



# Chiltern Model Steam Engines

## ***Installation and Operating Instructions Horizontal 3" Boiler v1.3***

**PLEASE CONTACT US IF YOU HAVE ANY QUESTIONS OR COMMENTS ON IMPROVEMENTS**

**NOTE: PLEASE CLOSELY FOLLOW THE FOLLOWING INSTRUCTIONS AS INCORRECT OPERATION OF THE BOILER CAN CAUSE DAMAGE AND INJURY TO YOURSELF AND OTHERS.**

The boiler specification as standard, is as follows:

- Cylinder Water Vol. Capacity: 500ml
- Cylinder Dimensions: 78mm(dia.) x 176mm(L)
- Overall Dimensions: 188(L) X 80(W) X 150(H)
- Cylinder Sidewall thickness: 3.5mm
- Safety Valve Release: 20psi
- Steam outlet valve: 1/4" x 40tpi ME
- Brass Fill Plug: 1/4" x 40tpi ME
- BIX Ceramic gas burner: 118(L) X 14(W) X 20(H)
- Burner jet connection: 1/4" x 40tpi ME
- Gas Jet Size: No. 8
- Materials: Brass, Aluminium Alloy, Steel
- Type: Unibody
- Weight including burner: 1.9kg
- Fuel: Butane or butane/propane mix

The standard kit includes:

- Aluminium boiler body/cylinder
- Safety valve
- Steel support base sides and ends
- Steel burner guides
- Insulation Sheet
- 8 M3 stainless steel screws
- Steam outlet valve
- Brass water fill plug
- BIX Ceramic gas burner, jet and jet carrier

Optional items if ordered:

- Gas Canister Regulator/Pipe and Adapter
- Pressure Gauge (0-30psi) and Pipe
- Water Level Gauge with draw down valve
- Copper Steam Pipe (made up with connectors to engine)

## Boiler General

**THE BOILER MUST BE OPERATED IN A WELL VENTILATED AREA TO PREVENT THE BUILD UP OF CARBON MONOXIDE. NEVER LEAVE THE BOILER UNATTENDED WHEN THE BURNER IS LIT - ALWAYS TURN OFF THE GAS. NOT SUITABLE FOR CHILDREN UNDER 16 YEARS OLD.**

The 3 inch Horizontal Model Steam Engine Boiler Kit is suitable for driving our single cylinder engines under light load or other similar size model steam engines.

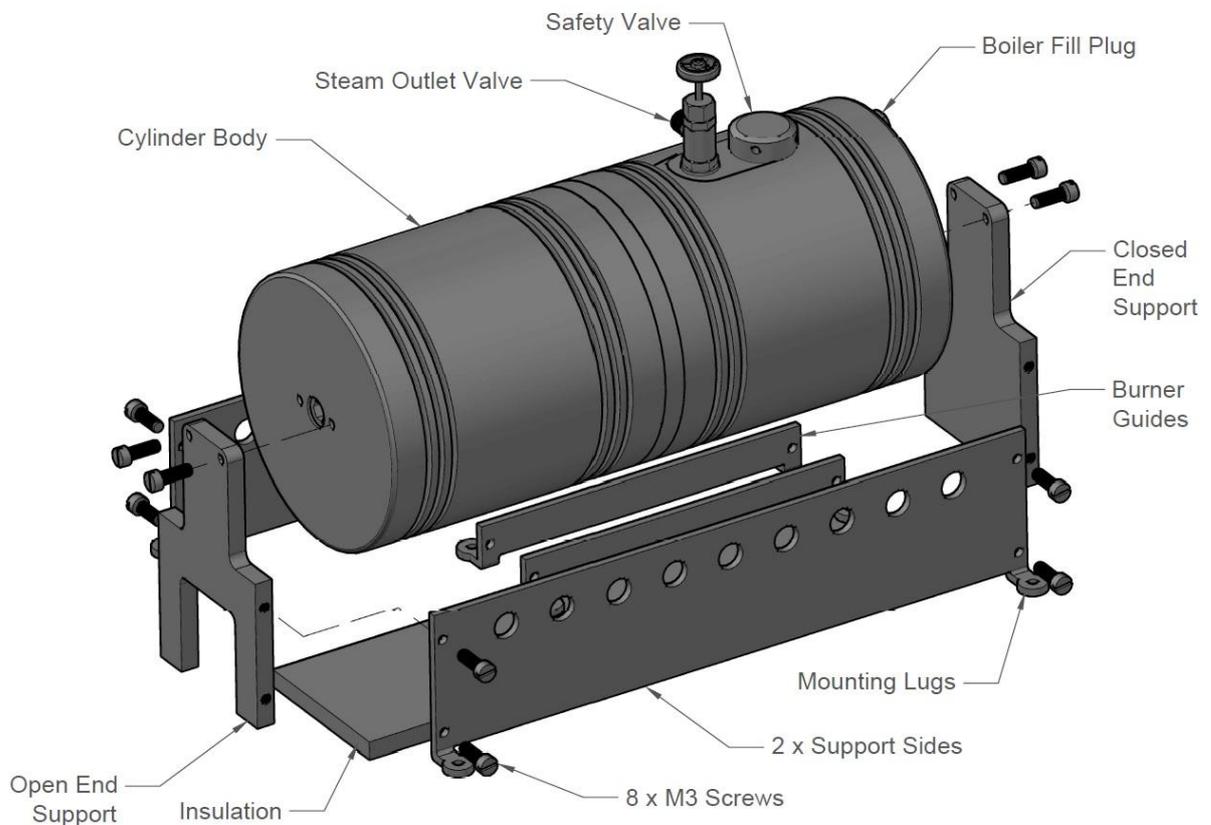
See the demonstration YouTube videos of the boiler driving our Beam engine <https://www.youtube.com/watch?v=-ZET-58BWwA> and Mill Single engine <https://www.youtube.com/watch?v=XBPHYm4m3XQ>

