Course: 3D Design
Title: Rocket Steam Locomotive - Modeling
Blender: Version 2.6X
Level: Beginning
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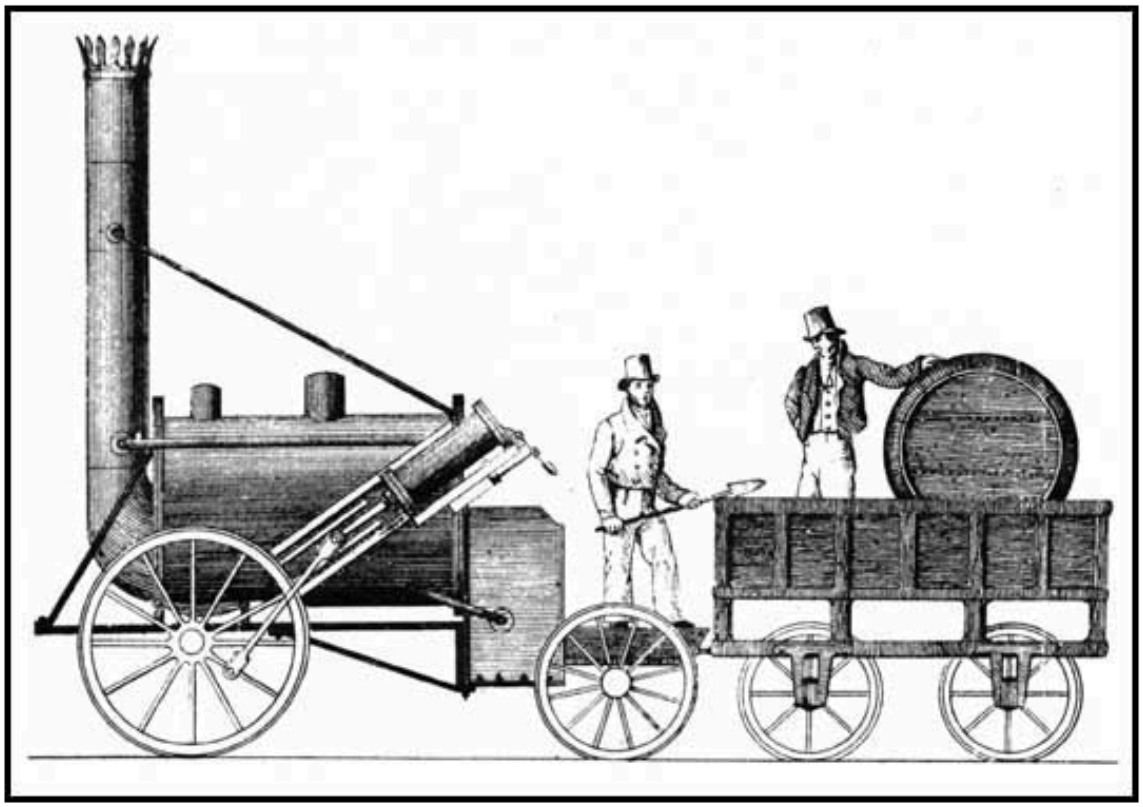
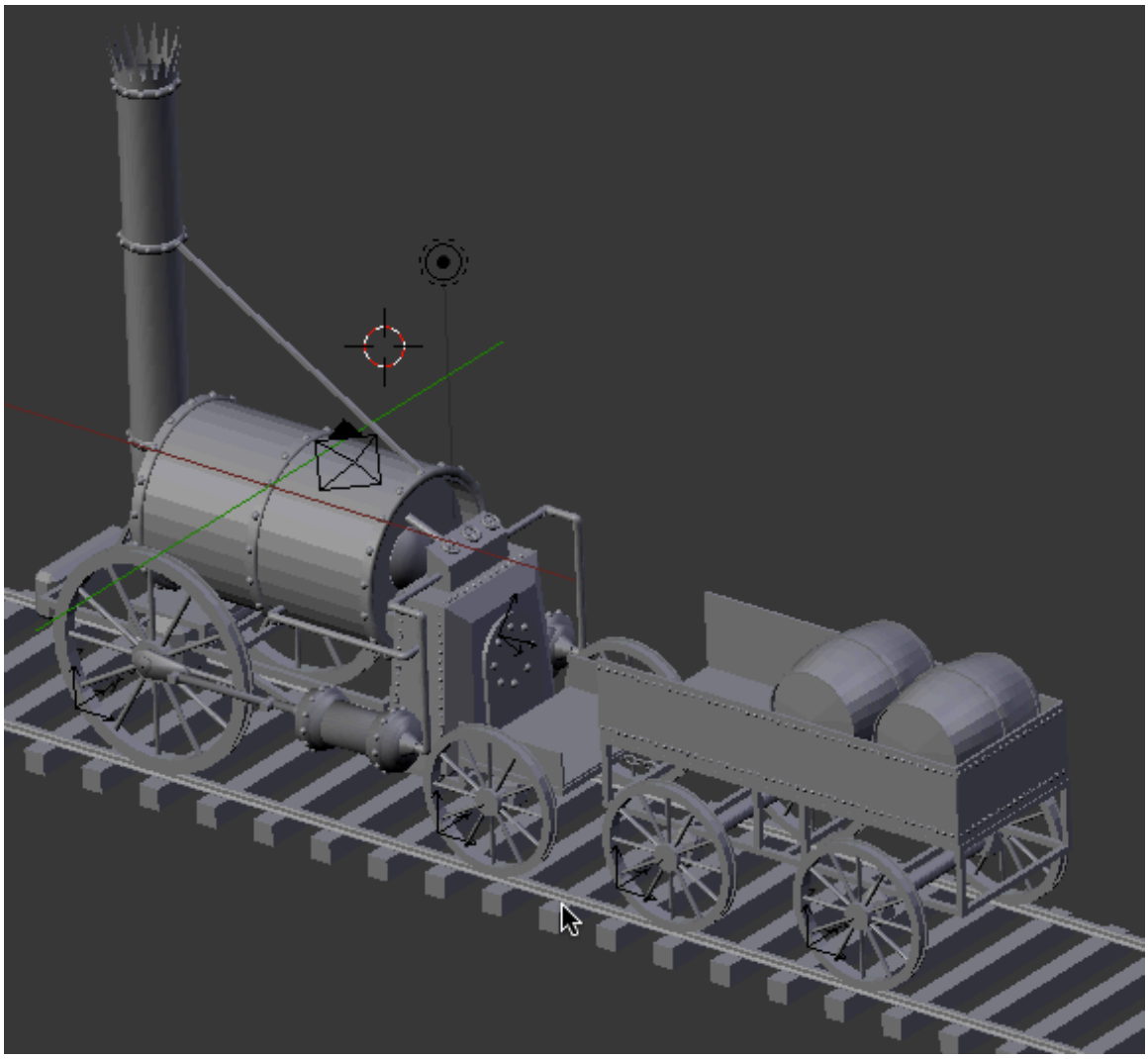
(May 2012)

# "The Rocket" Steam Locomotive - Modeling



In this tutorial we will be modeling Robert Stephenson's Steam Locomotive named "The Rocket". The rocket was the most advanced steam engine of its day. It was built for the Liverpool & Manchester Railway in 1829. It achieved the unbelievable speed of 25 miles per hour.



This is the second of 3 PDF tutorials focused on the Rocket Steam Locomotive. The other 2 PDF tutorials are Rocket Steam Locomotive Drive Chain, which focuses on the drive chain modeling for the Rocket locomotive and Rocket Steam Locomotive – Animation, which focuses on the animation.

## SET-UP:

Open up your Rocket Steam Locomotive Drive Chain.blend file that you created during the first tutorial.

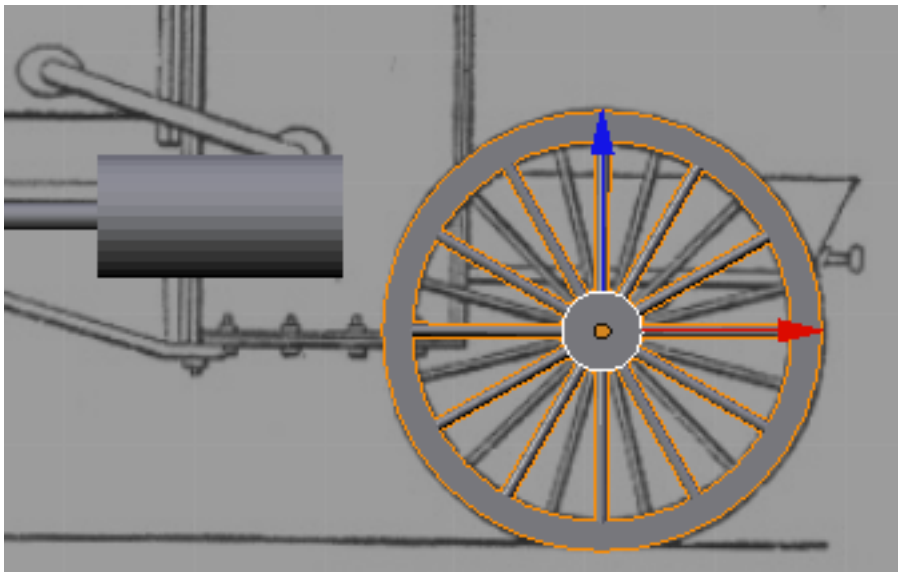
If you have not completed the first PDF tutorial (Drive Chain), you can download a completed .blend file named "RocketSteamLocomotiveDriveChain" HERE.

Open up this file which contains the modeling for the locomotive drive chain.

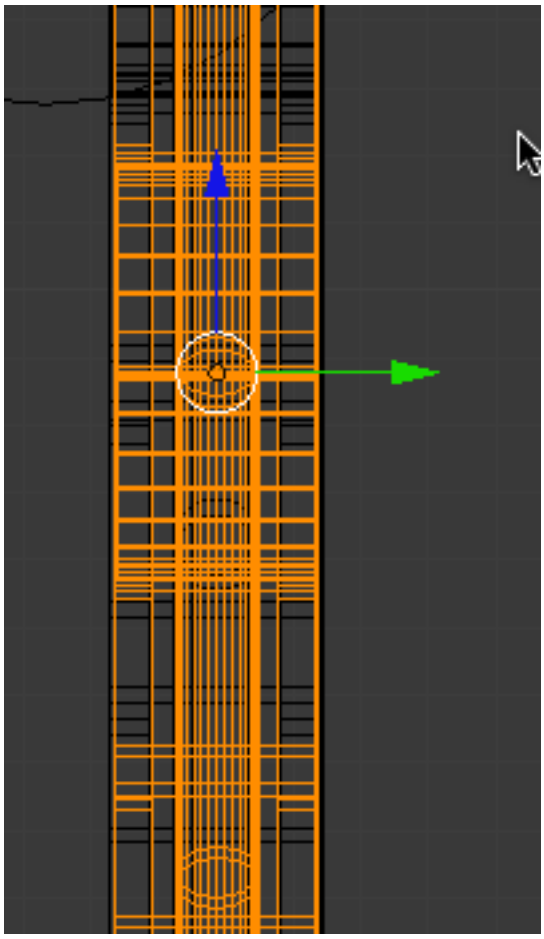
Go to front view - Go to solid display mode.

Select the Wheel Front Left object and press SHIFT-D (Duplicate) followed by the XKEY. Move the duplicate wheel object to the right along the X-axis to the back of the locomotive. Press the GKEY and place it centered on the left back wheel in the background image.

Scale the wheel down to the size of the wheel in the background image as shown below.



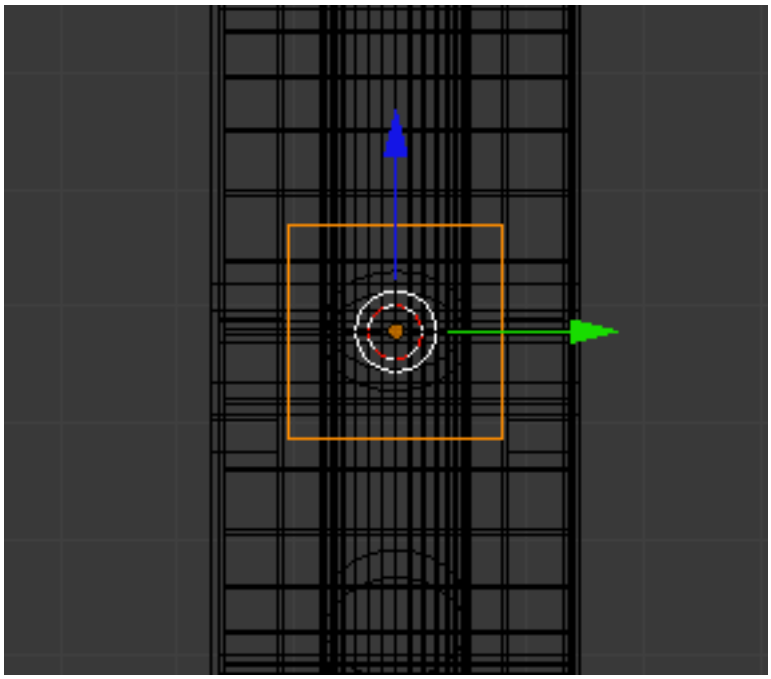
Go to side view. Go to wireframe display mode. Press the SKEY followed by the YKEY and scale the wheel out along the Y-axis so that it is as wide as the front wheel.



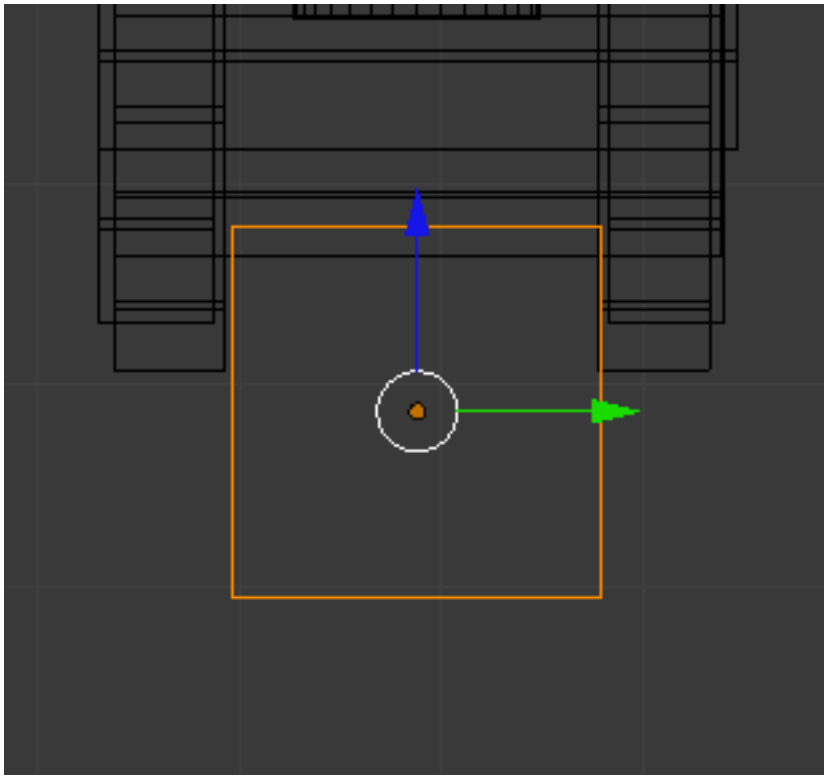
Name this object “Wheel Rear Left”
With the wheel rear left still selected press SHIFT-S and snap your 3D cursor to the selection.

Press SHIFT-A and add a cube object. Set the Y rotation to 90 degrees.

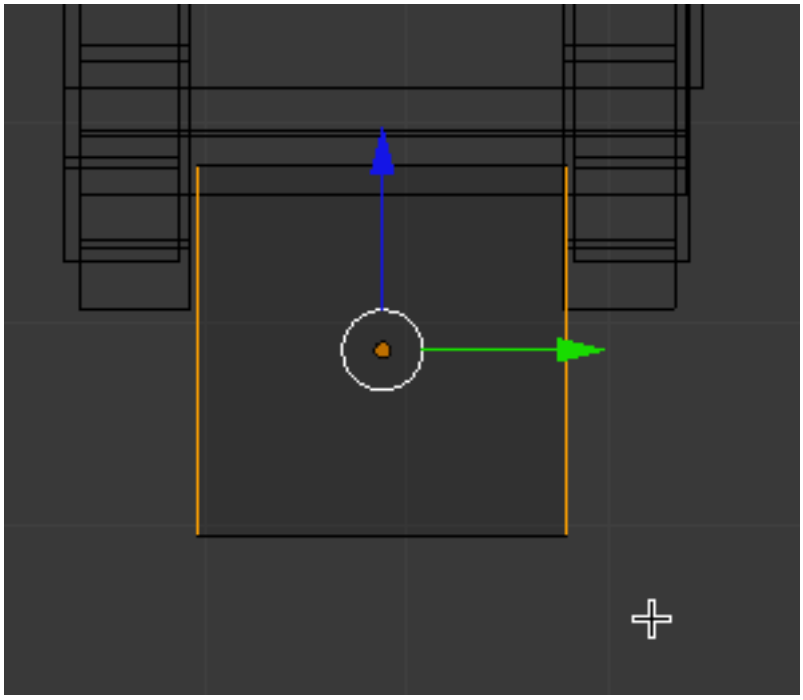
This object will become our railroad track. Scale this down to the size of the inside of the wheel edges as shown below.



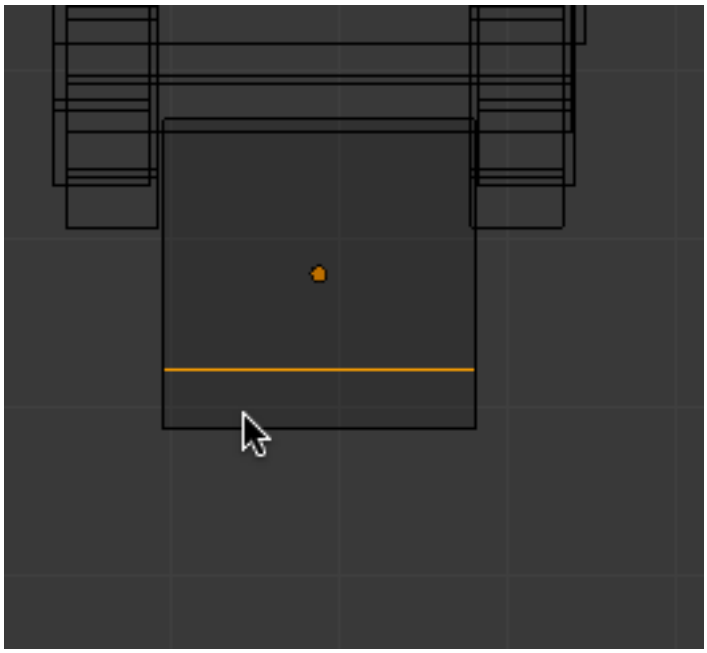
Use your translate widget to move the object down along the Z-axis to the bottom of the wheel objects.



