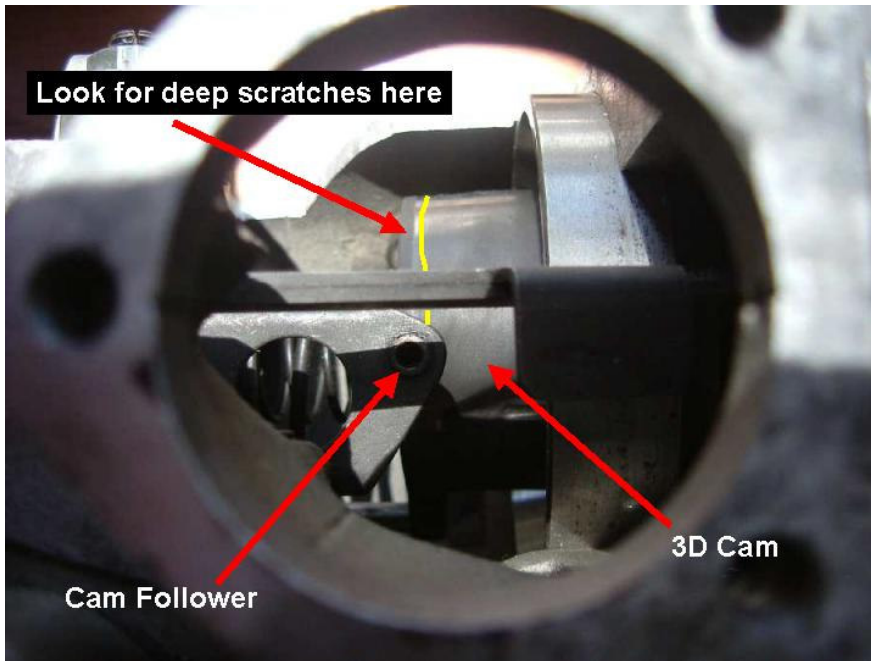


Fig 7. 3D Cam & Cam Follower

at the tip of the cam follower may be damaged or missing. In that case, you may see scratches in the 3D cam. If any of these is the case, the pump is not serviceable.

2. Checking the Barometric

Compensator (BC). Look at the BC that you previously removed. If damaged, it will greatly extend to something like 40mm instead of the normal 25mm. A bad BC will be immediately obvious.

3. Checking the Cam

Follower. Look down into the BC cavity onto the top of the 3D cam (see Figs 7-9). Rotate the throttle lever. Is the action smooth or scratchy? If scratchy, the ball bearing

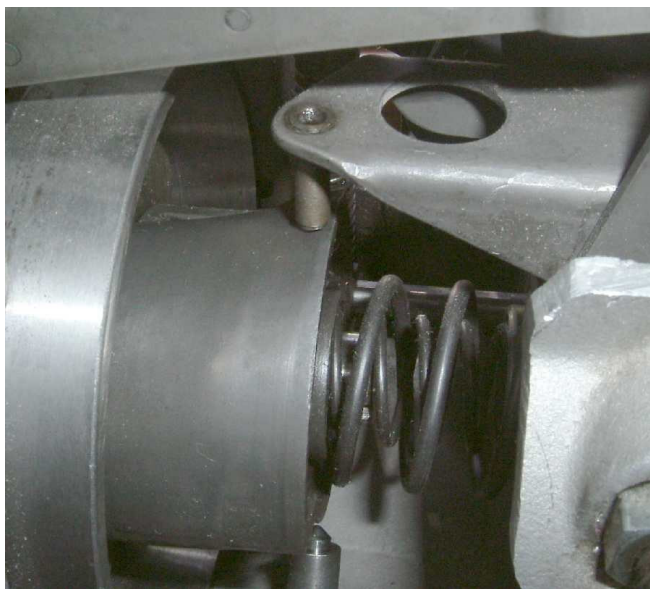


Fig 8. Cutaway view of 3D Cam & Cam Follower



Fig 9. Cam Follower Bearing. Example of flat-spotted bearing. Ball bearing could be missing altogether causing severe scratching of 3D cam surface and a decreased (leaner) fuel delivery. This view of the Cam Follower is not obtainable without dismantling the logic section of the pump.