The boiler has a simple cylinder design made of 3.5mm thick aluminium alloy, heated from underneath by a ceramic gas burner. There are no cross tubes, flue or chimney unlike our other boilers which have higher output.

These boilers are provided as a kit of fully machined, unpainted parts that can be easily assembled with simple tools. It is designed to operate at a pressure not exceeding 20 psi.

## Boiler Assembly

Using 4 M3 screws loosely attach each base side to the end supports and place the main cylinder between the end supports and attach it using 4 M3 screws, as shown in the following diagram;



### Horizontal 3" Boiler Instructions v1.3

Gradually tighten each screw ensuring the supports are not twisted and sits flat on a mounting board (customer supplied).

Place the insulation sheet, which protects the mounting board from the heat of the burner, where the boiler will be positioned. Screw the 2 burner supports centrally on the sheet 15-18mm apart, i.e. so that the burner can slide in between, using the lugs on the guides. Screw the boiler securely to the mounting board using the lugs on the support sides.

The boiler cylinder is normally supplied with the Outlet and Safety Valves already fitted. These can be removed by unscrewing the long cylinder M5 socket head screws. This will allow splitting the cylinder body into two halves and the centre joining section. Remove the valve nuts which are on the inside of the cylinder and then unscrew the respective valves from the cylinder body from the outside.

Assembly is a reverse of the above but ensure that the two O ring seals lubricated and are in their proper place.

### Painting

It is recommended that the base sides and ends are coated with heat proof/high temperature aerosol paint such as that used on barbeques or car brake callipers. The boiler cylinder can be left or sprayed black to match.

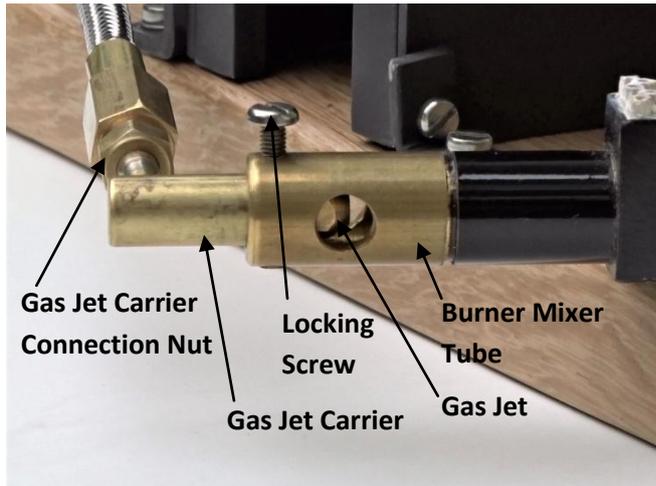
### Boiler Mounting

The boiler should be secured to a base mounting board using the 4 lugs on the sides. Allow plenty of space around the boiler's base to ensure a free flow of air to the burner.

### Gas Burner

***The BIX ceramic gas burner when lit gets very hot so always use protective gloves when handling and allow to cool before making any adjustments. Take care not to damage the ceramic burner element or gas jet.***

The boiler kit is supplied with a brass gas jet carrier which sits in the brass burner mixer tube and is secured with a locking screw, as shown in the photo.



The gas jet size installed in the carrier is No. 8.