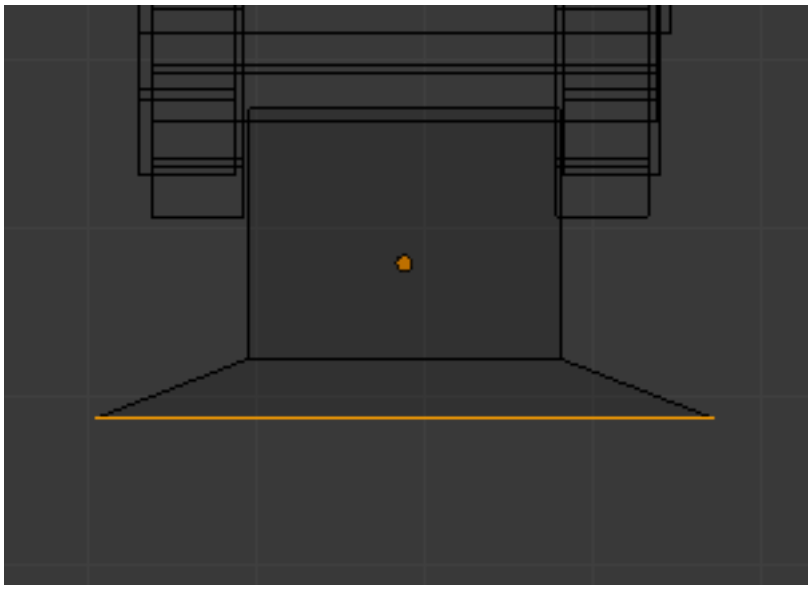
TAB onto edit mode. Press CTRL-TAB and select edge select mode.
Deselect the edges and then box select the 4 vertical edges.



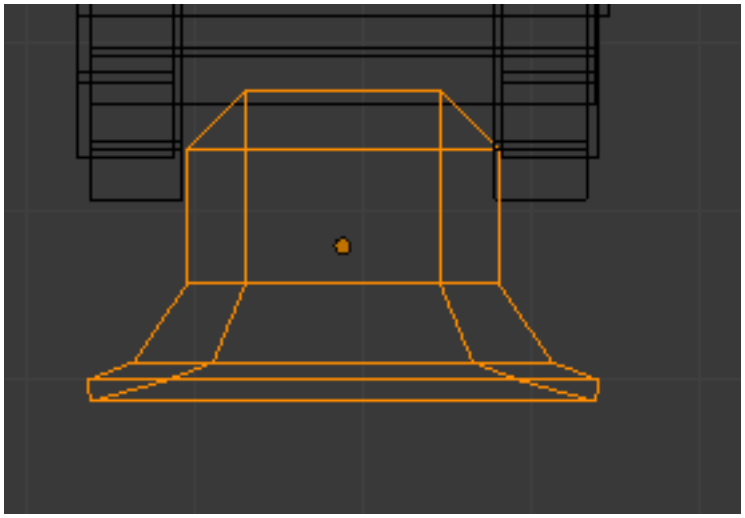
Press the Loop Cut and Slide button located in the 3D editor viewport tools panel. Move your cursor about in the cube object until you see a blue horizontal loop cut. Then left click and slide the loop cut down and left-click to place as shown below



Deselect the edges. Box select the two horizontal bottom edges. Scale them out a bit as shown below.

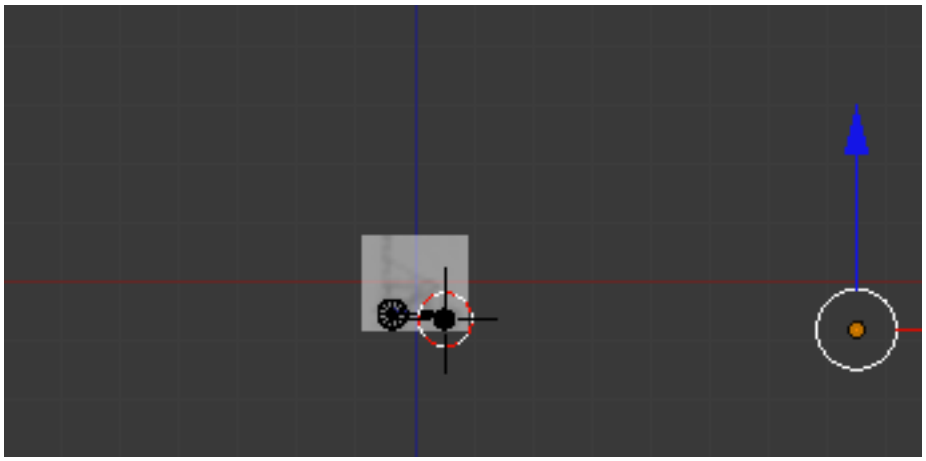


Deselect the edges. TAB out of edit mode. Press the Modifier context button on the Properties Editor and add a Bevel modifier to the cube.  Set the width at .375

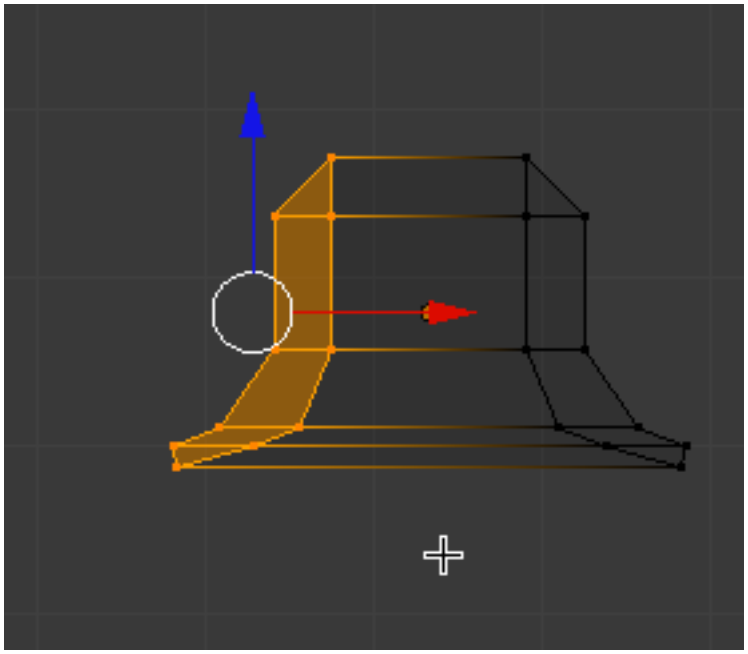


Press the Apply button in the modifier panel and permanently apply the modifier.

Go to front view and zoom out quite a bit. Select the cube object and using your translate widget move it far to the right along the X-axis as shown below.



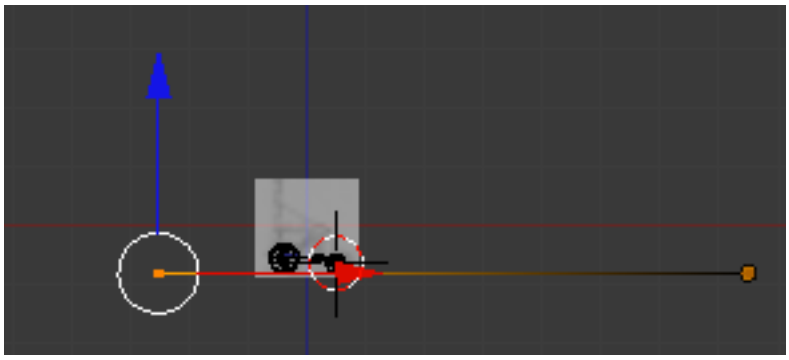
Now in front view, zoom back in on the cube object. TAB into edit mode. Press CRTL-TAB and select vertex select. Deselect the vertices. Box select the left half of the vertices as shown below.



Press the GKEY then the XKEY then -100 then ENTER.

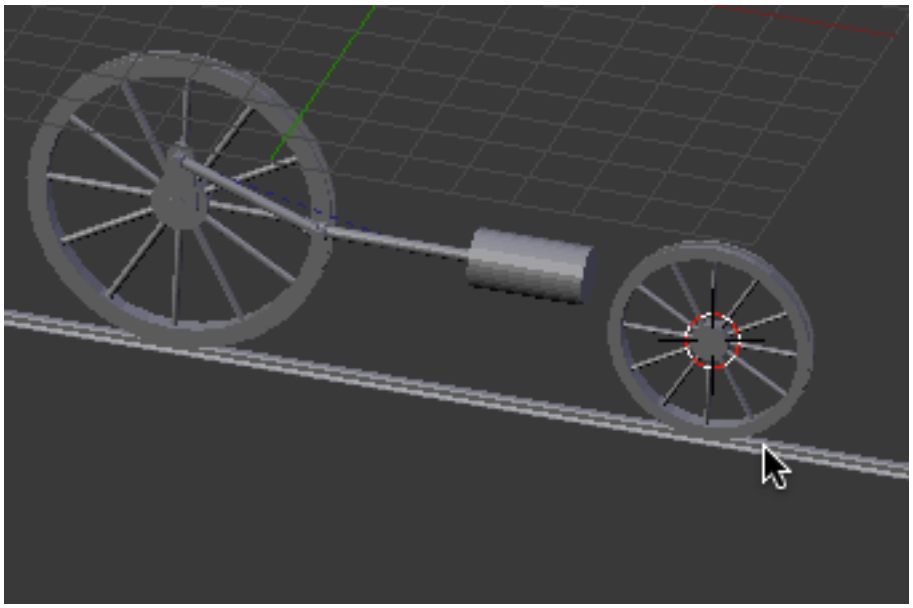
This will move the vertices 100 Blender units along the X-axis.

Zoom out to see the result.



Deselect the vertices – TAB out of edit mode – Go to solid display mode.

Name this object “Track Left”.



Save your Blender file.

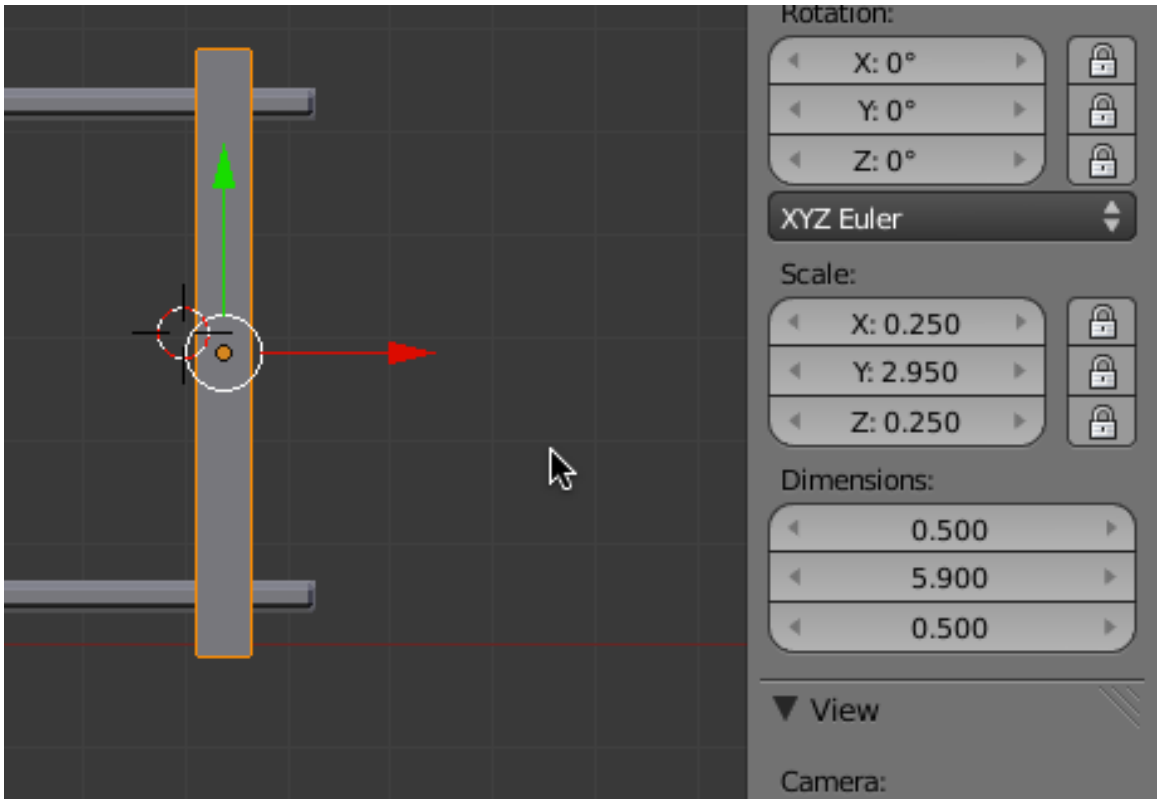
Go to top view. Select the Track Left and press SHIFT-D then the YKEY and then 4.8 then ENTER

This will create a duplicate track object and place it 4.8 Blender units up along the Y-axis.

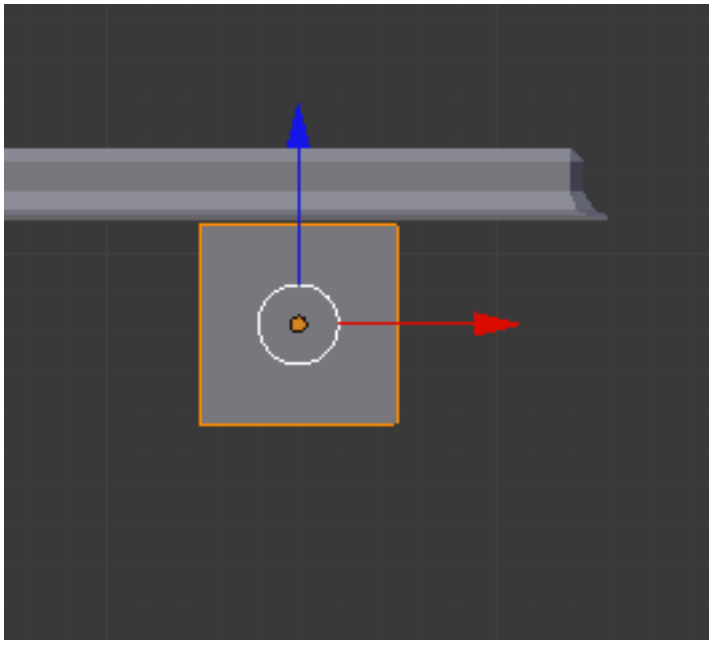
Name this object “Track Right”. This will establish the track’s gauge.

Go to top view and zoom in a bit on the far right end of the tracks. Place your 3D cursor in the center of the tracks and press SHIFT-A and add a cube object. Set the dimensions in the 3D editor properties panel at .5 x 5.9 x .5

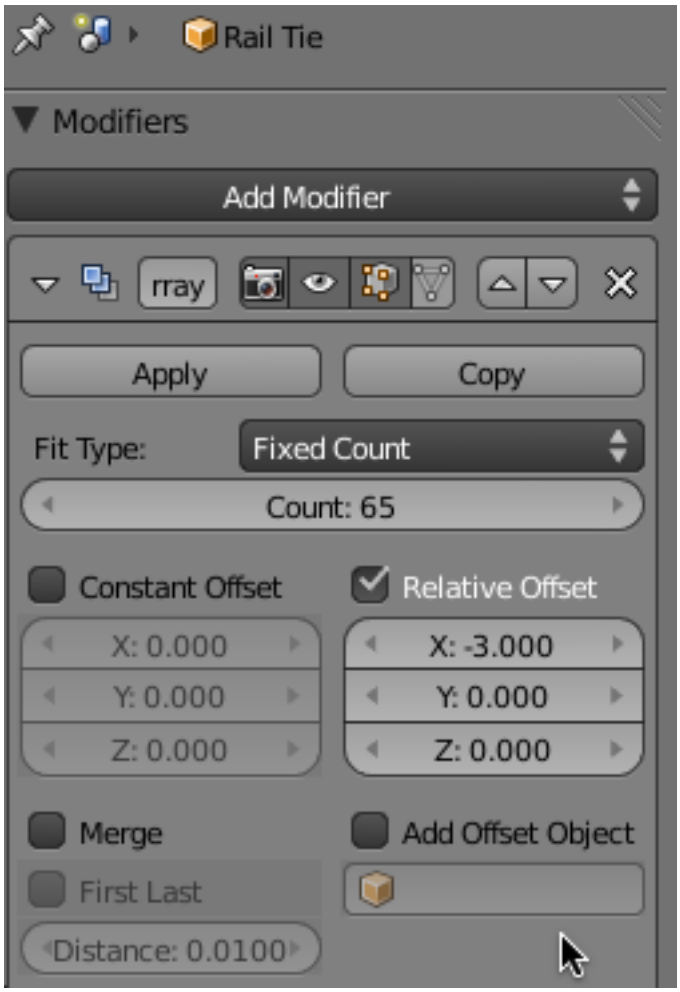
Place the object as shown below (Note: you may have to hold down your SHIFT key while moving it) and name this object “Rail Tie”.



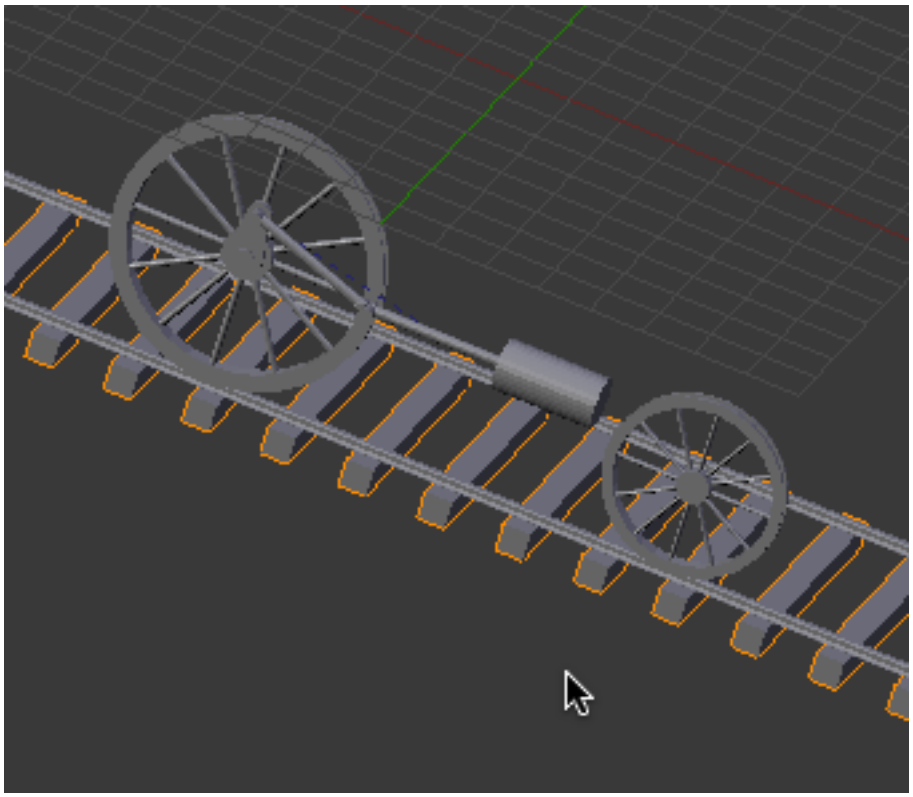

Switch to front view -- Select the Rail Tie object and press the GKEY and place the object below the rail object as shown below. You will probably need to hold down your SHIFT key while moving this object.



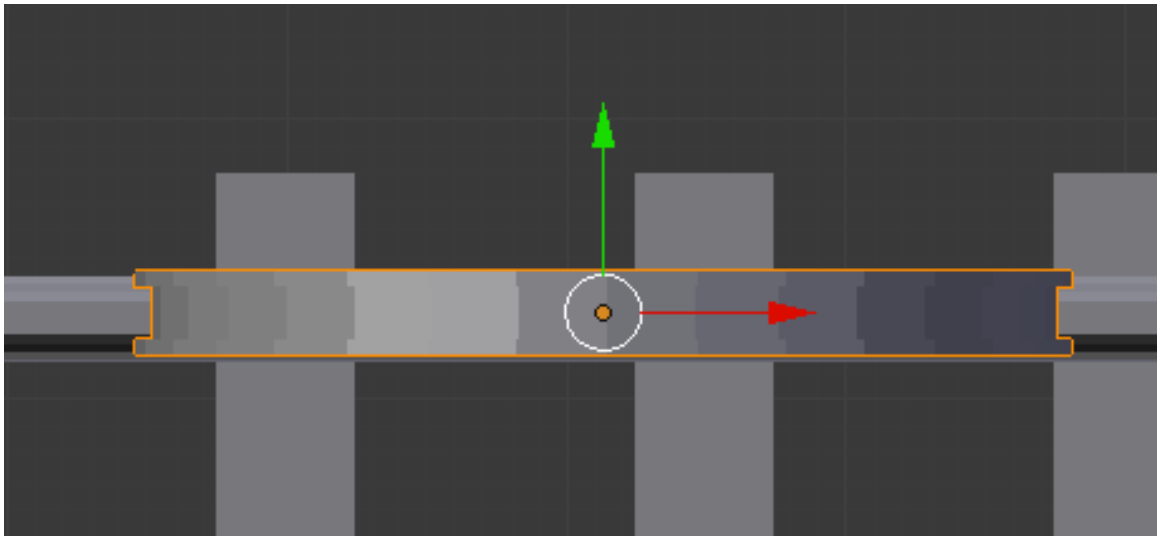
Add an Array modifier to the rail tie object. Set the relative X offset to -3 and set the count to 65.