4. Checking the Spring Clip. Look into the rear inspection port. You will see a small spring clip on the end of the compensator link that sits in a notch of the vertical notched lever. Normally it will be sitting in the 7th, 8th, or 9th notch from the top. Does the spring clip look like the one in Fig 10, i.e. not rusted or deformed?

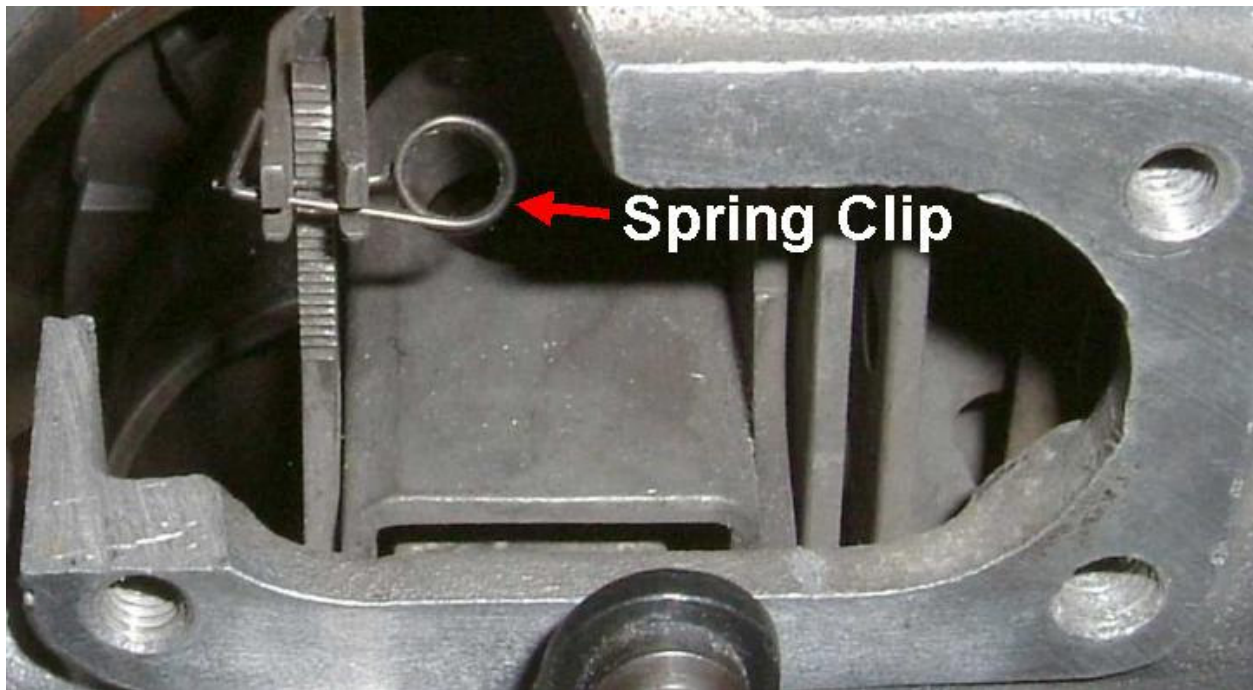


Fig 10. Spring Clip.

5. Checking the Fuel Cutoff Microswitch (not on 1969 models, “T237” pumps).

This is an important bench-check item because the microswitch is inaccessible with the pump installed on the engine. The microswitch sends an electrical current to the Fuel Cutoff Solenoid (FCS) when the driver lets off the throttle completely and the engine is above approximately 1300 rpm. The FCS moves the fuel delivery rack full forward and cuts off all fuel delivery to prevent backfiring. As the engine slows through approximately 1300 rpm, the microswitch cuts off current to the FCS and fuel delivery is restored for recovery to idle speed. Of course, if the driver presses the throttle is again at anytime, the microswitch deactivates and normal fuel delivery is restored. The microswitch itself is activated by a pin that passes through the pump body from the 3D cam to the microswitch mechanism.

a. Removing the Microswitch cover (see Fig 11). Remove the two machine screws and remove the cover. Spray interior with electrical cleaner spray to remove oil and dirt, if needed.

