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# Instruction for three-cylinder Shay



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## INSTRUCTION MANUAL

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## *Instructions for three-cylinder Shay*

### *Introduction*

*Shay locomotives were developed by Ephraim Shay. His first successful engine that we would recognize today as a Shay locomotive was produced in 1880 by Lima Machine Works (later, Lima Locomotive Works), who would go on to produce approximately 2,700 up until 1945, when production ceased.*

*Shay locomotives are unusual in that they are powered by a steam engine of either two or three cylinders mounted vertically near the cab on the right side of the locomotive (although there were a very few with the engine on the left). The boiler was offset on the frame to counterbalance the weight of the engine. The engine drove a drive shaft that, through flexible couplings, turned bevel gears that engaged the wheels. This type of engine is known as a geared engine, since the wheels turn at a different rate from the engine, due to the gear ratio. This arrangement made the engine very flexible and able to negotiate raggedy track without derailing. Because of this characteristic as well as its great power, it was an exceedingly popular engine with logging companies and other industries that relied on tough engines in unforgiving situations.*

*Operating a model live-steam locomotive is much different from running an electrically powered engine. It is a more hands-on, interactive experience. The locomotive must be periodically fueled, oiled, and watered. As supplied, the Shay is manually controlled, which means that you must actually drive the locomotive using the controls in the cab, just as you would a full-size engine.*

*The performance of the engine is also unlike electric locomotives. This Shay should pull a dozen standard-size freight cars or more on good, level track. Grades and sharp curves will diminish its capability. A good engineer will learn the engine's characteristics and idiosyncrasies over time, to get the best performance and longest duration from it.*

### *Safety*

*For your safety, there are certain rules that should be observed, as follows:*

- 1. The safety valve is atop the "T" section of the boiler, just ahead of the cab. It has been set at the factory to release at 55 pounds per square inch of pressure. Never tamper with the safety valve.*
- 2. The firing system has been designed to use butane gas only. Never use any other gas (including propane or butane/propane mix), as the storage pressures can reach unsafe levels.*
- 3. Always refuel the engine away from other working live-steam locomotives. The fuel filling system allows a small amount of the gas to bleed off as the fuel tank is being filled. A passing engine can ignite this bleed-off gas, causing a potentially hazardous situation.*
- 4. When lighting up, light your match first, then turn on the gas.*

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### **5. A steam engine gets hot. Be careful.**

#### **Preparing the engine for operation**

**A steam-locomotive engineer goes through a lighting-up ritual every time the engine is to be run. It is good to follow the same routine each time so that nothing is overlooked.**

**1. Oil all external moving parts of the engine, including wheel bearings, with a high grade, lightweight machine oil like 3-in-1. Be sure to oil all parts of the drive train. A little oil is all that's necessary. A lot of oil will just muck up your engine and attract dirt and grit.**

**2. Place the engine on the track and lift up the roof. It is hinged at the front.**

**3. The displacement lubricator is a vertical tank mounted to the floor on the right side of the cab. It has an extension handle built into the cap to aid in the cap's removal. This lubricator ensures the cylinders and valves are properly lubricated inside. As the steam passes through it, a small amount will condense into water. This water will sink to the bottom of the lubricator, forcing a similar quantity of oil into the steam line and thus to the cylinders. Remove the lubricator's cap, then open the drain beneath it to drain off any water from the previous run. Close the drain, fill the lubricator to the top with proper steam-cylinder oil, and replace the cap.**

**4. The boiler can be filled with water in two ways. It can be added by unscrewing the filler plug (above the throttle in the cab) and filling the boiler with a syringe, then replacing the filler plug. Alternatively, water can be pumped in using the hand pump in the dummy oil tank. Remove the top of the tank, fill the tank with distilled water, and use the auxiliary pump handle supplied to pump water into the boiler. Be careful not to fill the tank too full or the water will come out the water-pipe hole near the top of the tank. This locomotive is equipped with a water glass on the backhead. Fill the boiler until the water shows about half-way up on the glass. Do not overfill it. NOTE: Use only distilled water in your engine's boiler. Tap water contains minerals that will leach out and ultimately affect the performance of the engine.**

**5. Finally, add fuel. Your Shay burns butane gas. The gas tank is the square box on the left side of the cab, and the filler valve is located on top of it, above the control valve. Butane gas can be purchased at the grocery store or at a tobacconist's as cigarette-lighter refills. These come with a nipple suitable for the filler valve on the Shay's gas tank. You may need to use an adapter if the nipple on the refill isn't long enough. (Butane can also be purchased in larger containers at camping-supply stores, but these cans will require a special adapter for filling the engine's tank.) Simply press the nozzle of the butane canister hard onto the filler valve atop the tank, making sure that the control valve on the back of the tank is closed. You will hear the gas transferring and will see a little gas bleeding out of the valve. When the tank is full, the gas will begin to splutter and much more gas will escape the valve. With the full tank, you are ready to fire up the engine.**

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### *Firing up*

*The engine's burner resides at the back of the flue inside the boiler. Open the hinged smokebox door at the front of the engine and you'll be able to see the flue. To light up, strike a match and hold it at the open smokebox door, while simultaneously opening the gas valve in the tender very slowly until the gas ignites. You should hear the gas coming into the burner. Opening the valve too wide or too fast may blow out the flame or cause the fire to burn in the smokebox.*