Deselect the object.

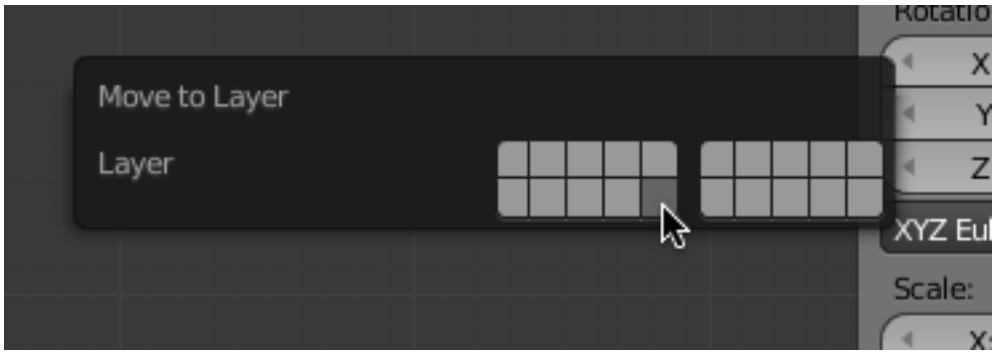


Switch to top view. Select the wheel rear left object and press SHIFT-D (Duplicate) followed by the YKEY. Move the duplicate object up along the Y=axis and position it on the right track. (again you may need to use your SHIFT key while moving).

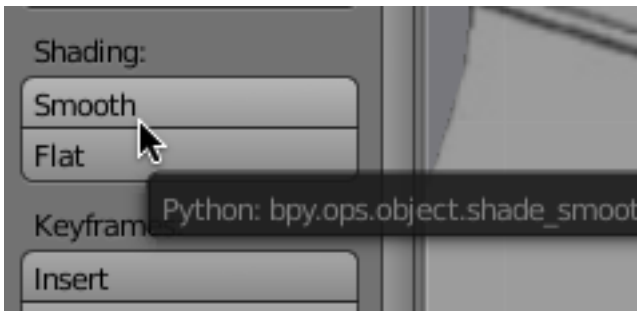


Name this object Wheel Rear Right.

Select the rail tie object. Press the MKEY and place it on layer 10 to get it out of the way for a while.

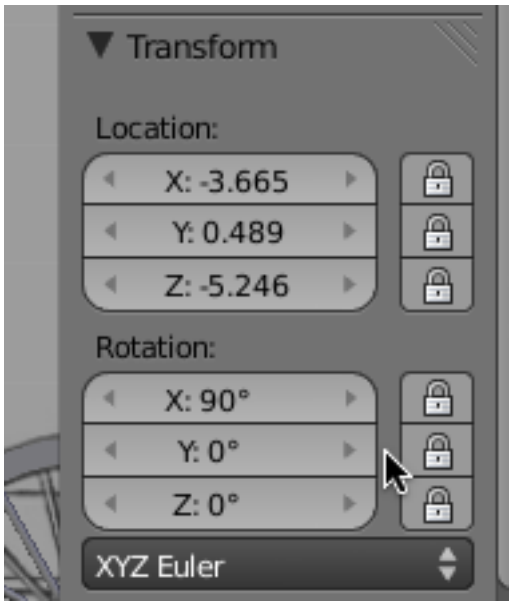



Go to front view. Select the piston object. Press the Smooth button in the 3D editor viewport Tool panel to smooth out the object's facets.

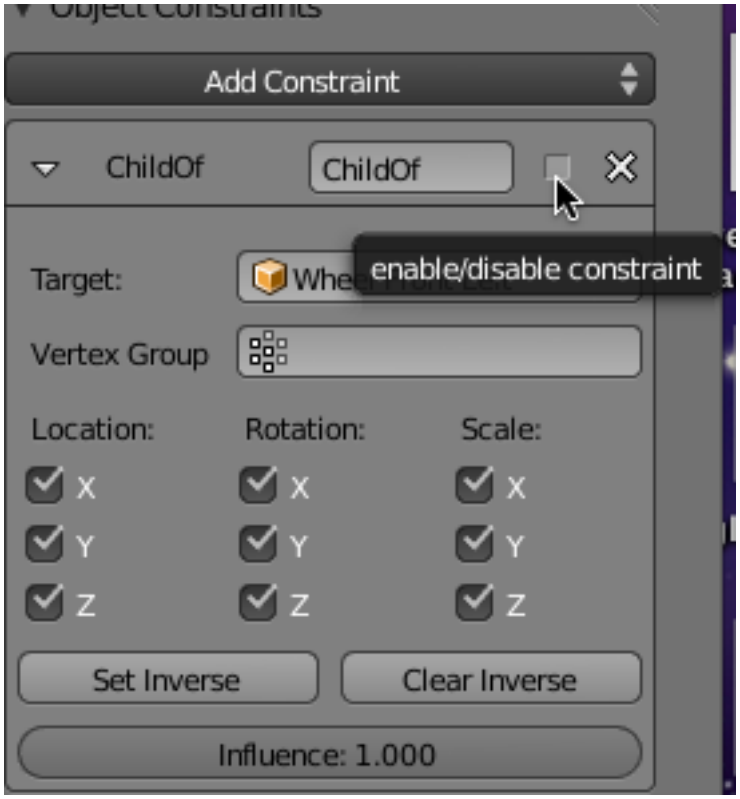



Smooth the piston rod object and the connecting rod object as well.

Go to front view. Select the wheel front left object. Make sure in the 3D editor properties panel that the Y rotation is set to 0 degrees.



We will next move the locomotive drive train. Before we do we have to temporarily turn off the associated constraints. Select the crank object. In the modifier panel uncheck the enable/disable constraint check box.

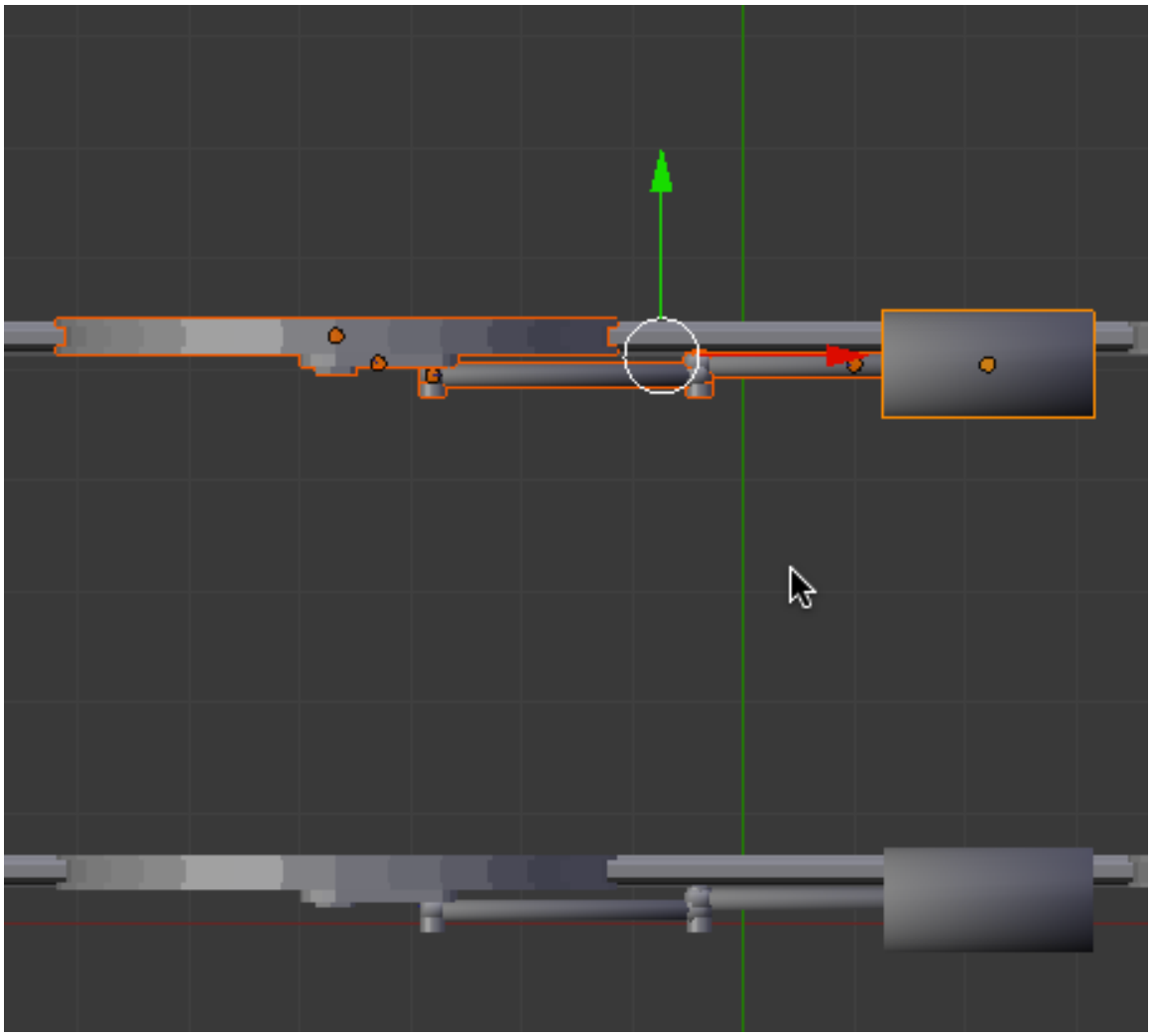



Disable the constraint on the crank pin, linking pin and piston rod as well. Disable **both** constraints on the connecting rod object.

Now select the wheel front left object and add to the selection the crank, crank pin, connecting rod, linking pin, piston rod and piston objects.

Go to top view. Press SHIFT-D followed by the YKEY and move the duplicate objects up along the Y-axis until the wheel front left duplicate object is positioned over the right track as shown below.

You will probably have to hold down your SHIFT key to precisely place the objects.

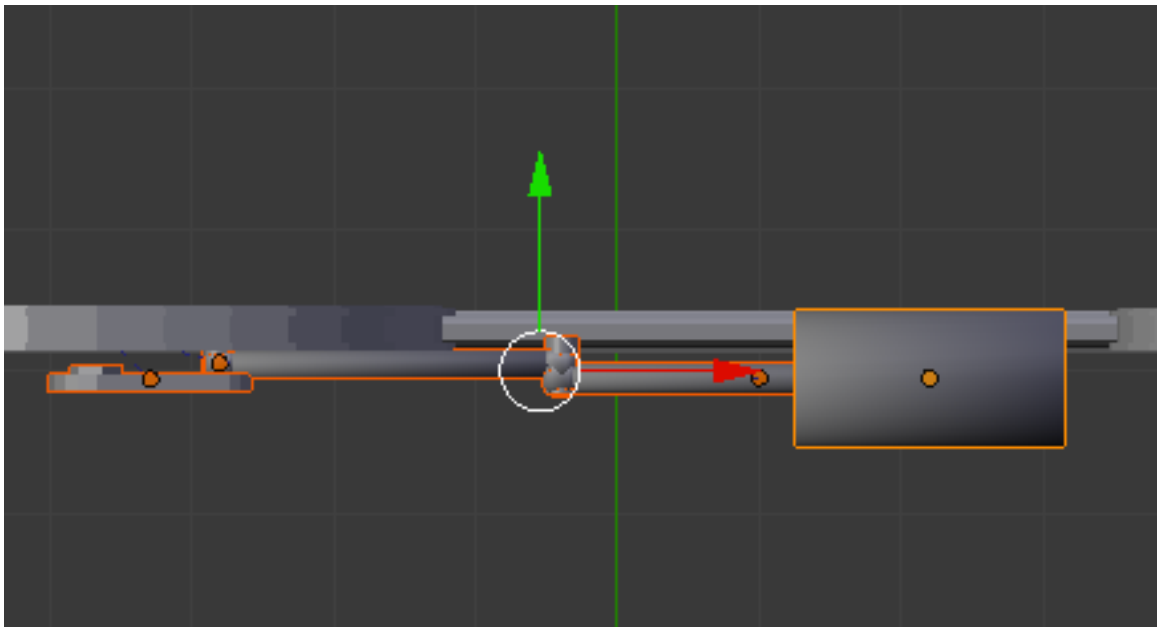


Deselect the objects.

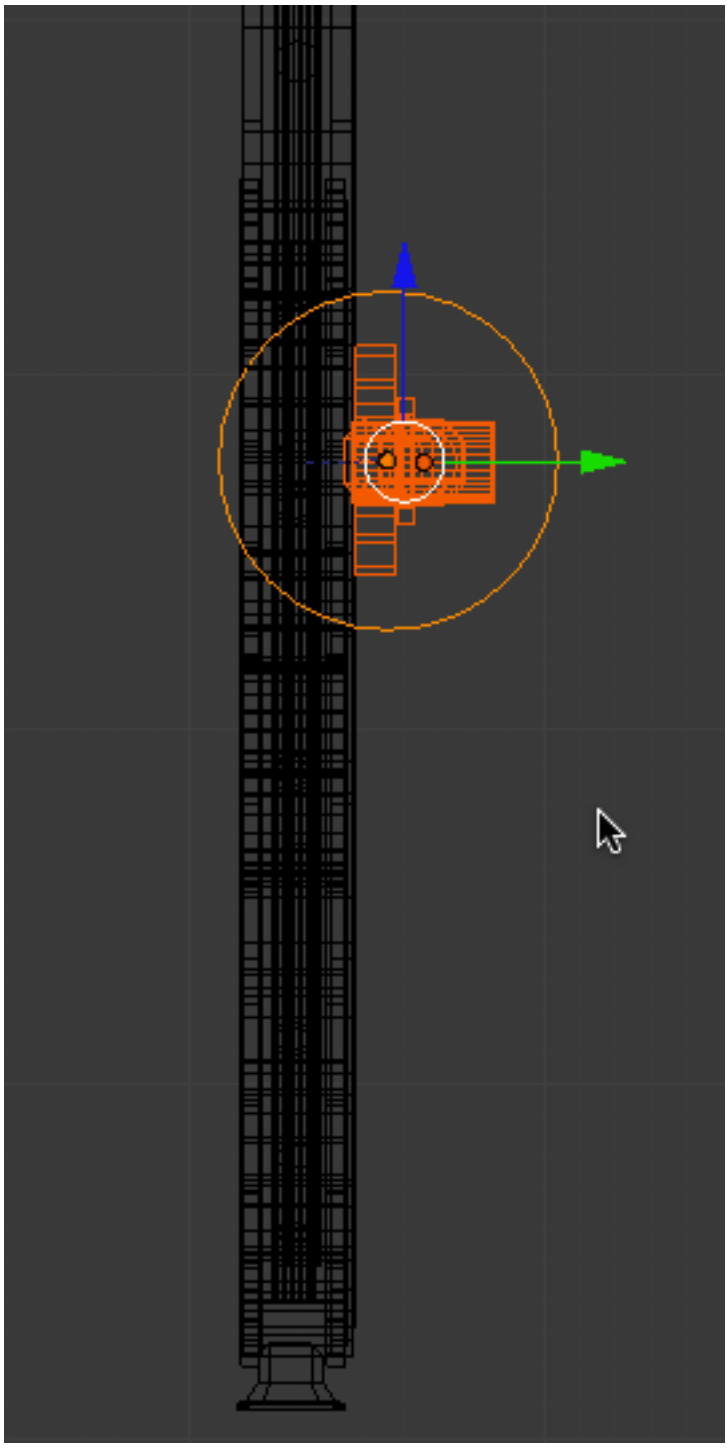
Now select the crank object and add to the selection the crank pin, connecting rod, linking pin, piston rod and piston objects.

Go to side view. Press the RKEY followed by the XKEY follow by 180 then press ENTER.

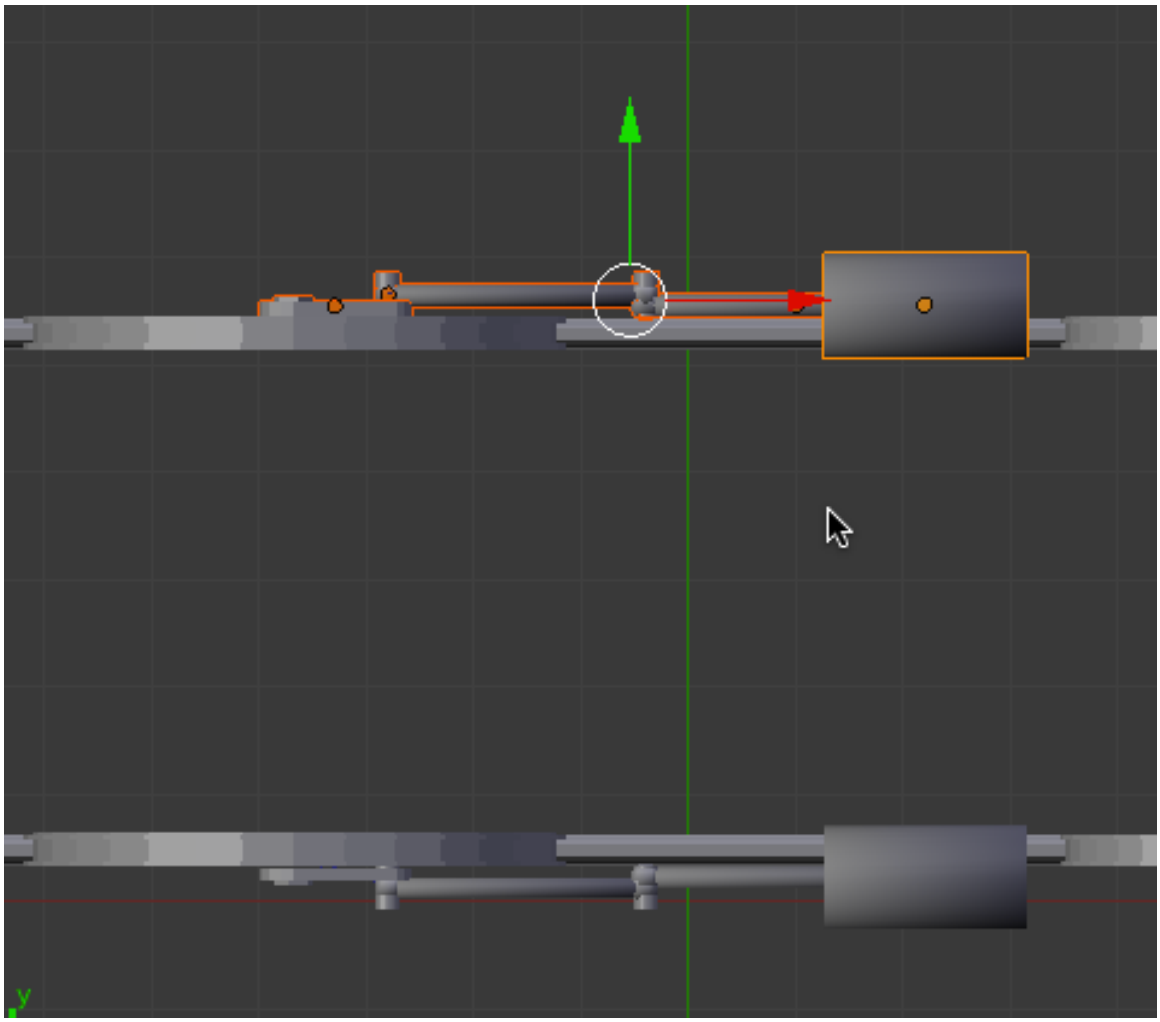
This will rotate the objects around the X-axis 180 degrees.  It should look like below in top view.