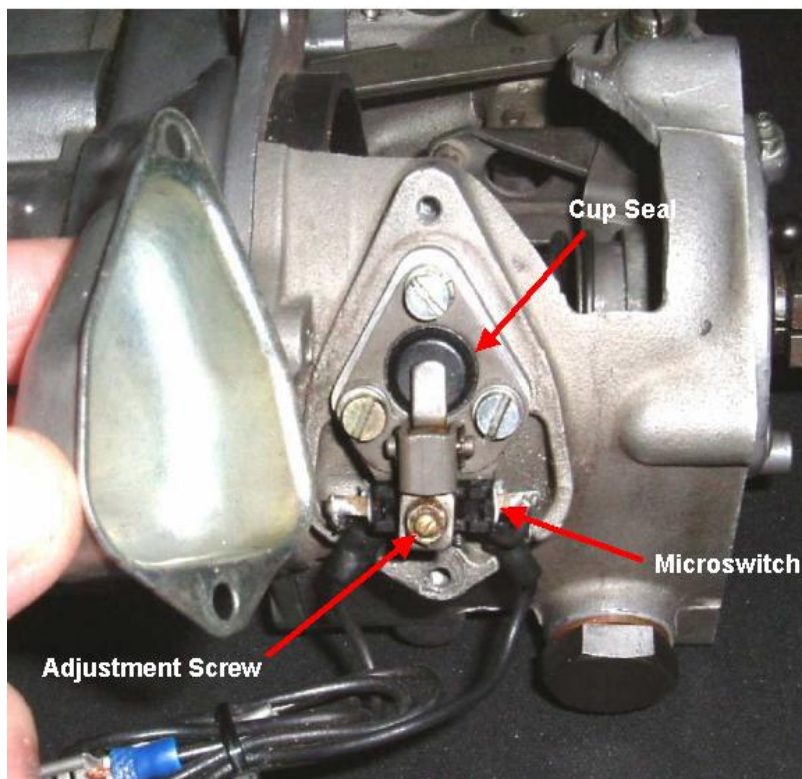


Fig 11. Microswitch Cover removed.

b. Checking the microswitch. You can either check the microswitch in conjunction with the FCS or separately.

1) To test together, attach the 12v+ wire to the microswitch wire with the other attached normally to the FCS. Attach the 12v – to the pump body. Press on the microswitch lever and listen for the FCS to “click.”

2) Using your electrical tester check the microswitch alone. The switch should be normally open (NO). When activating the switch by pressing on the adjustment screw indicated in Fig 11, the switch should close and allow current to pass. You should feel a slight “click” as the switch closes. If not, it’s likely the switch is broken internally. Switch internal parts are not repairable at home. Replacements are available from Ingram Enterprises or Centerline Alfa and cost



Fig 12. Checking the Microswitch adjustment

about \$50. If desired, you can remove the switch assembly from the pump casting by removing the three screws (see Fig 13). The entire assembly will come off the pump. With the assembly removed you can remove the cup seal (see Fig 14) for a closer inspection and also check the pushrod. The pushrod goes from the 3D cam to the microswitch. The pushrod is made up of two pieces with a spring in the middle. To check the spring, simply push in on the pushrod and you should feel it (will be fairly stiff). See Fig 15.



Fig 13. Removing microswitch assembly



Fig 14. Cup Seal



Fig 15. Testing spring in pushrod

c. Check the condition of the small round rubber cup seal.

d. Check the adjustment. as pictured in Fig 12. Feeler gauge should be 1mm (.040"). To adjust the microswitch, connect a 12v (or lower) power source to the lead with a light bulb (or voltage tester) in the circuit. Place the 1mm shim between the pusher and the switch operating lever, then turn the adjusting screw till the light just comes on. Tighten the lock nut.

e. Replace the cover making sure to capture the wire grommets between the cover and the pump body. Make sure the wires not frayed or have brittle and cracked insulation. If necessary, carefully solder new wires onto the microswitch.

6. Testing the Fuel Cutoff Solenoid (FCS).

Test by connecting 12v + to the male spade terminal on top and 12v – to the pump body (ground). You should hear an audible “click.” The function of the Fuel Cutoff Solenoid is to cutoff fuel delivery during throttle-off deceleration.