The gas jet carrier is connected to a gas source, canister or tank, using the 1/4" x 40tpi ME union nut. The optional Gas Canister Regulator/Pipe is connected to the jet carrier via the supplied adapter. Use plumbers PTFE tape on the threads to ensure a good seal.

***Before use always check the gas pipe is securely attached to the carrier and the gas source.***

The flame intensity coming from the ceramic burner can be adjusted by moving the gas jet carrier in and out of the burner mixer tube – a hot flame is blue and short, not long and yellow – see next section.

In operation the burner sits under the cylinder body inserted via the open end support. The holes in the burner mixer tube/gas jet carrier should sit just outside the open end support to ensure a free flow of air, see attached photo.



No forced draft is required and indeed could have a detrimental effect on the burner/boiler.

### Setting up the Burner

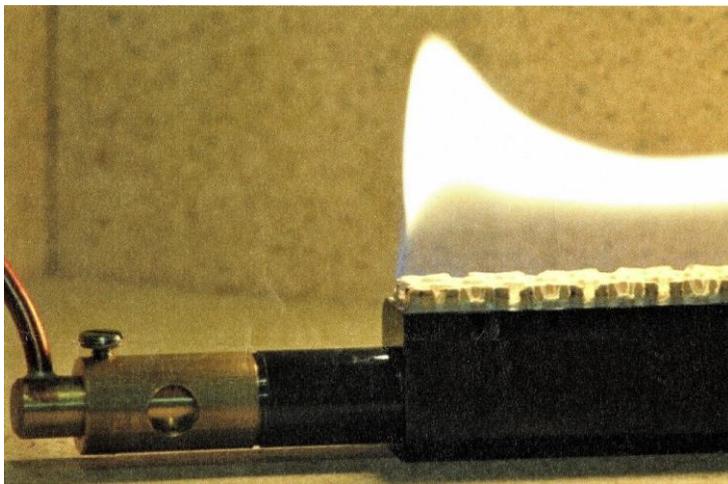
### Horizontal 3" Boiler Instructions v1.3

Setting up the burner is best done in subdued light so the flame can be easily seen. Put the burner on a fireproof surface such as a baking tray.

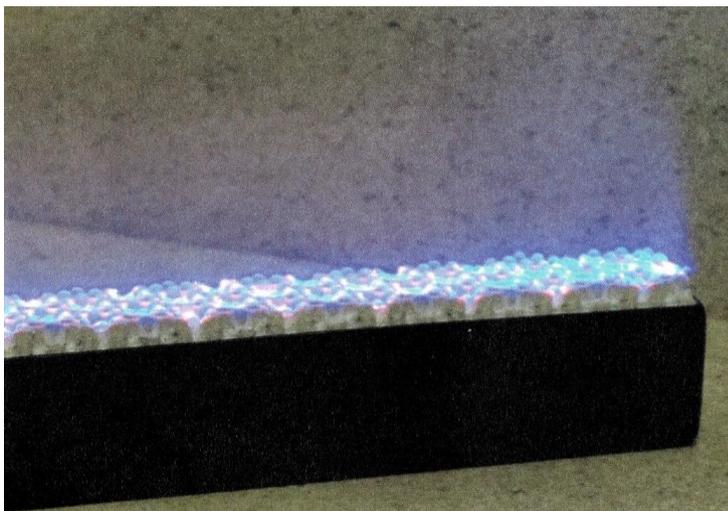
Slide the gas jet carrier into the burner mixer tube so that approximately 12mm (1/2") sticks out. Lightly tighten the locking screw.

Turn on the gas and light the burner and allow it to run for 30 seconds noting how the flame looks. Always turn off the gas and allow the burner to cool before handling or adjusting.

Slackening the locking screw and moving the jet carrier *into* the burner mixer tube will result in a *soft yellow flame* which means the burner is running "rich", that is there is not enough air in the gas/air mixture. This should be the case initially as it is safest to tune the burner from "rich" to "lean" rather than the other way around.



To get the burner running correctly loosen the locking screw and *very slightly* move the jet carrier out of the burner tube, tighten the screw, light, wait 30 seconds and observe the flame. Turn off the gas and allow the burner to cool before repeating the process. The burner is set correctly when there are *little blue jets* dancing on the ceramic and (almost) no yellow flame above them.



The burner can now be installed beneath the boiler cylinder when fine tuning may be necessary.

The lock screw can then be securely tightened – make a note of the position of the jet carrier in case it needs to be removed.