Go to side view.  Go to wireframe display mode. With the objects still selected use your translate widget to move them to the right and position them so that the crank object is at the outside of the wheel as shown below. (Again, you will have to use your SHIFT key to precisely move the objects.)

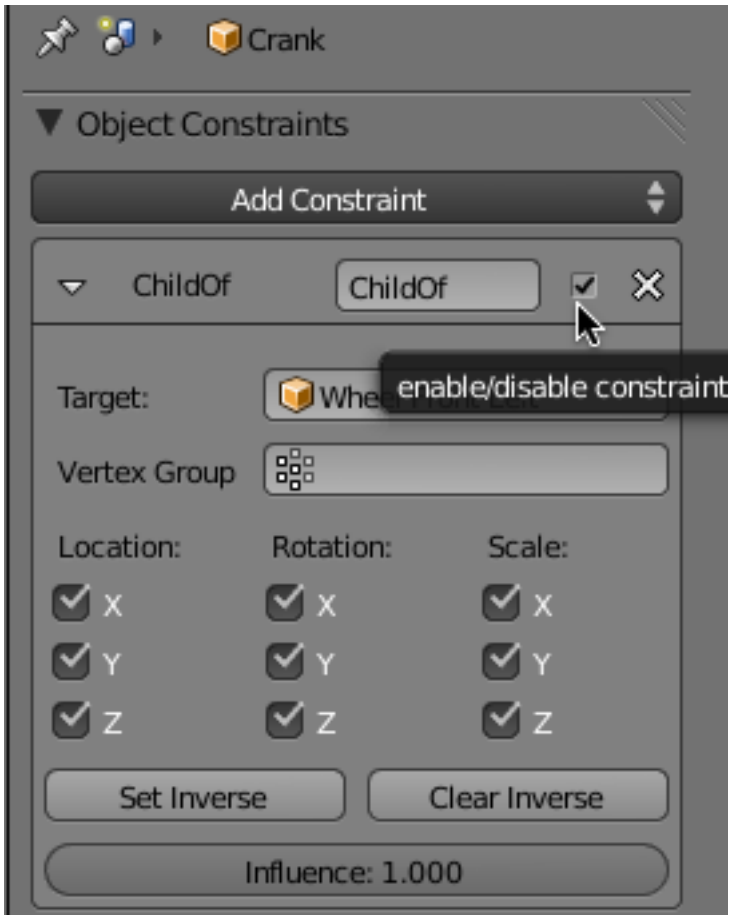


Go to solid display mode. In top view it should look like this.



We will leave the names (with the suffix .001) automatically created by Blender for these duplicate objects.

Select the original crank object and in the modifier panel, enable the constraint.




Enable the constraints for the crank pin, linking pin and piston rod objects. Enable both constraints for the connecting rod object.

The drive chain should again work when the front wheel is rotated.

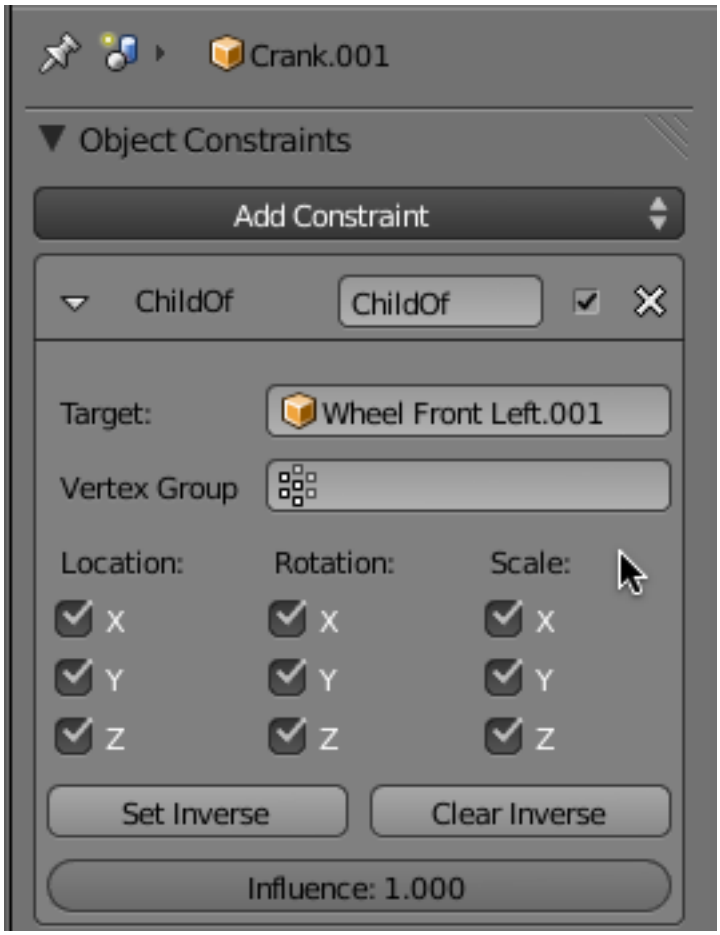
Go to back view (CTRL-NUMPAD-1)

When we duplicated the locomotive drive chain, the constraints were also duplicated and the new “Targets” were automatically set to the new duplicate object names (.001).

However, there are some modifications we need to do.

Select the crank.001 object. In the modifier panel

1- CLEAR INVERSE
2- Enable the modifier
3- SET INVERSE




The clear inverse will disconnect the original location and scale settings. The enable checkmark will enable the constraint. The set inverse will reset the object to its new location and scale.

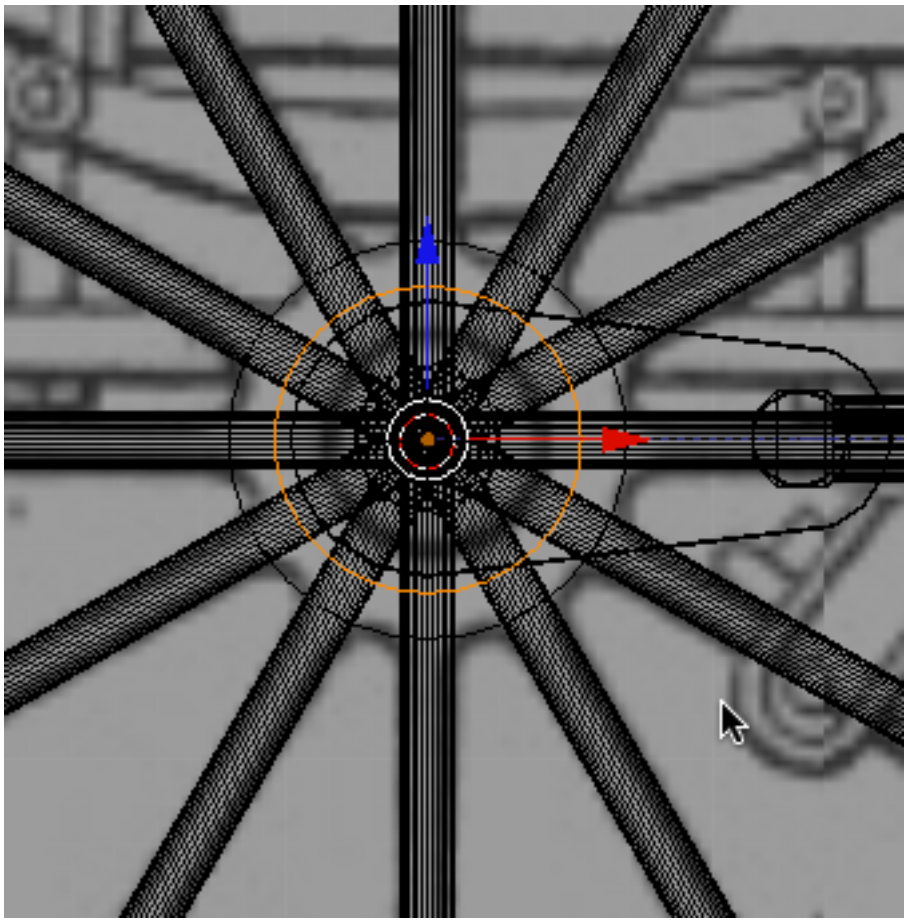
Enable the constraints for the crank pin.001, linking pin.001 and piston rod.001 objects and perform these 3 operations on each of them as well.

Select the connecting rod and do the same on the “Child Of” constraint and then simply enable the locked track constraint.

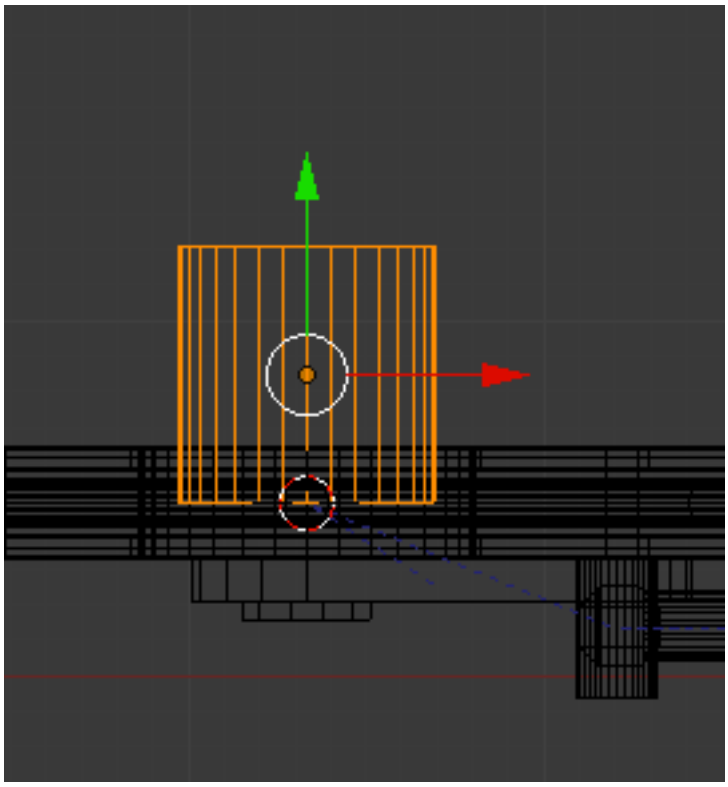
Now the .001 drive chain will work as the wheel front left.001 object is rotated about the Y-axis.

We will now model the front axel. Go to front view. Go to wireframe mode. Select the wheel front left object. Press SHIFT-S and snap your cursor to the selected object.

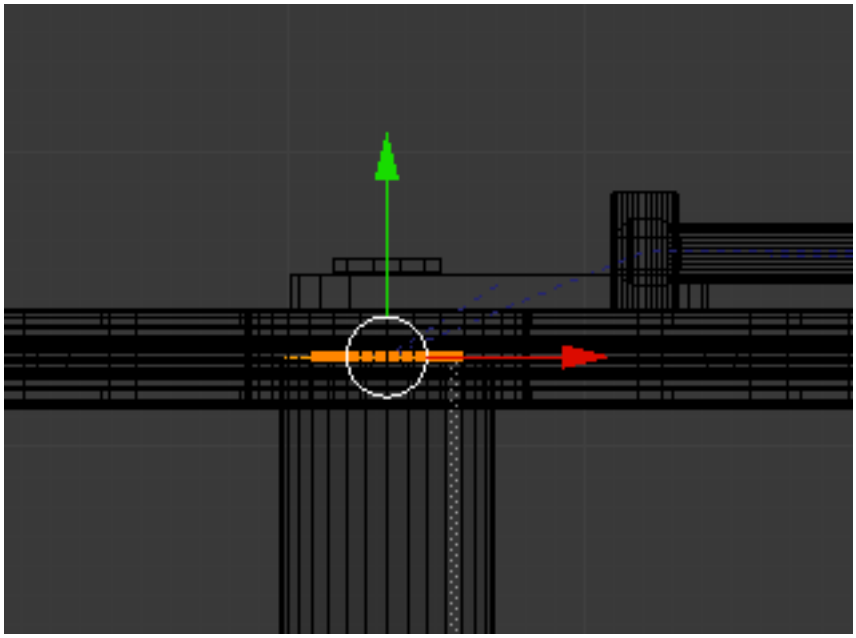
Press SHIFT-A and add a (capped) Tube object. Set the X rotation to 90 degrees. Press the SKEY and scale the tube down to somewhere between the width of the crank and wheel hub as shown below.



Go to top view. Place the tube so that the bottom is inside of the wheel’s hub.



TAB into edit mode. Deselect the vertices. Box select the top set of vertices and using your translate widget move the vertices to the other wheel just inside the hub as shown below.



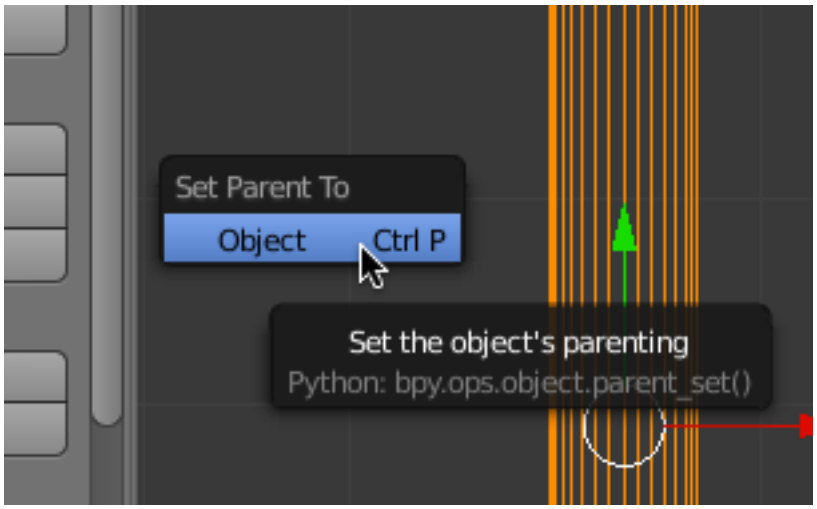
Deselect the vertices  -- TAB out of edit mode

Name this object “Axel Front”.

With the Axel front object selected press SHIFT-CTRL-ALT-C and set the origin to the geometry.

Select the wheel front left object and then add to the selection the wheel front left.001 object then add the axel front object to the selection (it must be selected in this order).

Press CTRL-P (Parent).

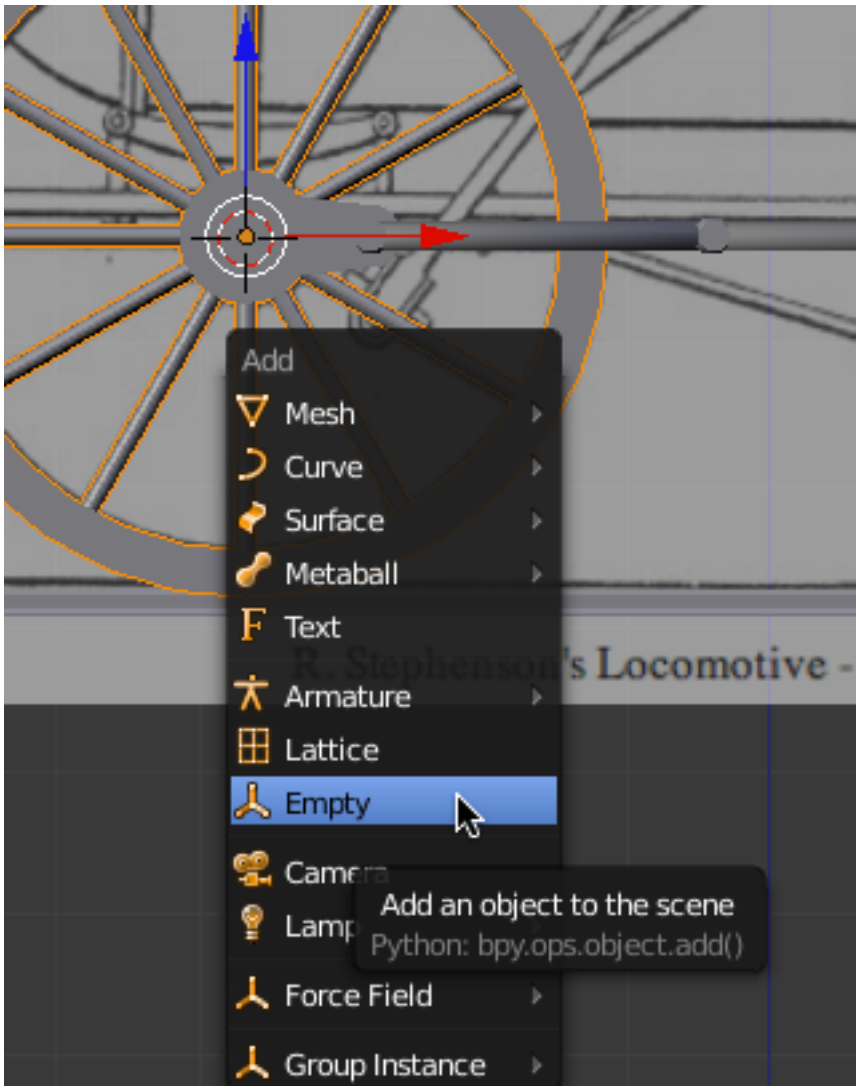



This will parent the wheel front left and the wheel front left.001 objects to the axel front object.

This means that the axel front object is a parent to the wheel objects. Rotating the axel front object around the Y-axis will in turn rotate the wheel objects, which in turn will move the drive chain for both sides of the locomotive.

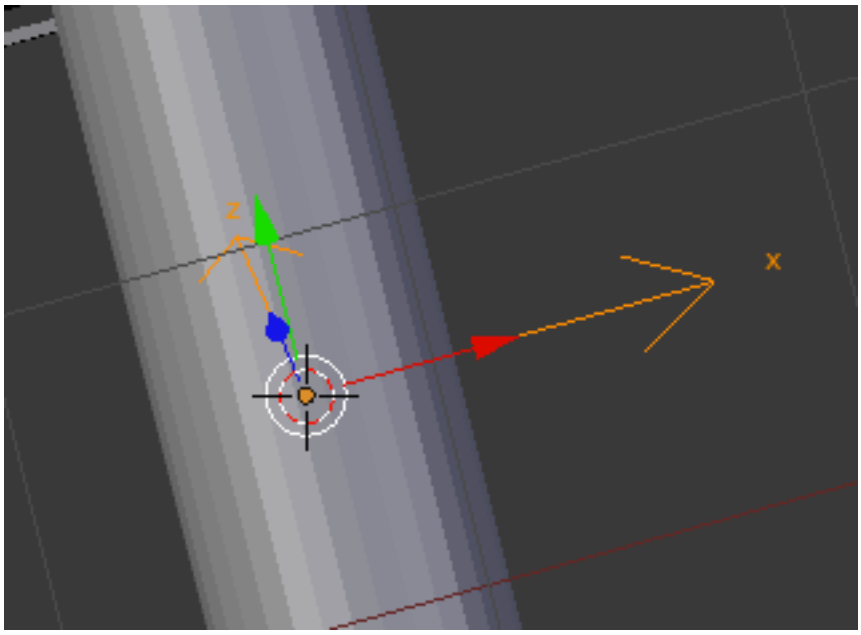
Select the axel front object alone. Press SHIFT-S and snap your cursor to the selected object.