7. Cleaning and testing the Cold Start System.

The purpose of the Cold Start System is to momentarily enrich the mixture for starting. The CSS is only energized while the starter motor is cranking. The CSS is attached to a rod and hydraulic plunger/piston that slightly delays and smoothly decreases enrichment for a few seconds after the CSS is de-energized. Since there is no oil in the logic section of the injection pump during this test, the hydraulic delay in deactivating won't be there, hence the CSS will snap on and off as current is applied and removed.

a. Test the Cold Start Solenoid the same way you did the FCS. Do not energize the CSS for more than several seconds at a time. Energizing the CSS for prolonged times can overheat the unit and melt the plastic sealant on top the CSS. When you energize the CSS, the mechanism should “click” on and off as power is applied and removed. You will see the long rod in the inspection port get pulled up by the solenoid. The plastic plunger/piston at the bottom of the rod should not stick. Sticking of this plastic piston is a common problem due to swelling over time. If bad enough, the piston can stick and constantly enrich the mixture, even after the CSS is de-energized.

b. Replace the brass plug on the bottom of the plunger bore.

8. Testing the Thermostatic Actuator (T/A). (Should only be done while wife is out shopping!)

a. Put the bulb end of the T/A in a pan of heating water (see Fig 16). Monitor with a thermometer. As the water heats measure the extension of the bottom piston (actuator) of the T/A . Measure from the bottom of the flange to the tip of the actuator. Record and check your readings against the specification chart in Fig 17. There are two different types of T/As. One is a 27mm extension model (early) and a 29-31mm extension model (later). Most all rebuilt T/As you will get now are 29-31mm. There is no external markings differentiating the two types, however the older models will have a shorter brass housing below the flange.



Fig 16. Testing the Thermostatic Actuator

The cold extension of the T/A should be about 23-24mm at room temperature. Fig 17 compares a good with a bad T/A at room temperature extension. There is no point in testing the T/A on the left because it has obviously lost all its fluid.

In the charts below, it directs a load be put on the piston. I've found that is unnecessary.



Fig 17. Bad T/A left. Good T/A right.