### Lighting the Burner

***WARNING: Before lighting read the section on troubleshooting and be aware of potential problems. If the gas system is not operating correctly, shut it off immediately or damage may result.***

***Be aware that Butane is heavier than air and small pockets of gas can collect around the canister/tank during connection/filling. Also Carbon Monoxide can be produced by the burner, so always use in a well ventilated location, preferably outside.***

***Use heat resistance gloves when lighting or handling the burner while still hot.***

This system is designed for use with butane or a butane/propane mix. There are a variety of mixes ranging from 90/10 to 60/40 with one of the most common being 70/30 (70% butane and 30% propane).

The burner is best lit whilst inside the boiler enclosure (under the boiler cylinder) using a long nozzle oven/hub piezoelectric lighter or taper. The burner can be lit outside the boiler enclosure but be aware the flame can initially spread out beyond the burner and the burner will become hot very quickly.

To light the burner, hold the lighter/taper over the top of the ceramic element of the burner and slowly open the gas control regulator. The gas should ignite almost immediately and the burner should be audible.

If not already in place push the burner into the boiler enclosure, keep it central in the enclosure and for the first couple of minutes keep the burner on low. This is important, as until it warms up, the flame will be a little unstable and turning it up too much could cause it to go out. Also, with a completely full canister/tank, liquid gas could be drawn off instead of vaporized gas, which can also extinguish the flame.

After a couple of minutes, the gas control regulator can be opened slowly to speed up steam raising. Conversely when the boiler is up to pressure reduce the gas flow.

### Safety Pressure Valve

The boiler is fitted with a safety valve to prevent the steam pressure rising above the maximum allowable working pressure. ***It must not be adapted to increase this value.***

The safety valve will start to release/blow off as the pre-set pressure is reached. It is factory set to start venting steam pressure around 20 psi.

During operation, check that the safety valve is releasing and not allowing the pressure to continue to rise. Do this by opening the outlet valve.

If the safety valve does not appear to be working properly it can be removed as mentioned above. The valve consists of a piston/spring which needs to move freely. Clean and lubricate as needed or replace.

***If the safety valve becomes defective in any way do not use the boiler and repair or replace the valve.***

### **Pressure Gauge (optional extra)**

The pressure gauge and its siphon pipe are easily damaged and can if needed be removed. The cone fitting does not require sealing but be careful not to overtighten when replacing. If required, the siphon pipe can be bent to a more convenient position but this must be done with care.

### **Steam Connection to Engine**

The boiler should be securely connected to the steam engine by a pipe specifically designed to withstand the operating temperature and pressure of the boiler - preferably a copper pipe with silver soldered connections - these are available ready made from Chiltern Model Steam.

The boiler's steam outlet valve is situated on top of the boiler and has a 1/4"x40tpi ME connector which takes 5/32" or 1/8" pipe ferrules. This thread is the same as the inlet/outlet on all Chiltern Model Steam engines.

The valve is secured in place with a 1/4" brass nut on the inside of the boiler which needs to be removed before the valve is removed or re-orientated. So to get access to the nut the boiler first needs to be split by removing the M5 cylinder screw(s), see diagram on page 2. Once the nut is removed the valve can be unscrewed.

Be careful when reassembling not to over tighten and hence strip the brass threads. Also ensure the large O ring is in place when putting the boiler body back together.

### **Boiler Filling**

The boiler fill plug screws into the end of the boiler and uses an O ring to seal. It is used to fill the boiler with water whilst the boiler is inactive, i.e. the burner is not ignited and unpressurised.

Distilled water is recommended, as sold for battery topping up, but clean soft water can be used if this is not available. Dehumidifier, condensing tumble dryer or even rain water is also an acceptable alternative, provided that it is adequately filtered for example with paper wine filters. Do not use demineralised or de-ionised water, as this is not the same as distilled water and could cause long term damage.

Remove the boiler filling plug and fill the boiler with clean water. There has to be a space above the water to allow steam to be raised so fill with up to around 450ml of water or empty out 50ml if filled to the top.

A tube from a garden pressure sprayer or large syringe can be used to fill the boiler. To allow air to escape while water is being pumped into the boiler, disconnect the steam outlet pipe and open the outlet steam valve.

Replace the boiler filling plug - do not over tighten.

TIP: Using hot water will reduce the time taken to get the boiler up to steam, hence saving gas.

## Boiler Water Level

Care should be taken to always ensure that there is sufficient water in the boiler whilst the burner is lit. The boiler could otherwise be damaged.

The minimum water level is around quarter full (125ml), hence ensuring the hottest part of the boiler is always covered by water.

Experience will be gained using the boiler as to how much water is consumed and therefore left in the boiler at a particular run-time. So when the boiler has cooled pour out the remaining water into a measuring container – hopefully there is at least 125ml.