Go to front view. Press SHIFT-A and add an empty object to the scene.

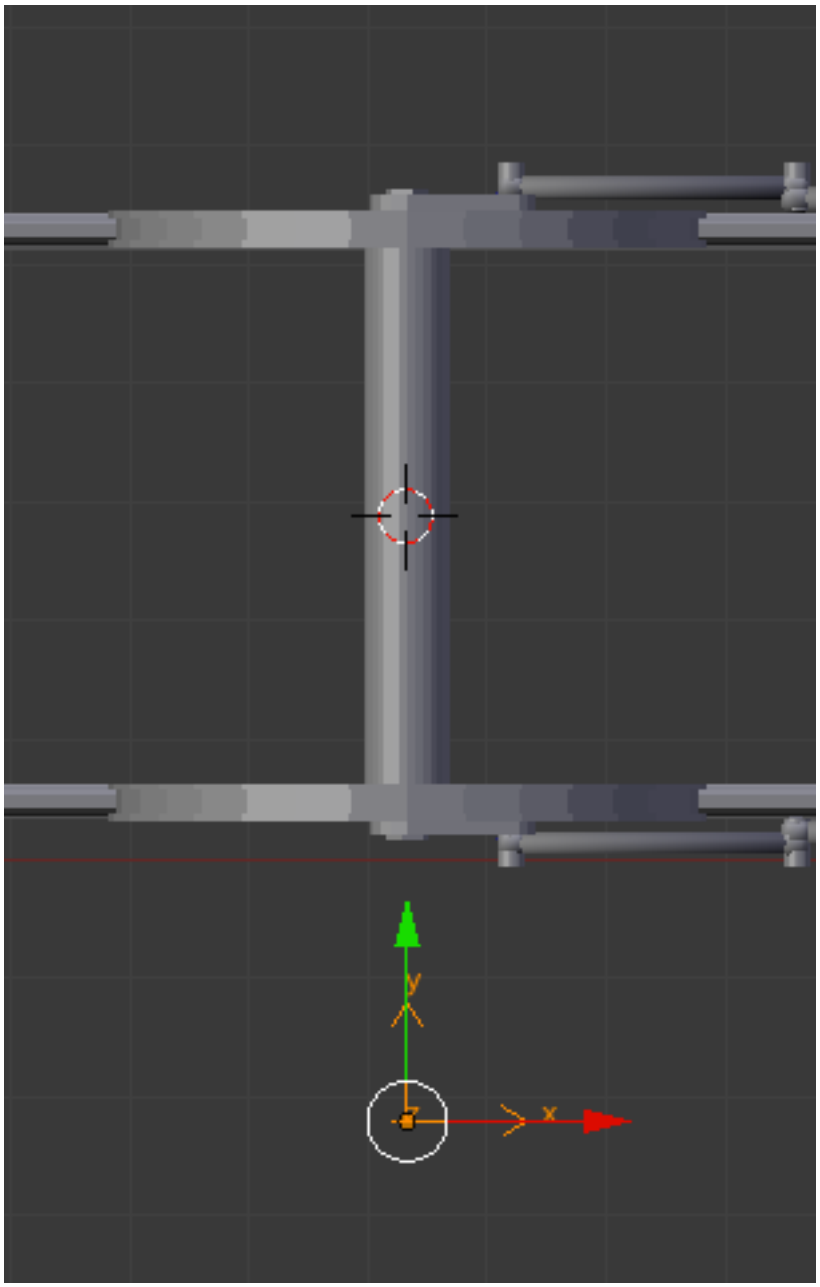



An empty object is a non-renderable object that represents a point in 3D space. Name this empty object Drive Train Empty.

It is represented as an axis icon.




Go to top view. Select the empty object and press the GKEY followed by the YKEY and move the object down below the wheel front left object as shown below.

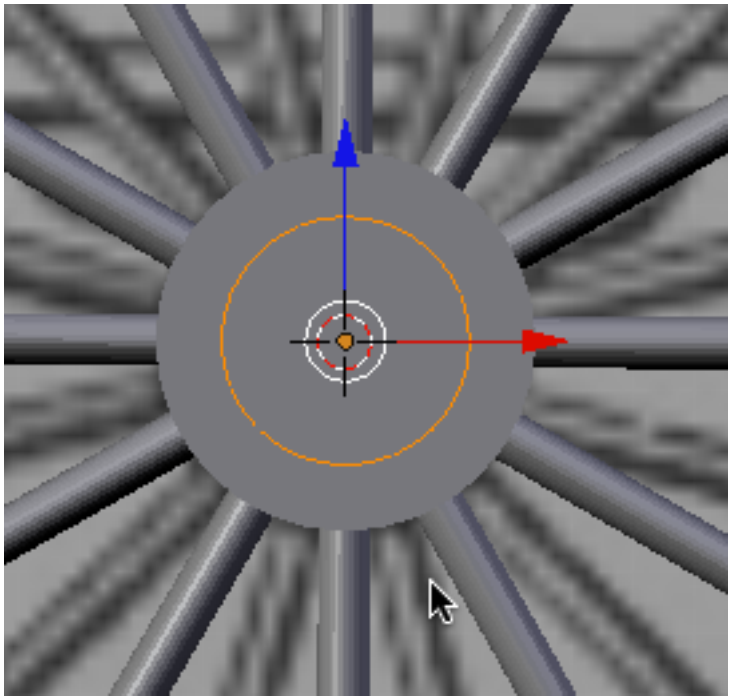



Name this object “Drive Train Empty”.

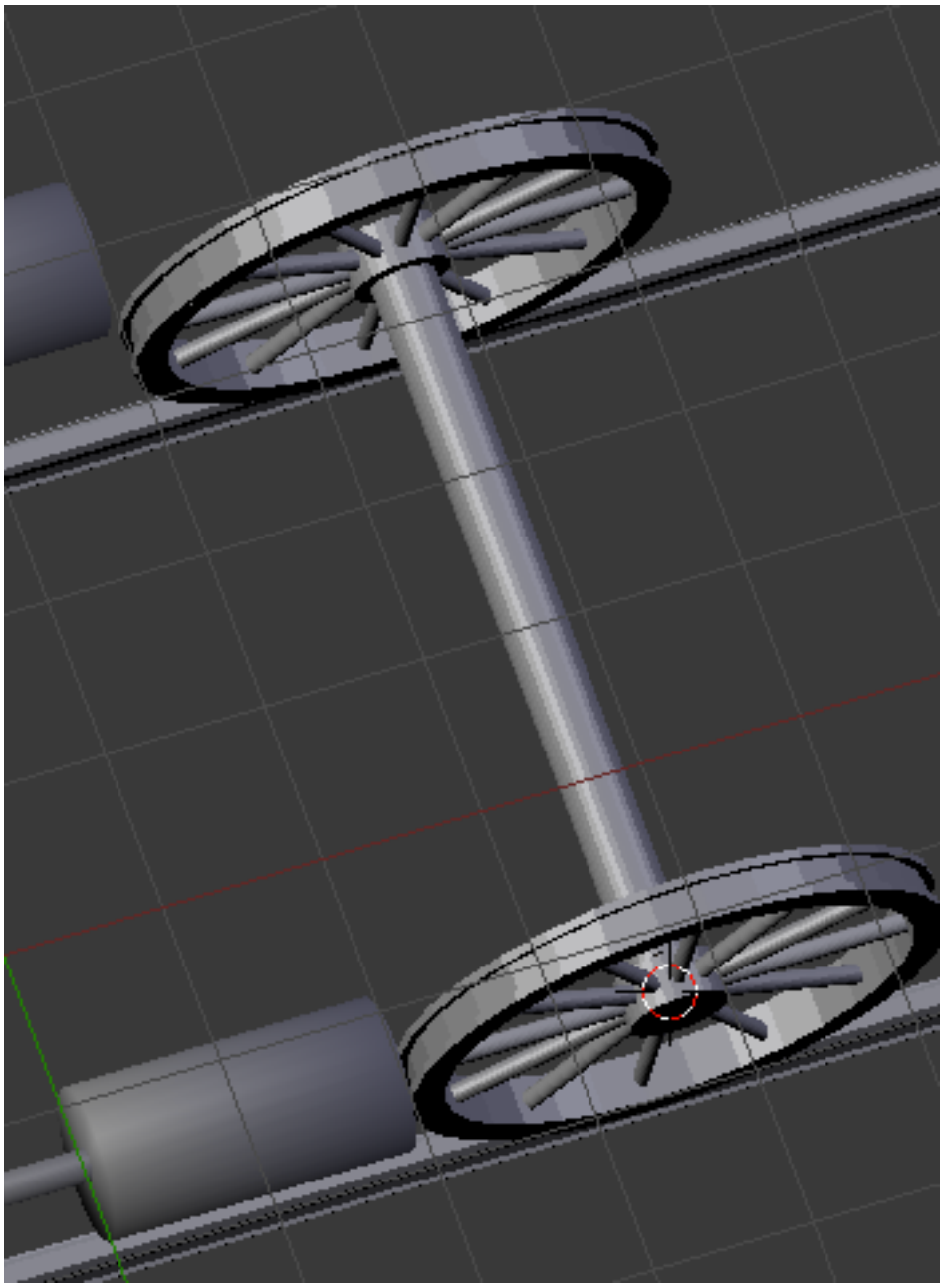
In top view, select the axel front object then add the drive chain empty object to the selection (it must be in this selection order). Press CTRL-P and parent the axel front object to the drive chain empty object.

Now the drive chain empty object controls the whole drive chain. It will be easier to select this later when we animate than the axel front object.

Go to front view and select the wheel rear left object.  Press SHIFT-S and snap your cursor to the selected. Press SHIFT-A and add a (capped) tube object. Set the X rotation to 90 degrees.  Scale the tube down as shown below.



Go to top view and place and extend the tube object to form the rear axel as we did the front axel.  Name this object “Axel Rear”.



Select the axel rear object and press SGIFT-CTRL-ALT-C and set the origin to the geometry.

Select the wheel rear left object and then add the wheel rear right object to the selection and then add the axel rear object to the selection (it must be in that order).

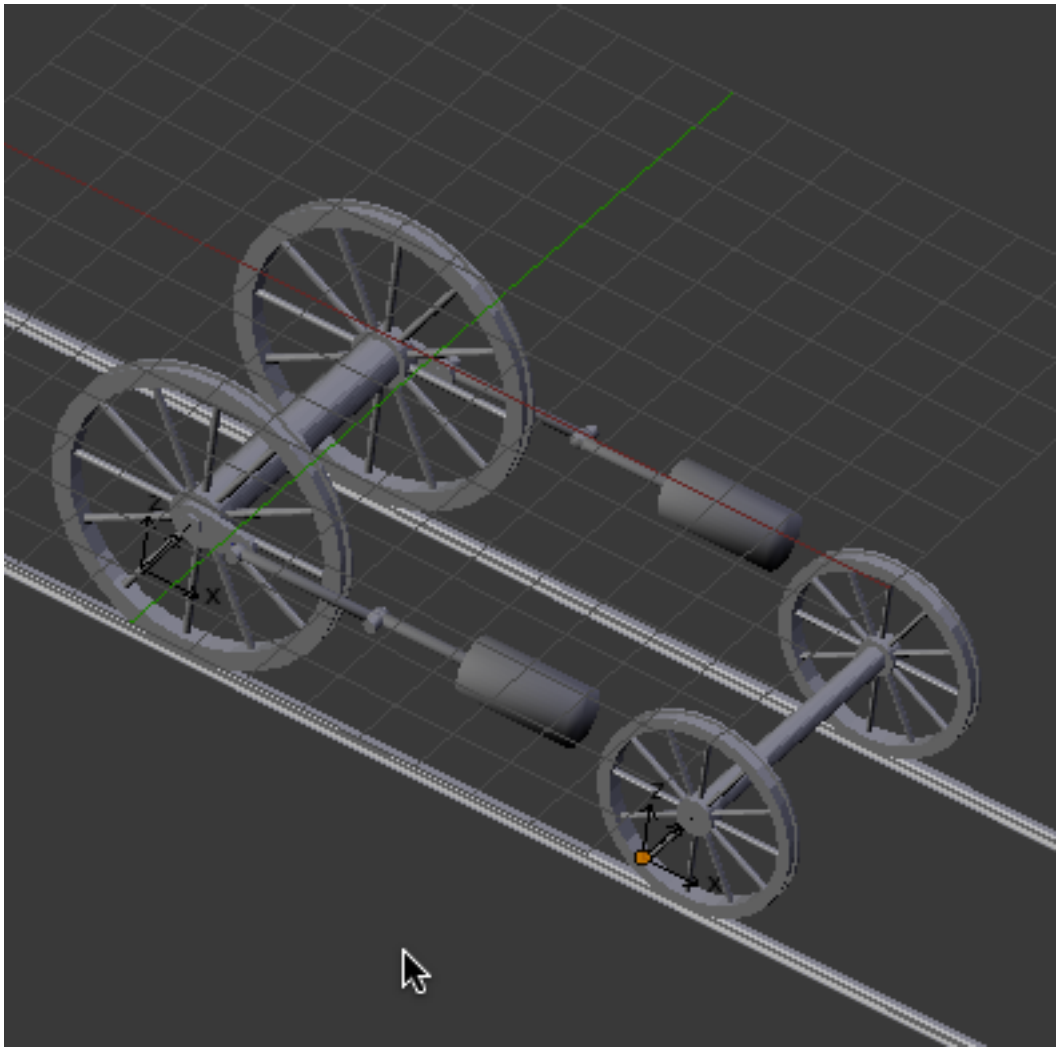
Press CTRL-P and make the axel rear object a parent of the rear wheel objects.

Now the Axel Rear object will control the rotation of the rear wheels.

Select the axel rear object and press SHIFT-S and snap your cursor to the selected object.

Add another empty object to the scene and move it just outside of the wheel left rear object. Name this “Wheel Empty” Make the axel rear object a child of the wheel empty object.

Now the wheel empty object will control the rotation of the rear wheels.

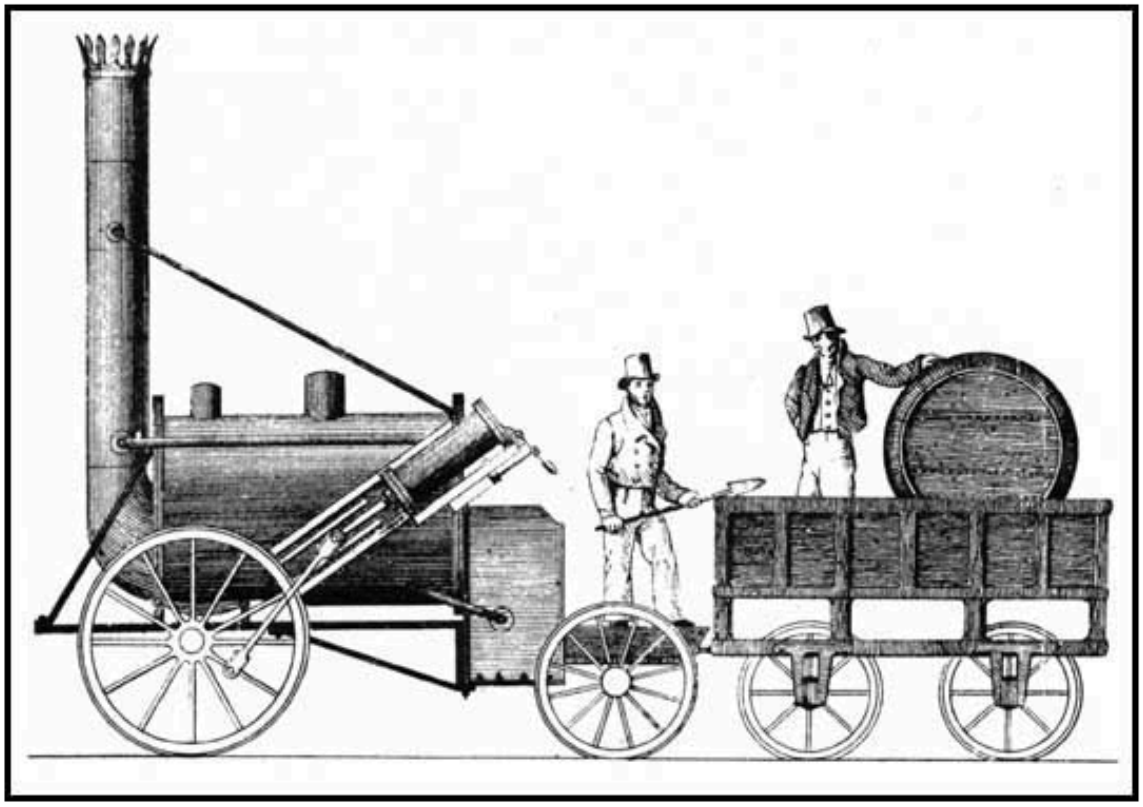


Selecting the Drive Chain Empty and pressing the RKEY followed by the YKEY operates the drive chain.

Selecting the Wheel Empty and pressing the RKEY followed by the YKEY operates the rotation of the rear wheels.

Save your Blender file.

The model will include a second car that carries the engine coke and a water barrel.



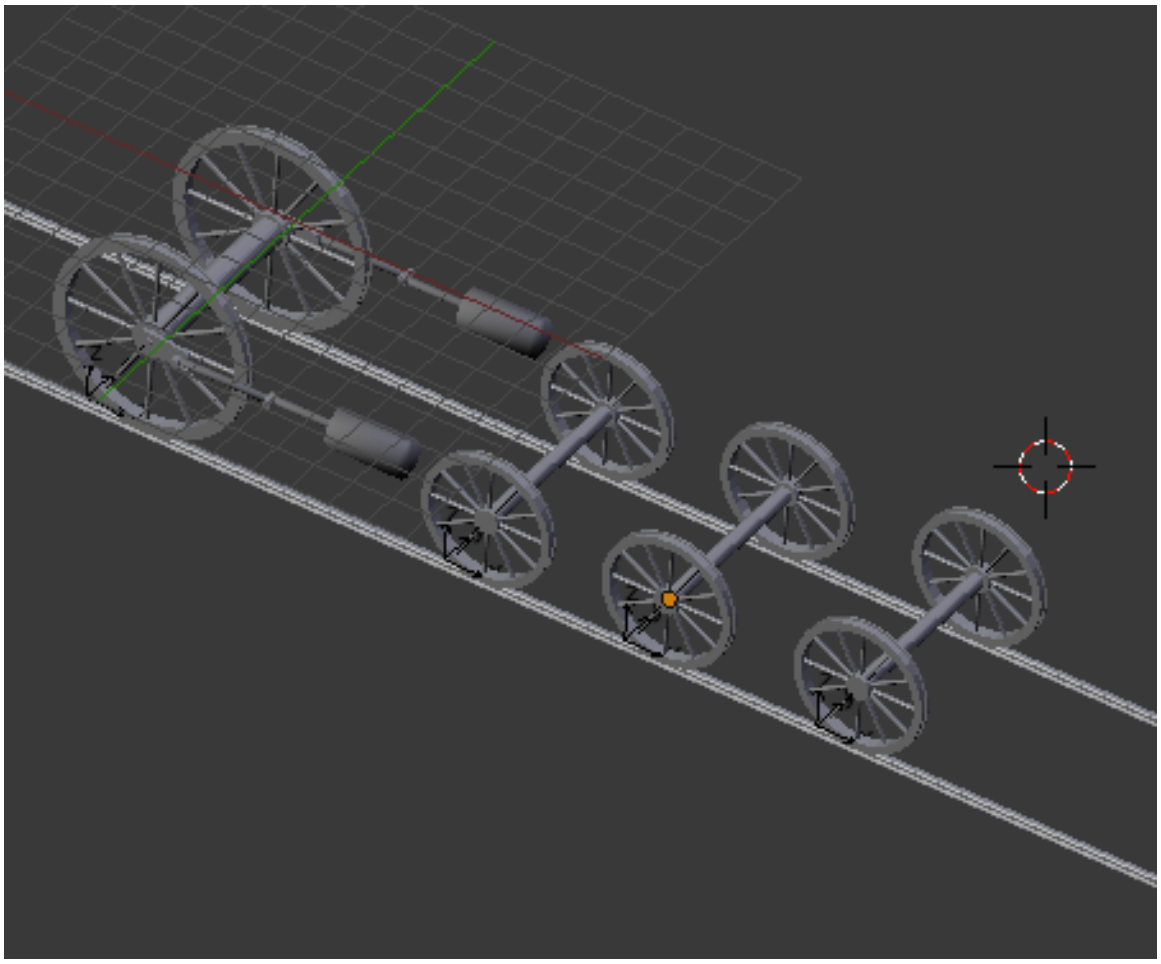
Go to top view. Select the wheel rear left object and add to the selection the wheel rear right, axel rear and wheel empty object to the selection. Press SHIFT-D followed by the XKEY followed by 4.7 then press ENTER.