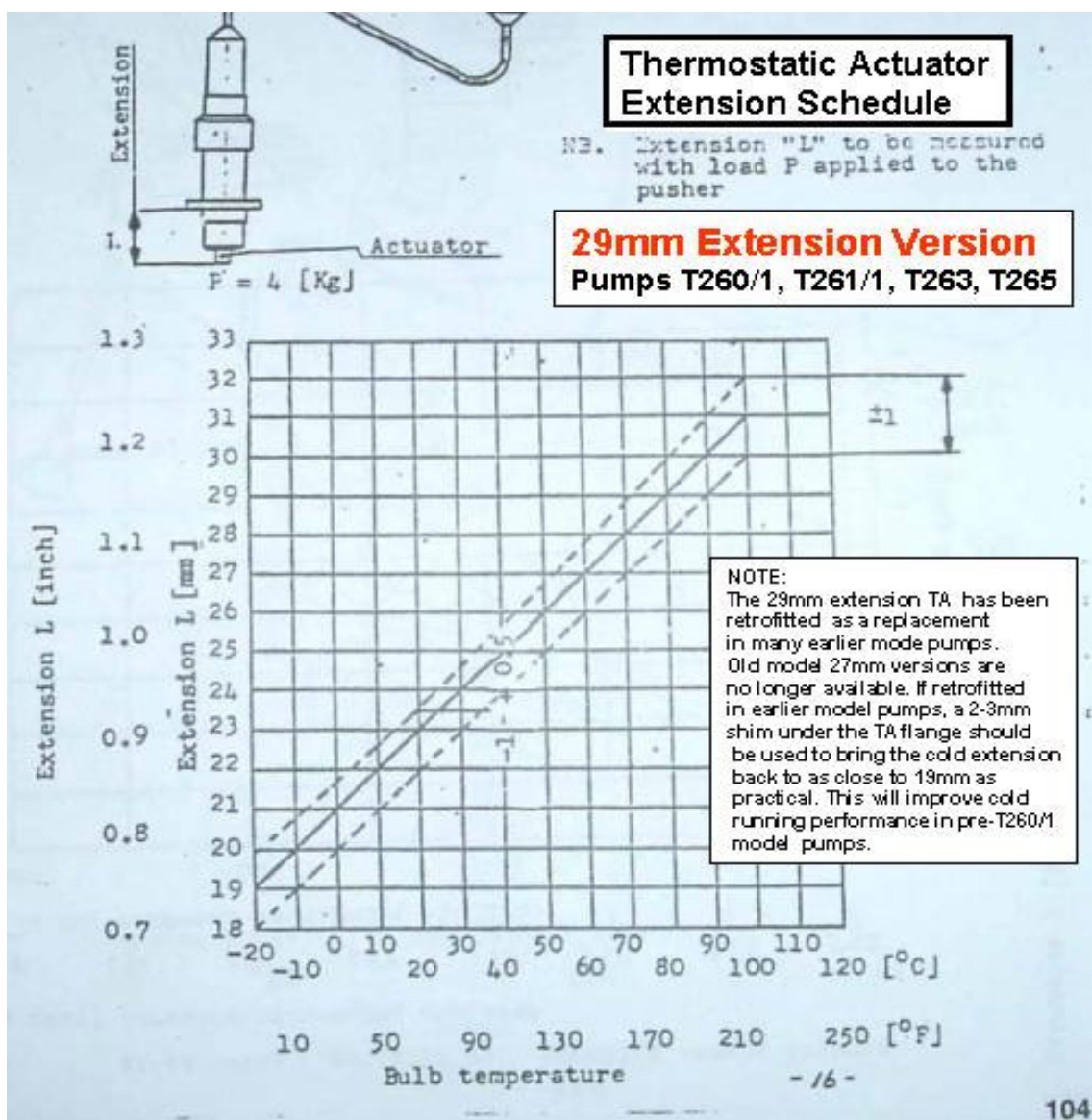


Fig 17. TA Spec Chart 29mm Extension Versions

The following pump models use a 27mm (at 175F) extension T/A: T237/1, T237/2, T255, T255/1, T260, and T261.

The following pump models use a 29mm (at 175F) extension T/A: T260/1, T261/1, T263, and T265.

The “T” number (model) of the pump is located on the data placard on the side of the pump.

I have no spec chart on the old 27mm T/As, however the cold extension should be about 19mm with the hot (175F) extension at 27mm.

If you find that your T/A is not quite to specification, you can compensate somewhat with the adjustment screw under the T/A piston in the injection pump. However, if it's not to spec, it's leaking and will eventually require replacement.

9. Replacing all inspection plates. Spray some WD-40 on the toothed rack and pinions in the pump section (long rectangular inspection plate) and replace plates.

10. Re-attaching the pump to the base. Spray some WD-40 on the crankshaft and crankcase areas and re-attach pump to base.

11. Re-installing the Barometric Compensator (BC). If the pump is going to go into long-term storage, put some clean engine oil in the logic section and swirl around to coat all the internal parts prior to reinstalling the BC. Pour out the excess.

12. Setting the pump gap. Remove the dummy T/A and verify that it's set at the correct extension. Re-install and check the gap between the reference screw and the throttle lever on the rear of the pump. It should be exactly .019". If not, remove the dummy T/A and adjust the screw underneath to obtain .019". The spring in the T/A mechanism is fairly stiff and will require some force to push down. That's normal. In badly corroded pumps, this mechanism is one of the first to seize due to rust.

13. Re-installing oil filter access plate. If a filter is not installed at this time, **BE SURE TO ATTACH A TAG** to the pump indicating that there is no oil filter installed.

14. Preserving the SPICA pump for long-term storage. Pour some Marvel Mystery Oil into the four fuel towers on the top of the pump and the inlet and outlet ports on the sides. Rotate the pump crankshaft to distribute the oil. Cap all six ports with tight fitting plastic caps (available at most hardware stores or auto parts shops). **Attach a tag** to the pump to remind you to fill the pump with ½ pint of clean engine oil after installation on the engine. Store the pump in a dry plastic bag in dry heated area.

Questions or comments concerning this guide should be addressed to: John Stewart, roadtrip999@rap.midco.net For more information and discussion about Alfa Romeos and the SPICA Fuel Injection System, go to www.alfabb.com.