From testing with Chiltern Model Steam single cylinder engines a full boiler can be run for 30-40 minutes on light load, e.g. Beam engine ticking over gently. Around 20 minutes under heavier load, e.g. Mill single running at speed driving a dynamo – see the YouTube videos mentioned above.

***Turn off the gas to the burner immediately if it is suspected the boiler is running low or if steam stops coming from the boiler.***

## Boiler Water Level Gauge (optional)

The optional water level gauge if fitted will provide a visual indication of the amount of water in the boiler.

If bubbles get trapped in the water gauge's glass tube making it difficult to get an accurate reading, use the draw down valve on the base of the water gauge to vent a little air/steam. Take precautions as this will be scolding hot.

The water gauge has a replaceable 5mm glass tube which can be accessed by removing the blanking nut on top of the gauge. Replacement tubes are available from multiple model engineering suppliers. Only finger tighten the tube retaining nuts.

## Gas Regulator/Valve and Pipe

***The connection of the gas supply should be checked before every use.***

If the optional Chiltern Model Steam Gas Canister Regulator and Pipe is not being used, ensure that there is a valve connected directly to the gas canister or tank which can be used to turn off the gas supply. The gas regulator/valve should also be capable of graduated control of the supply to the gas burner once the boiler is up to steam.

The supply pipe from the canister/tank must be connected securely to the burner's gas jet carrier, use PTFE tape to get a good seal on the threads. Check this if the optional regulator/pipe adapter is purchased from Chiltern Model Steam. Also check the connection of the regulator to the canister/tank is secure.

## Gas Canister/Tank

***For safety reasons ensure the gas canister or tank is located away from the burner in a secure location.***

***After extended use the pipe, gas canister or tank's surface can, in exceptional circumstances, become cold enough to stick to your skin, so use gloves.***

If a gas tank is used please follow the supplier's installation and operational instructions especially for filling.

Positioning of the canister/tank is very important for both safety and good operation. Propane/Butane gas is stored as a liquid, but changes to a gas as it mixes with air. As gas from the top of the canister/tank is drawn off, more of the liquid below it turns to gas and this process causes a drop in temperature which also lowers the pressure within the canister/tank. If allowed to get too cold, then the pressure of gas can drop until it is insufficient to maintain steam production.

To offset this temperature drop, turn off the gas and let the canister/tank warm up naturally. It is also possible to make use of the conducted and radiated heat from the boiler to maintain a good working pressure within the canister/tank – this is not recommended for less experienced operators/builders.

If however, the canister/tank is allowed to get too hot, the pressure of the gas inside the canister/tank can become dangerously high and this must never be allowed to happen. It is important therefore that there is plenty of air space between it and any hot items such as boiler or steam pipes. The gas canister/tank should be slightly warm to the touch, no warmer.

Please refer to manufacturer's guidance and ensure that their maximum operating temperature is never exceeded. Usually the temperature of the canister/tank should not be allowed to get higher than 30 degrees Celsius.

### **Pressure Vessel Care and Maintenance**

It is recommended that the boiler be drained after use.

Boilers do have a finite life so it is recommended that if the boiler is used regularly or operated in public it should undergo the following checks, carried out by a "competent person", club, society, or pressure vessel manufacturer, every one to two years:-

1. Thorough visual inspection.
2. Hydrostatic pressure test to not less than 1.5 and not more than 2 times the maximum working pressure.
3. Steam pressure test to check the correct functioning of the safety valve.

### **Troubleshooting**

The tiny gas jet hole can become blocked by small particles of dirt or if left unused, making the burner difficult to light, burn weakly on cold days or fail completely. If any of these should happen, clean out the jet as follows:

1. Disconnect the gas supply pipe from the jet carrier. Note when connecting or disconnecting the gas pipe, do not use excessive force as it is possible to cause damage by bending the pipe.
2. Slacken the screw retaining the jet carrier in the burner mixer tube and slide it out.
3. Remove the jet from the jet carrier using a 4BA spanner. Wash out the jet in fast evaporating thinners (Cellulose or similar). Blow through the jet from the front, which should clear most blockages. Although the hole through the jet is tiny, if you hold it up to the light you should be able to see quite clearly if it is blocked or not. If in doubt, fit a new jet - they can be

### Horizontal 3" Boiler Instructions v1.3

purchased from model engineering suppliers – the boiler is fitted with a No. 8 Gas Jet. Do not use wire to clean the jet as this can damage the precision hole and may upset the delicate balance of the gas system.

4. Reassemble in the reverse order, wrap a little plumbers PTFE tape around the jet's and other connection threads and ensure all gas connections are tight. Re-position the gas jet carrier in the burner mixer tube, as described above.