This will create a duplicate set of wheels/axel/empty and place it 4.7 Blender units along the X-axis.

With the duplicate wheels/axel/empty still selected, press SHIFT-D followed by the XKEY followed by 5 then press ENTER.

This will create another duplicate set of wheels/axel/empty and place it 5 Blender units along the X-axis.

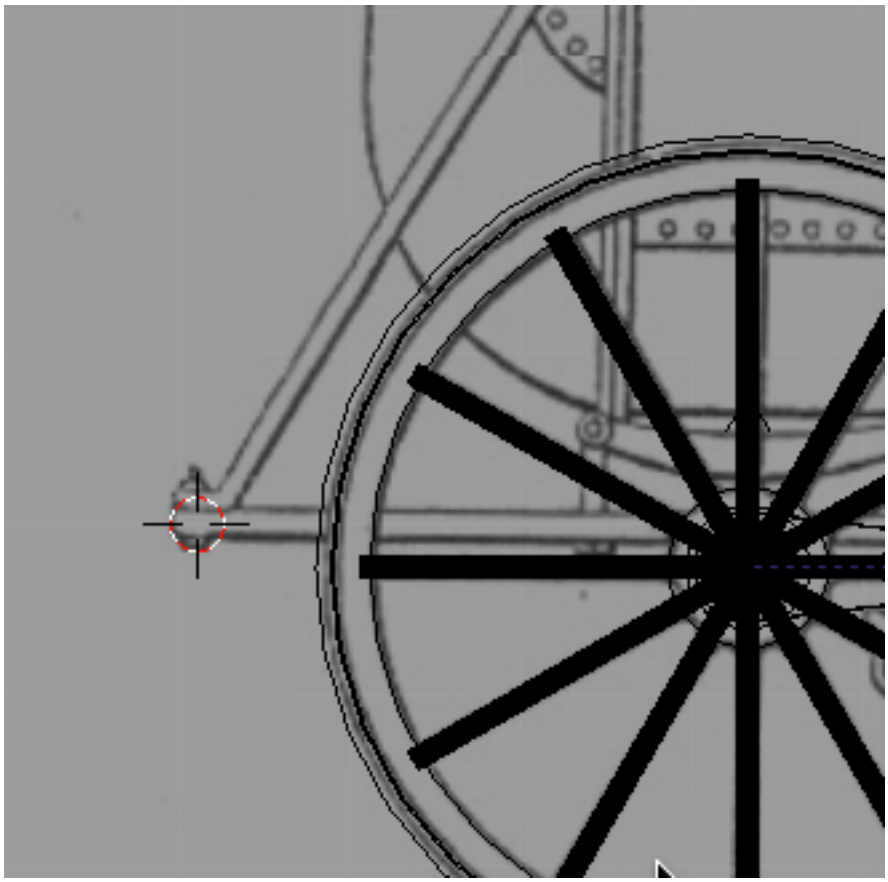
We can accept all of the Blender created object names (.001 and .002).



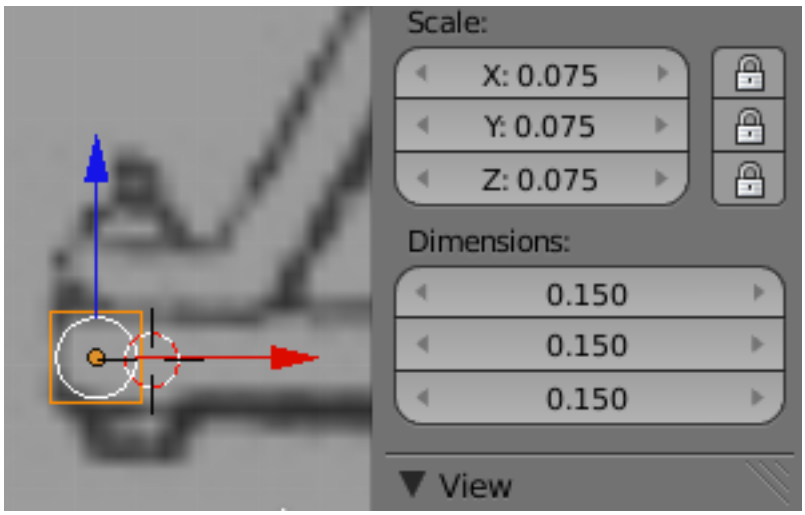
We will next model a frame to hold the wheel and upper components.

Go to front view.  Place your cursor at X, Y, Z = 0 (in the 3d editor properties panel)

Now place your cursor in the center of the very front frame member as shown below.

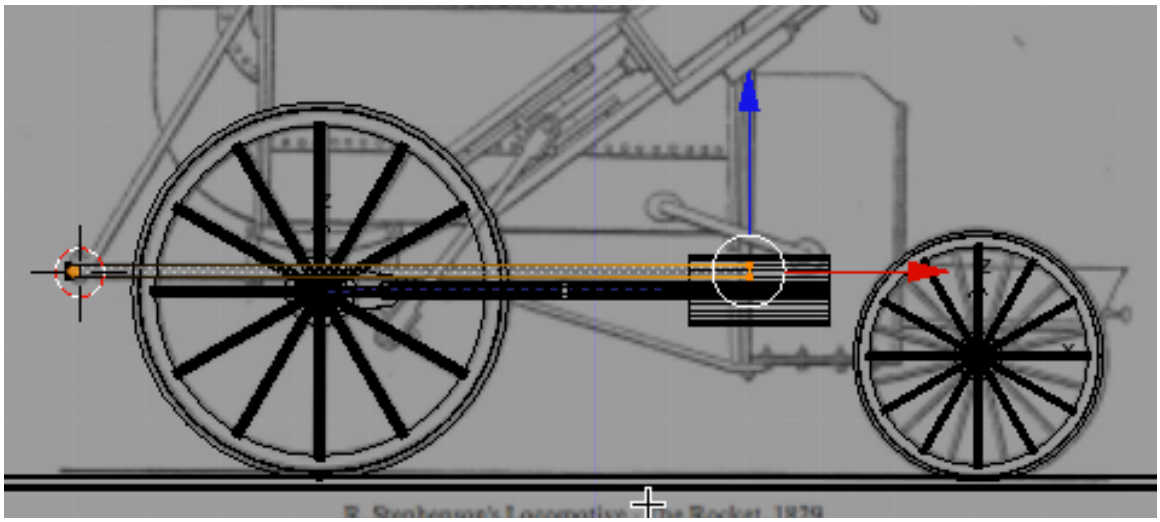


Press SHIFT-A and add a cube object. Set the dimensions for the cube object to .15 x .15 x .15  Move the cube to the far left of the frame as shown below.

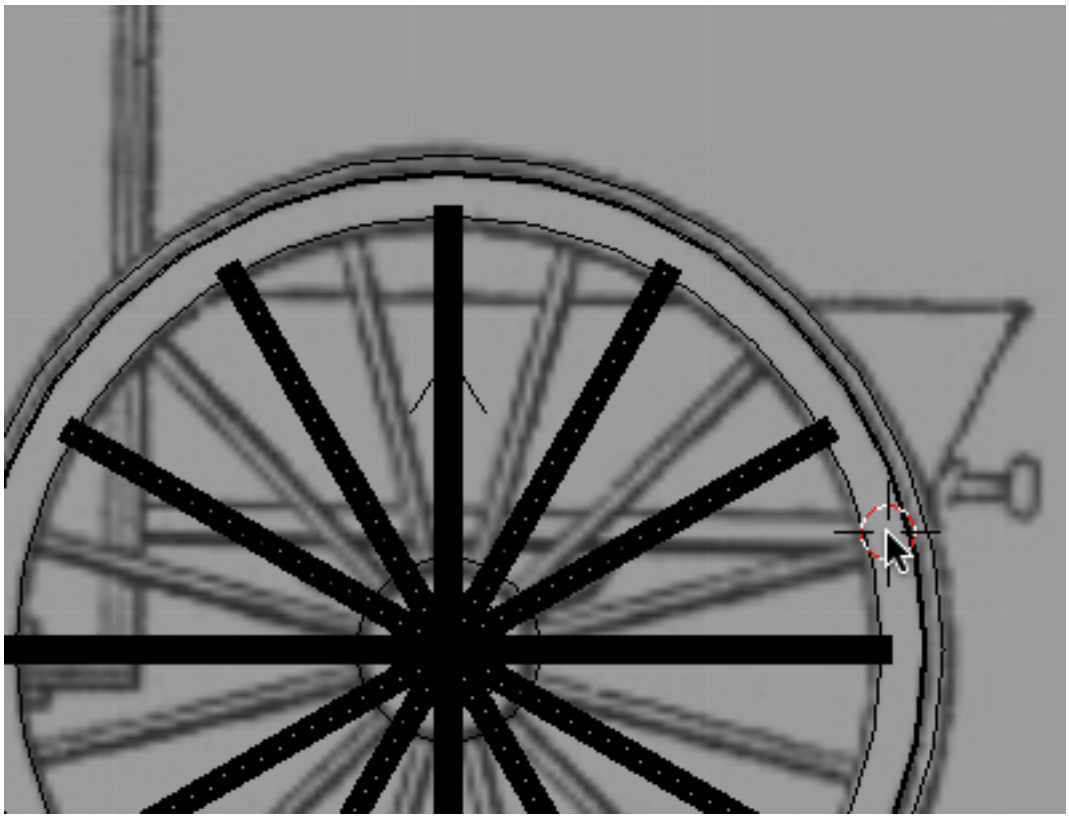



TAB into edit mode.  --  Deselect the vertices  -- Box select the right set of vertices. Use your translate widget to move the vertices along the X-axis to the far right of the engine frame as shown below.

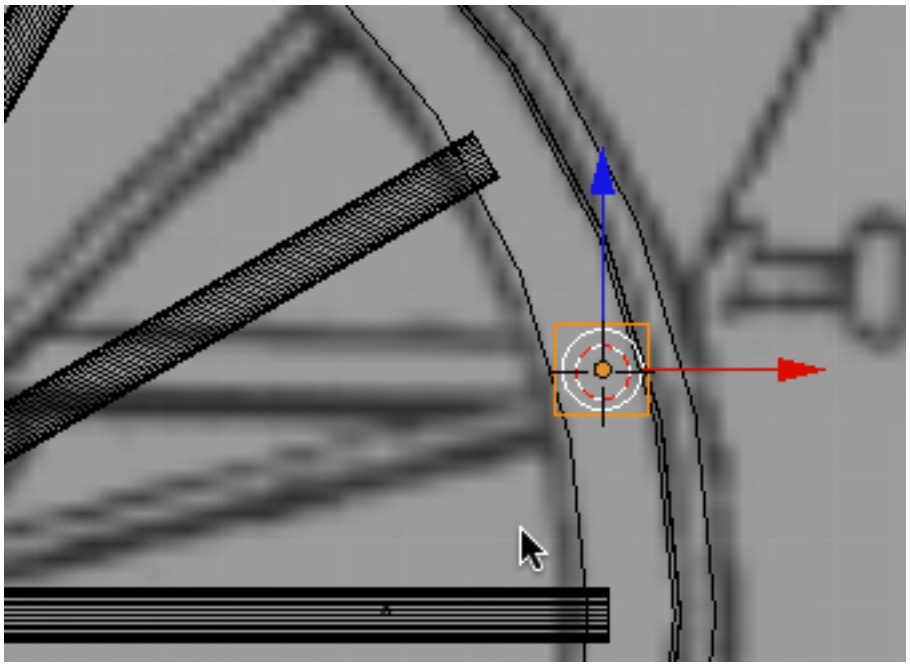
NOTE: If you are having difficulty moving things precisely, click on the translate arrow for the direction you want to move it, then hold your SHIFT key down and move your mouse. The movement will be constrained.



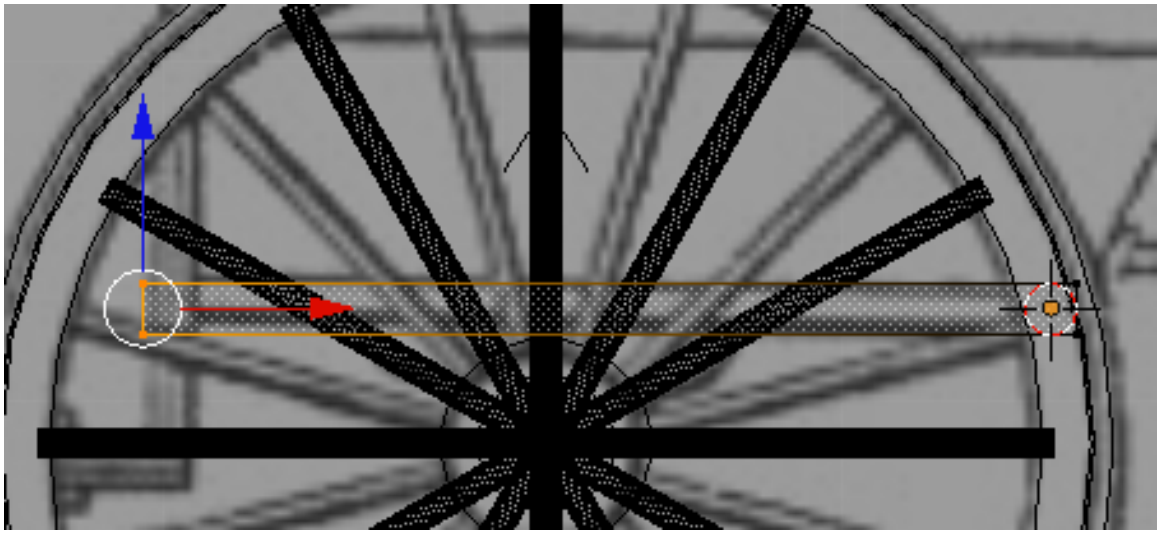
Deselect the vertices. – TAB out of edit mode – Now place your 3D cursor in the center of the frame at the back of the engine as shown below.



Press SHIFT-A and add a cube object. Set the dimensions for the cube object to .15 x .15 x .15  Move the cube to the far left of the frame as shown below.

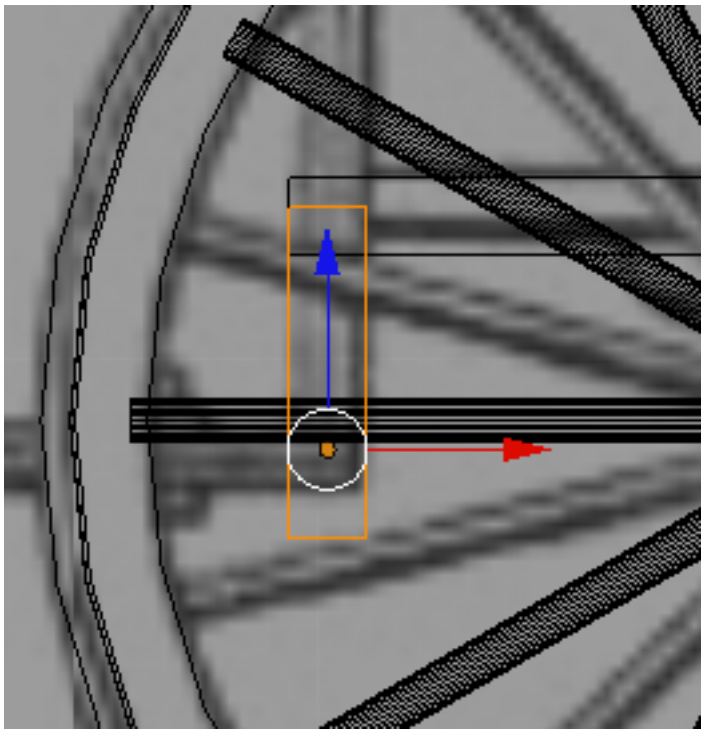


TAB into edit mode.  --  Deselect the vertices  -- Box select the right set of vertices. Use your translate widget to move the vertices along the X-axis to the left as shown below.

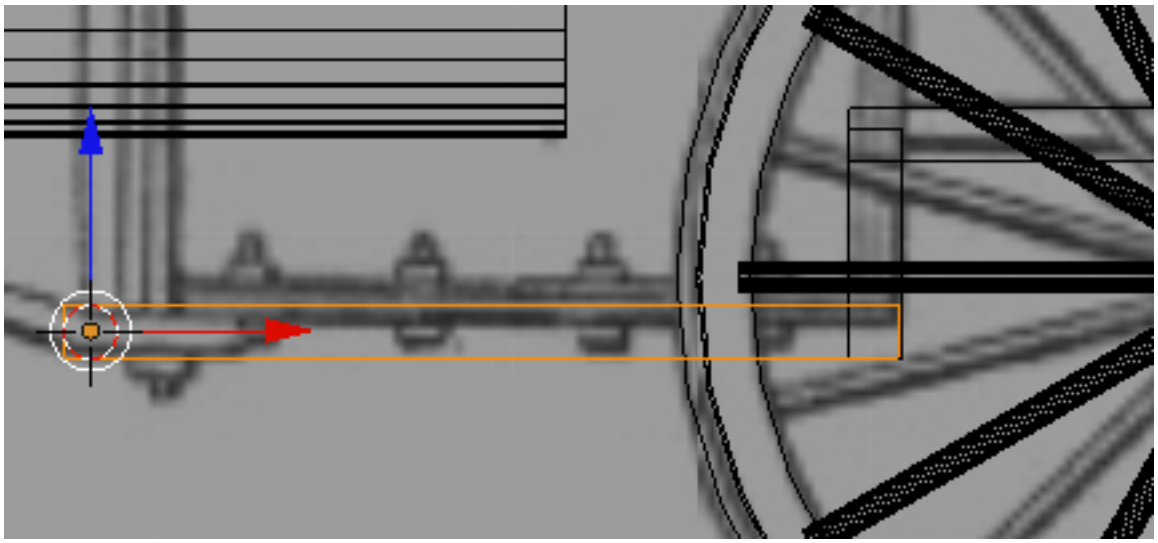


Deselect the vertices.  – TAB out of edit mode

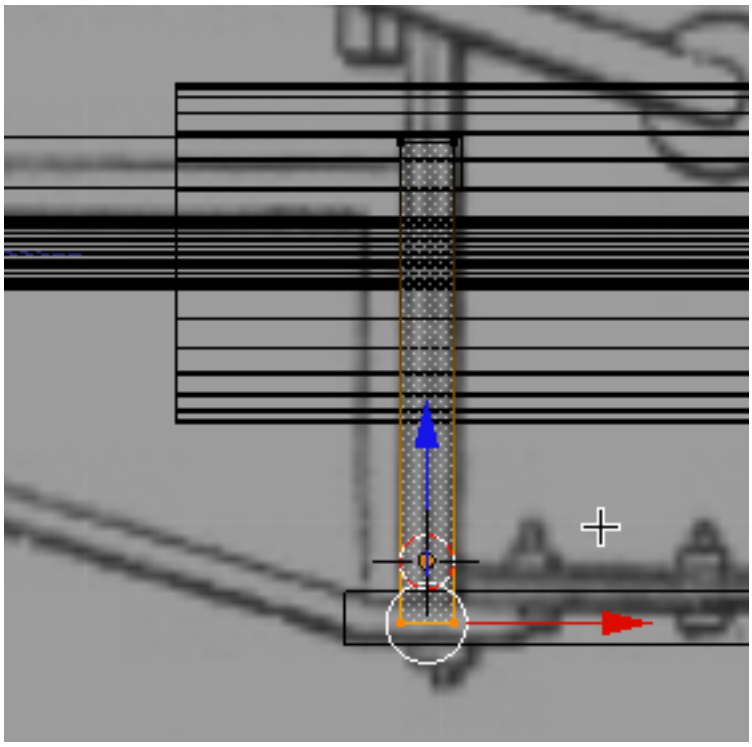
Make another frame member here.