*The fire should flash back into the back of the flue with a quiet "pop." If it wants to burn in the smokebox or in the forward part of the flue, slowly close the gas valve until it flashes back to the burner. Don't let the fire burn in the smokebox-your engine will not run as it should and may be damaged. The fire should burn under the burner in a crescent-shaped flame, which should be clearly visible through the smokebox door. The flame should be bright blue and should burn steadily. If it sputters or looks yellow or green, adjust the gas valve accordingly. The object is to run the burner at the lowest setting possible to operate the engine, thereby increasing the efficiency of the engine and the duration of the run. You'll get the hang of this with practice.*

*Initially, the fire may gurgle and sputter a bit. This is due to liquid butane getting into the gas line. After a couple of minutes, the engine should settle down and the fire burn steadily.*

*After another four to six minutes, pressure on the pressure gauge should read about 20psi (pounds per square inch) or so. The safety valve is set at 55 psi. When the pressure on the gauge reaches 40psi, the engine can be run.*

### *Running*

*Move the reversing lever at the right side of the cab to the forward position. With the engine on the track, and without a train, open the throttle. Because the cylinders are cold, the hot steam entering them will condense into water and be exhausted through the stack. With the throttle open, move the reversing lever to reverse, then back to forward a few times. This will help to clear the condensate. The engine may need to be pushed a little to help get it going. You may find the engine to be balky and rough-running until the cylinders heat up. This is normal. After a few moments, it should take off on its own, moving away smoothly. After it has had a few runs and is more broken in, starting will be easier.*

*Once the engine is running smoothly, a train can be coupled on and the run can proceed. Since all of the locomotive's functions are controlled from the cab, it can be driven like a full-size engine, meaning that you'll have to stay with the engine through the run if you want to change its speed or direction. If you have a suitable track, the engine can be left to run on its own at a steady speed.*

*While running, keep a close eye on the water level. When it reaches the bottom*

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*nut of the water glass, stop the engine and pump more water in to bring the level up. It is best to pump a little water in frequently rather than waiting for the level to get too low, then pumping a large quantity of cold water. Keep the water tank topped up, too.*

*When the gas has run out, the engine will slow to a stop. Immediately close the throttle to prevent oil from being sucked back into the boiler. To shut the engine down before the water is gone, simply close the gas valve and allow the engine to run off any residual steam. **IMPORTANT NOTE:** Never attempt to fill the gas tank while the fire is lit. Always shut it down before refilling the gas tank.*

### **Shutting down**

*After a day's operation in the garden you'll probably find that your engine has a coating of oil all over it. This is steam-cylinder oil that has been exhausted from the stack. A simple wipe-down with a dry cloth is all that's necessary to restore the engine to pristine condition. This is best done while the engine is still hot. Wipe any grit and excess oil from the wheels and running gear.*

*The boiler can be drained of water, or not, as you will. Leaving water in the boiler will not harm it. Water in the lubricator can also be drained and the lubricator refilled with steam oil in preparation for the next run.*

### **Notes on the drive train**

*Your model Shay works the same way a full-size Shay works. Rotary motion is transmitted by the engine to the drive train. At the ends of the train are small bevel gears that engage large bevel gears on the wheels, thus providing a gear reduction. This reduction makes your engine more powerful, while it reduces its speed. Shay locomotives were known for lots of power at low speed.*

*This locomotive is equipped with three cylinders. The cranks are set at 120° apart from one another, as opposed to 90° for a two-cylinder engine. Three cylinders make for a more powerful and smoother-running locomotive.*

*The drive train incorporates four universal joints (U-joints) and a pair of sliding, square shafts. If a truck is turned too far, the male part of the sliding shaft could fall out. If this happens, simply slip it back into place. When the engine is in operation, this will not happen. Do not tamper with or try to adjust the position of the gears. These have been set at the factory.*

### **Notes on the gas jet**

*It is possible for the gas jet at the rear of the burner (in the cab) to become clogged or blocked. This will be evident if the fire will not light, you hear no gas coming out, or the engine performs poorly even though the fire is lit (partial blockage). To solve this problem:*

- 1. With a small, adjustable wrench, loosen the fitting on the gas control valve.*
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- 2. Carefully remove the gas line from the valve body, then slide the jet backward out of the burner.*
- 3. Squirt a little butane into the jet from the front. The pressure of the gas should not only clear the blockage, but blow whatever was blocking the jet out of the line altogether.*
- 4. Replace the jet and reattach the gas line.*

### **Notes on radio control**

*Although the Shay was designed as a manually controlled locomotive, it might be possible to fit radio control (RIC) gear, with some ingenuity. A two-channel radio is all that's necessary, one for the throttle and one for the reversing lever. The gas valve should always be controlled manually.*

*The reversing lever will have to be modified so that it does not lock in position. To do this, simply remove the M2 screw near the top of the quadrant with the driver provided. To control the throttle, the knob will have to be replaced by a lever.*

*The cab is already very crowded and the bunker is used for water. RIC gear would have to be concealed either beneath the engine and/or in the cab roof.*

### **Specifications**

**Scale:** 1:20.3 (15mm = 1'0")

**Gauge:** N° 1 (45mm)

**Boiler:** Single flue, gas fired, silver-soldered copper, blow-off pressure, 55 psi

**Boiler fittings:** Safety valve, throttle, pressure gauge, water glass (hand pump in water tank)

**Fuel:** Butane gas

**Cylinder lubrication:** Displacement lubricator on right-side floor of cab

**Cylinders:** Three fixed cylinders, piston valves, exhaust through the stack

**Valve gear:** Fixed eccentric

**Reversing gear:** Reversing valve in cab

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