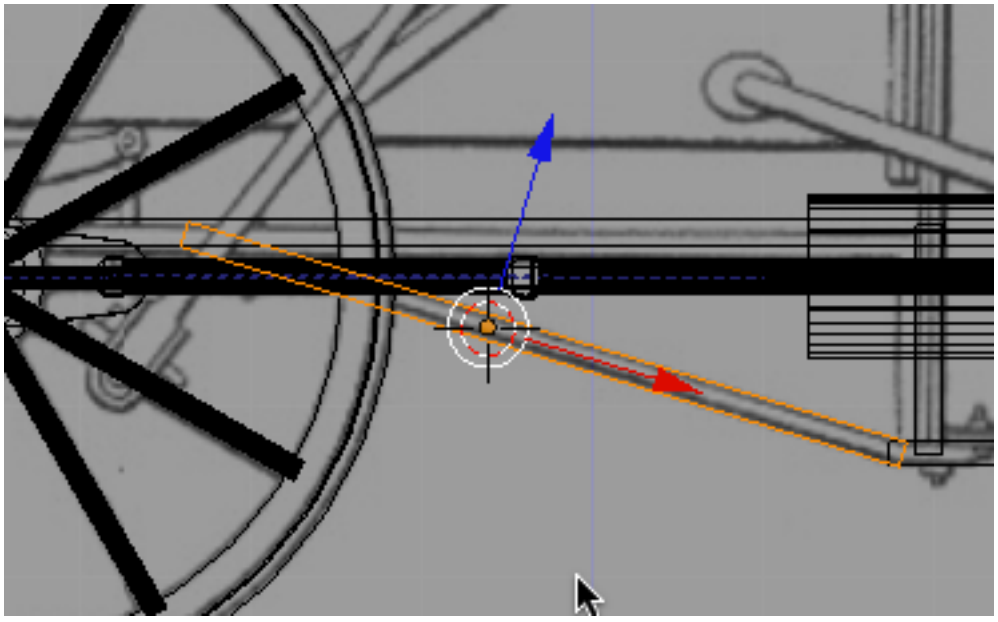
Make another frame member here.



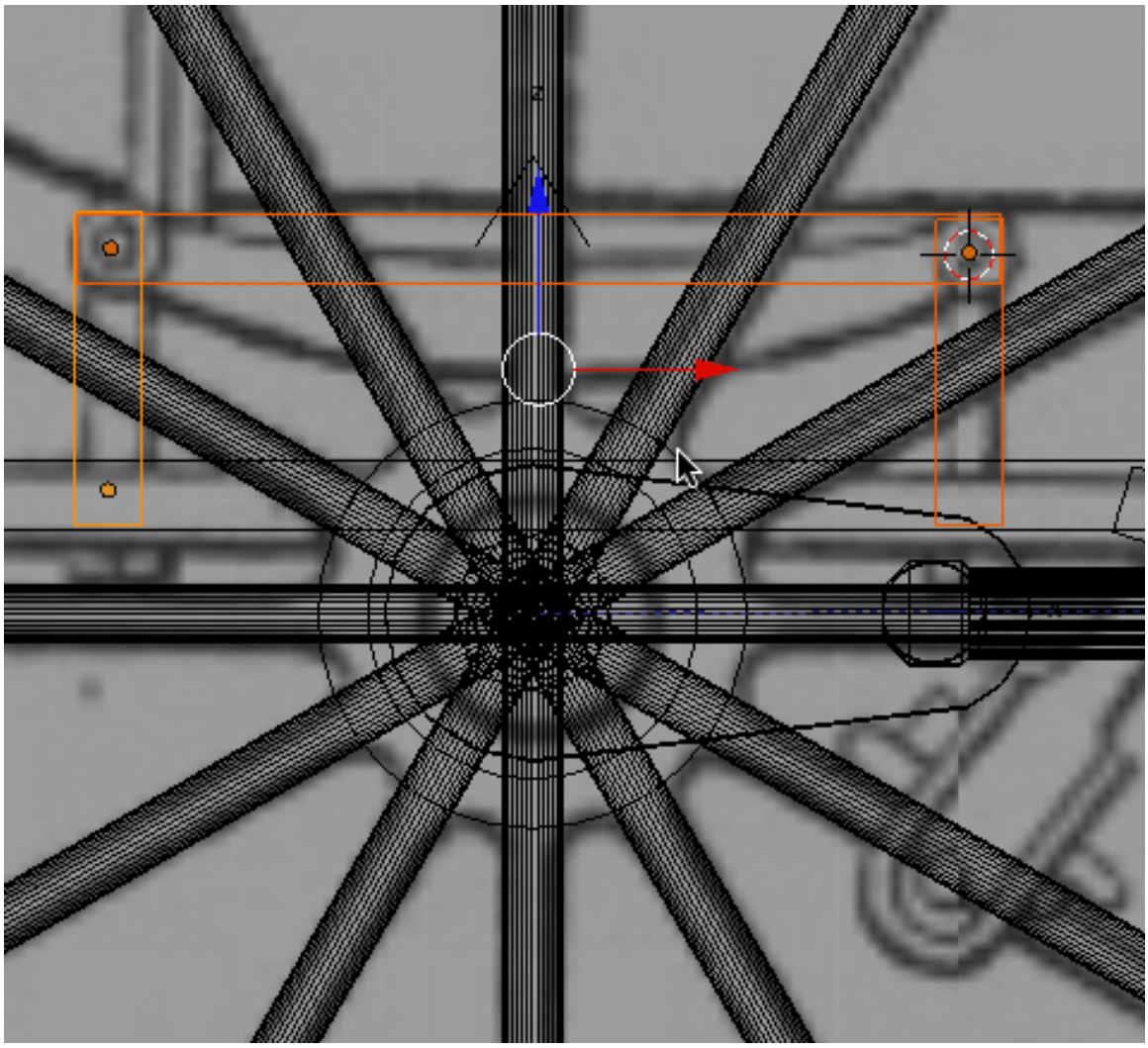
Make another frame member here.



Make another frame member here.

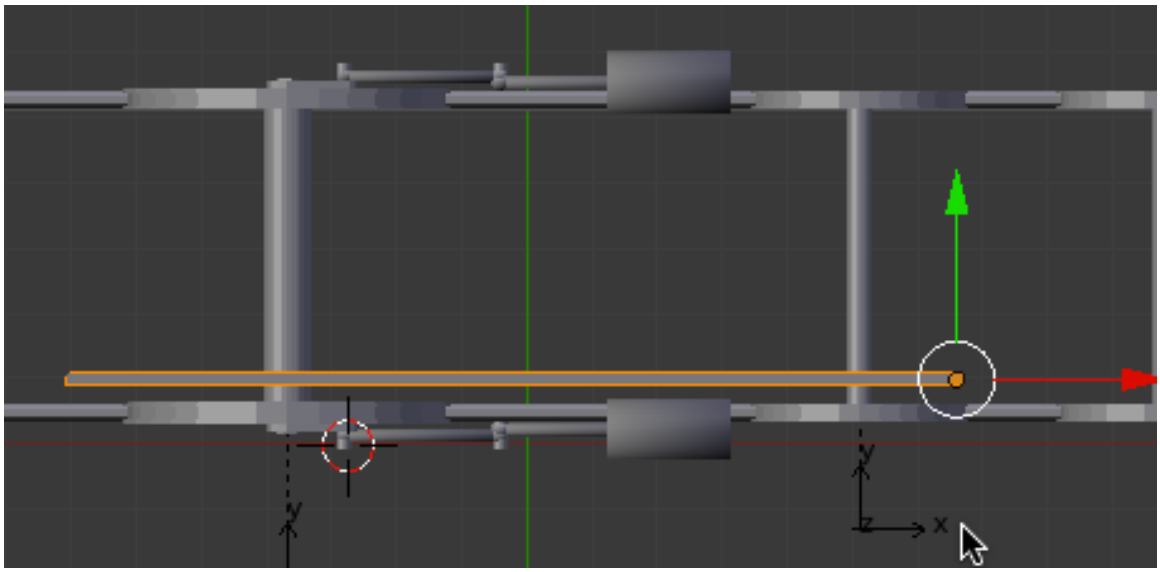


And 3 more frame members above the front wheel here.



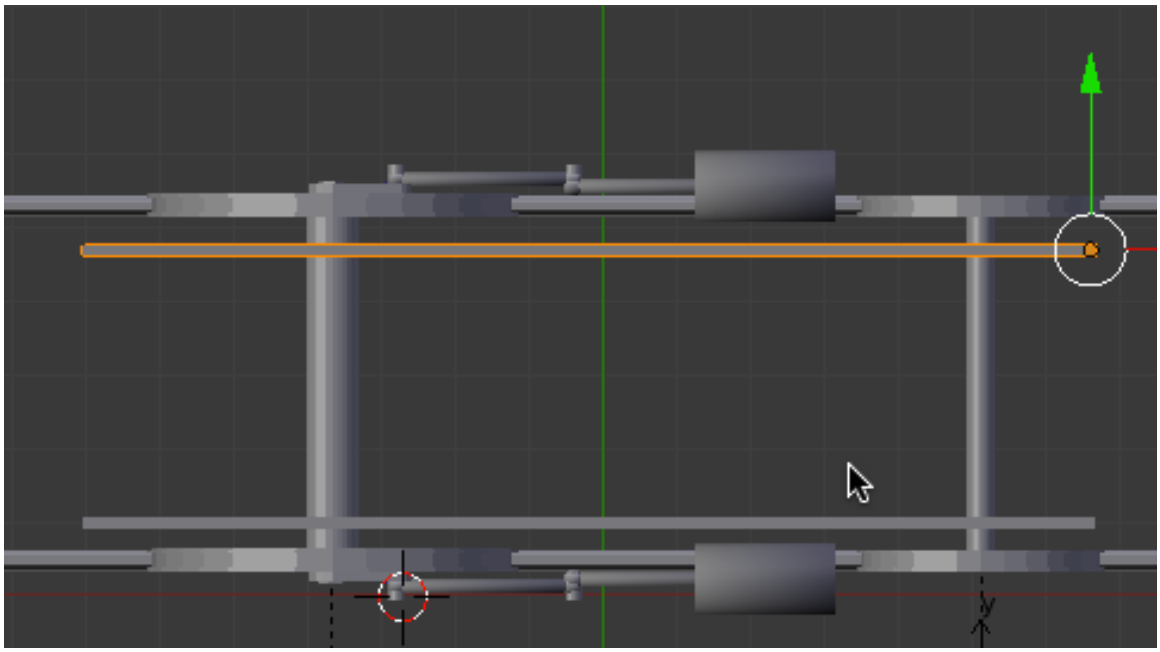
Select all 9 frame pieces and press CTRL-J and join them into one object. Go to top view.

Move the frame up along the Y-axis to a position as shown below.

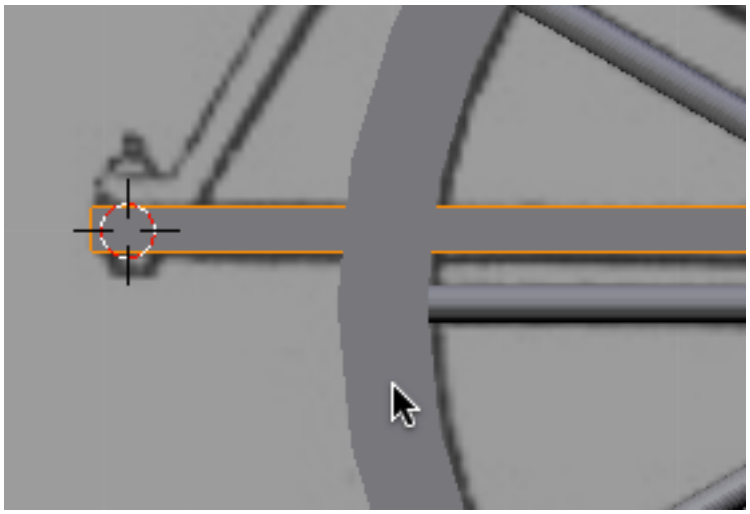


Rotate your view to a more dimensional view. Move the frame up along the Z-axis so it is above the front wheel axel as shown below.

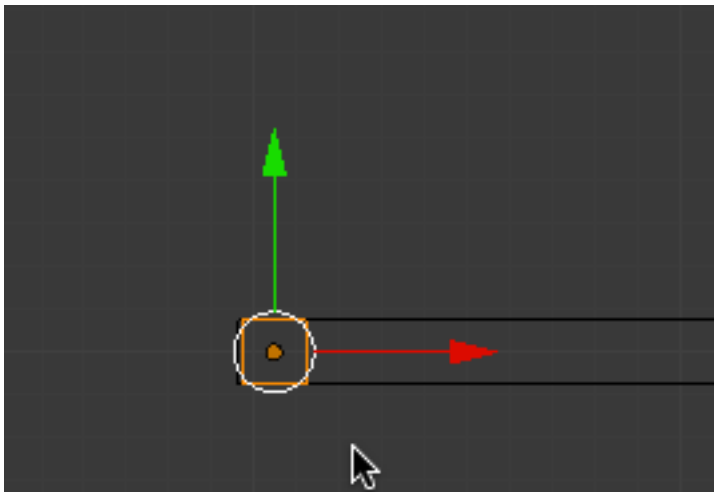
Go to top view. With the engine frame selected press SHIFT-D  the YKEY and make a duplicate frame and place it up along the Y-axis as shown below.



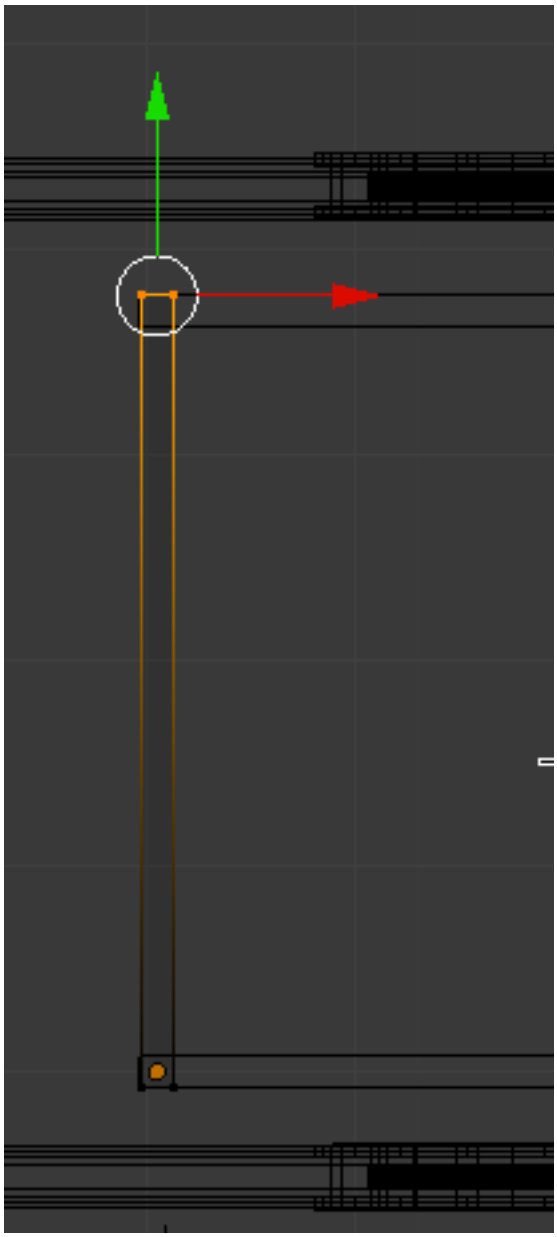
Go to front view. Place your cursor on the frame in the front of the engine as shown below.



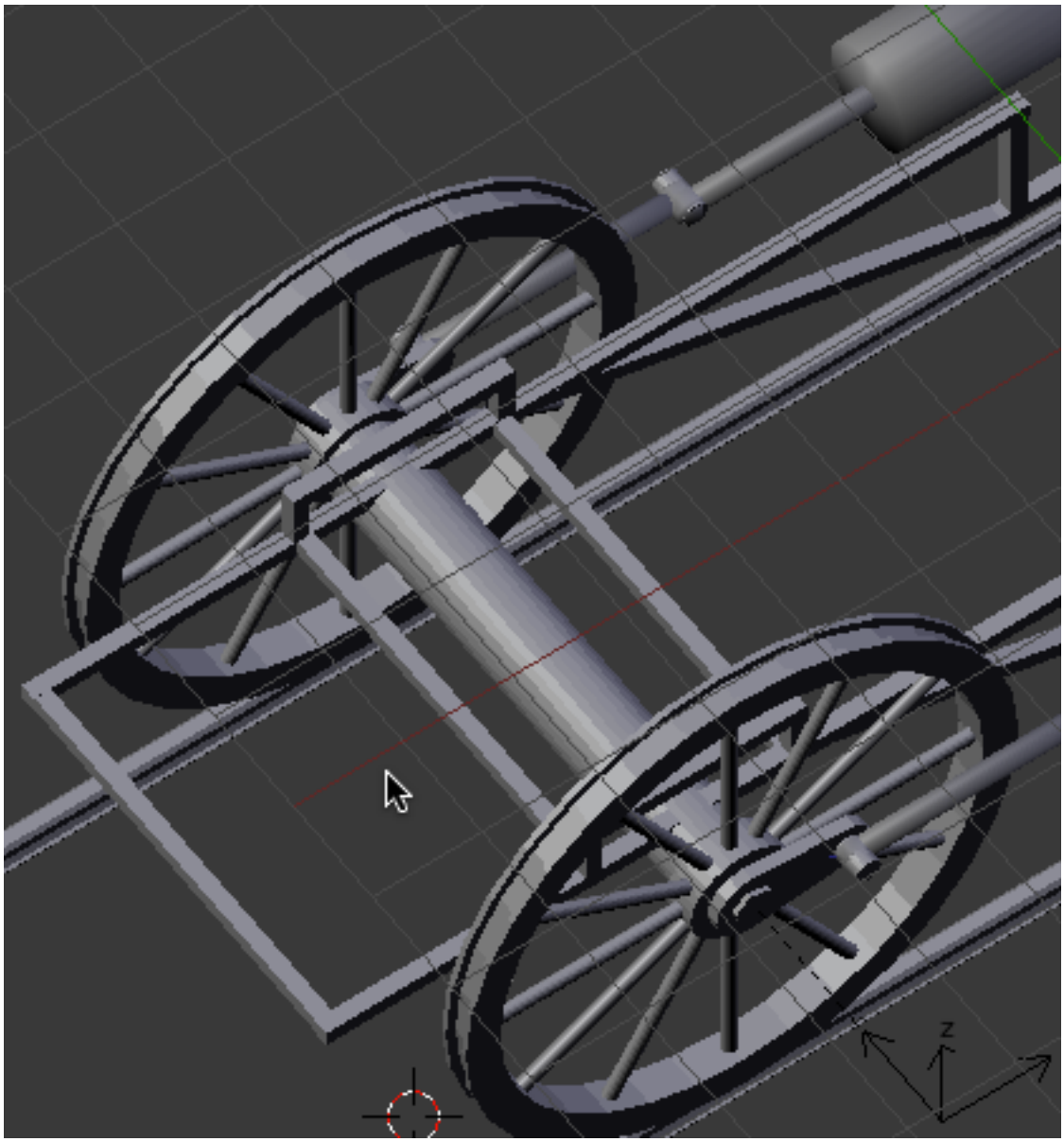
Press SHIFT-A and add a cube object. Set the dimensions for the cube object to .15 x .15 x .15  Go to top view. Place the cube at the end of the frame piece as shown below.



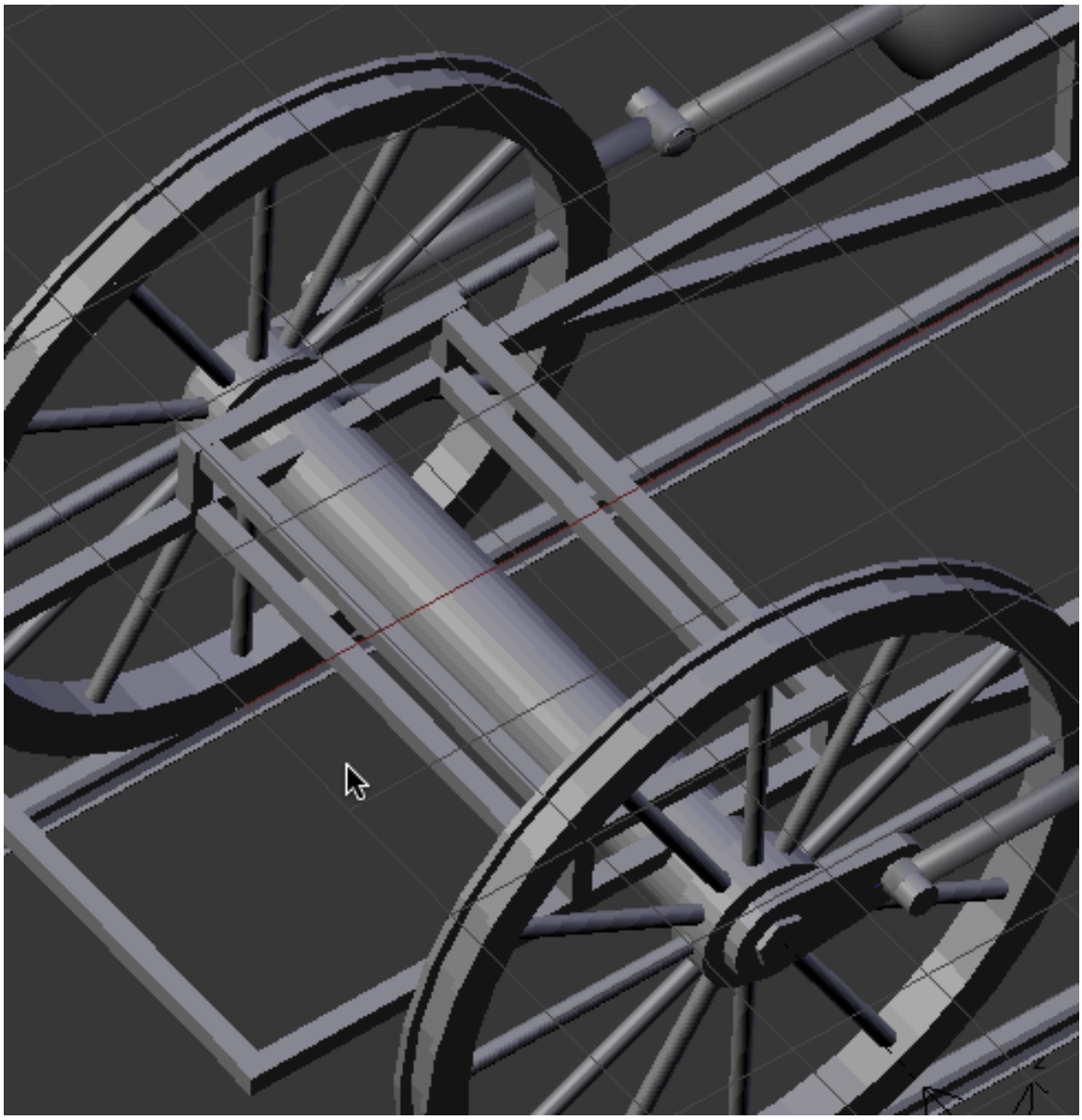
TAB into edit mode.  Deselect the vertices. Box select the top end vertices and move them to the other frame member as shown below.



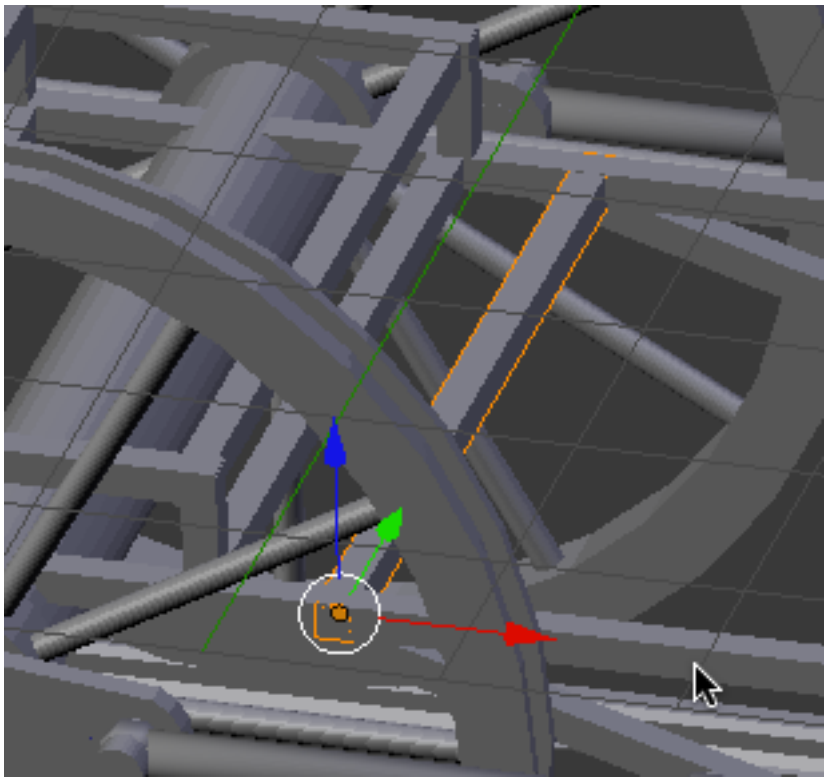
Deselect the vertices. Tab out of edit mode. Make 2 duplicates and place them along the X-axis as shown below.



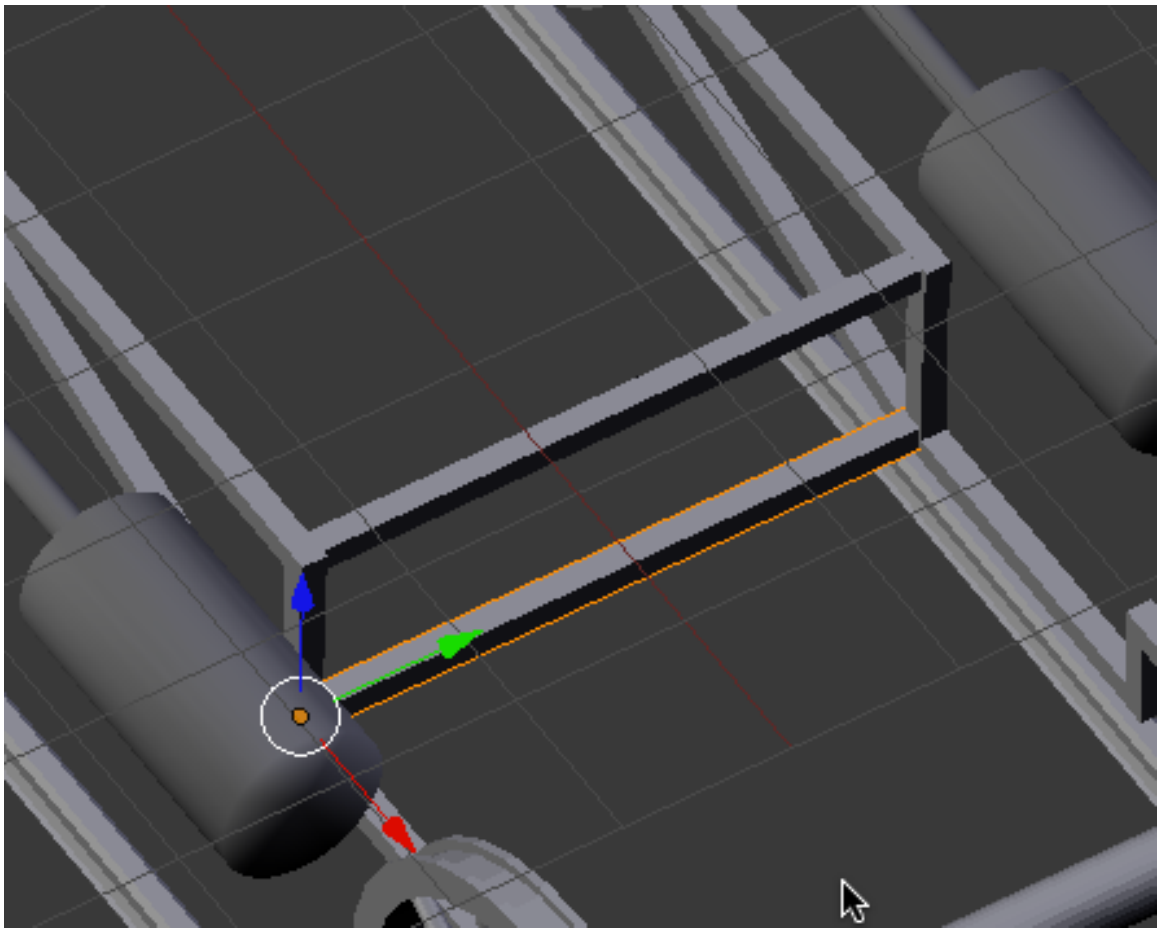

Make a duplicate of each of these new frame members and place them up along the Z-axis as shown below.



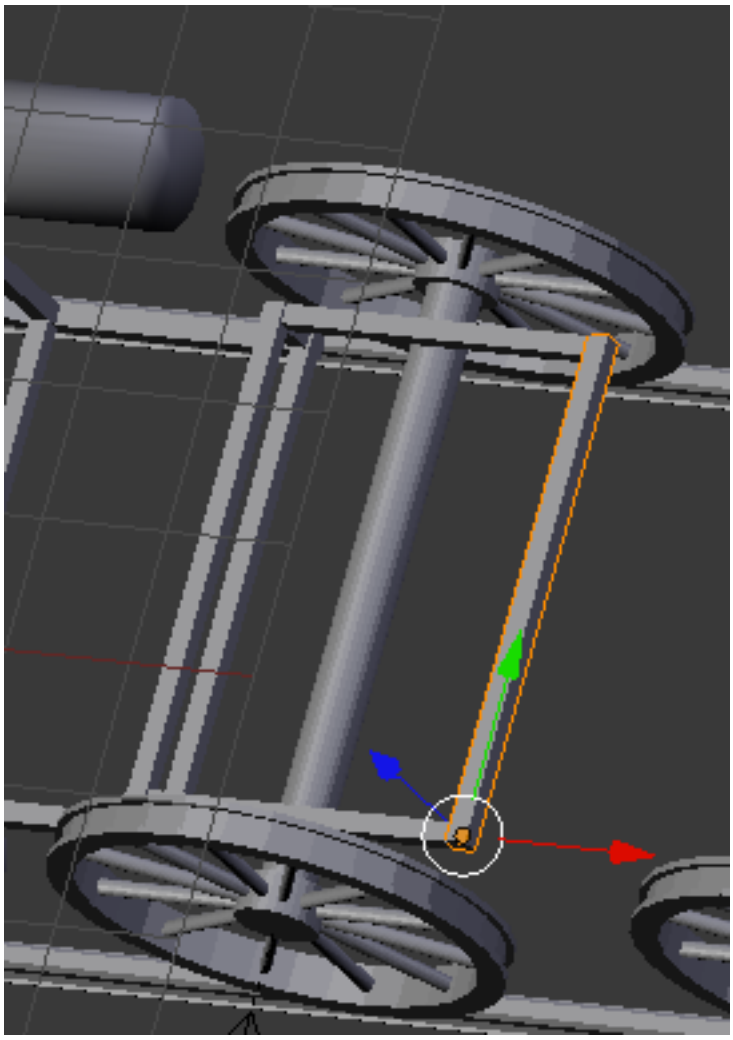
Make another duplicate of the bottom cross frame member and place it here.



Put another 2 frame members here.

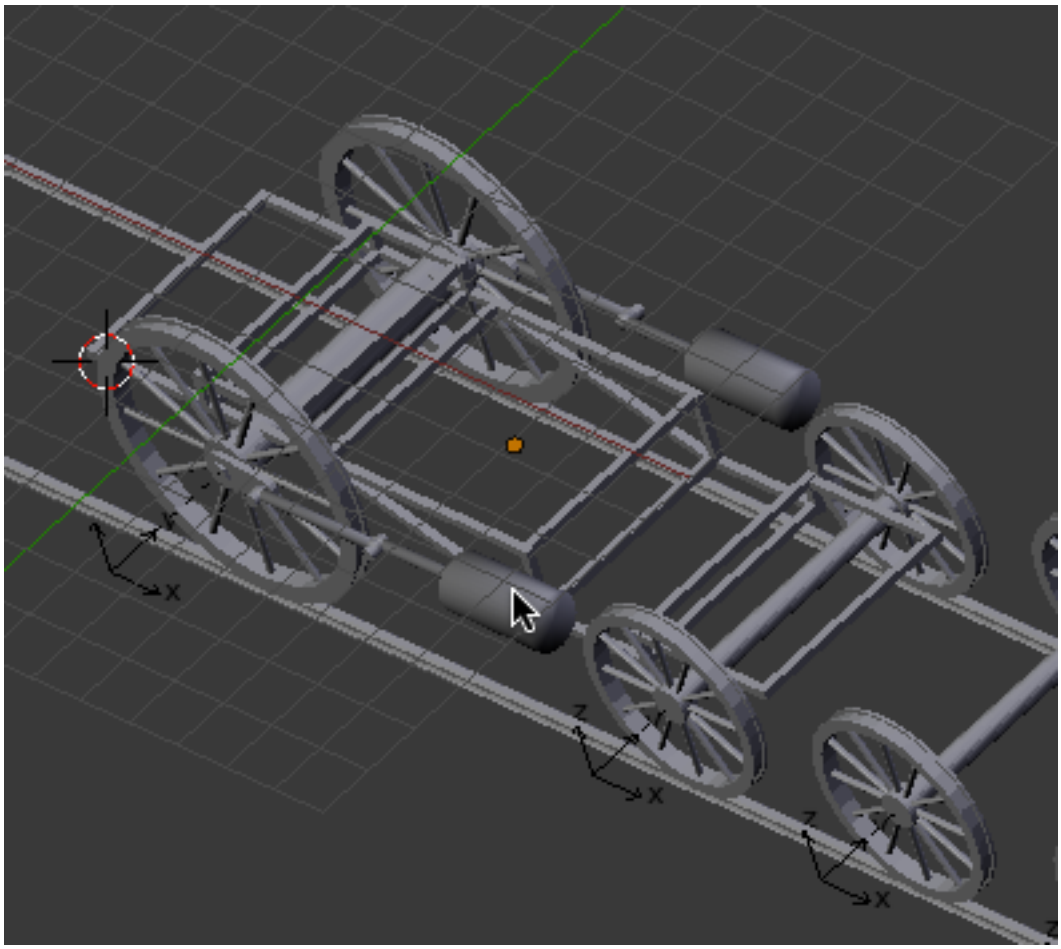


And place another 3 duplicate here.



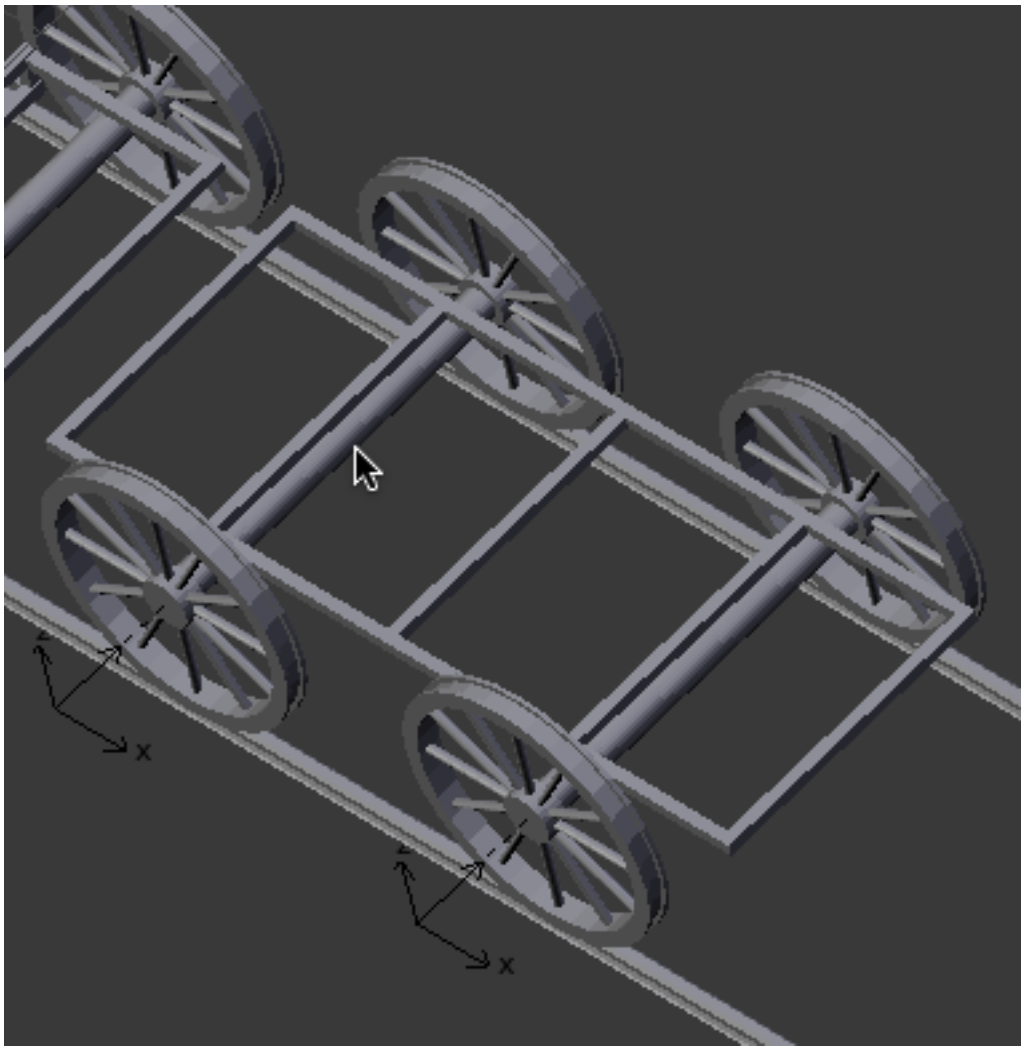
Select all 9 new cross member frame pieces and the duplicate side frame member and the original side frame member and press CTRL-J and join them into one object named Engine Frame.

With the engine frame object selected press SHIFT-CTRL-ALT-C and select origin to geometry.

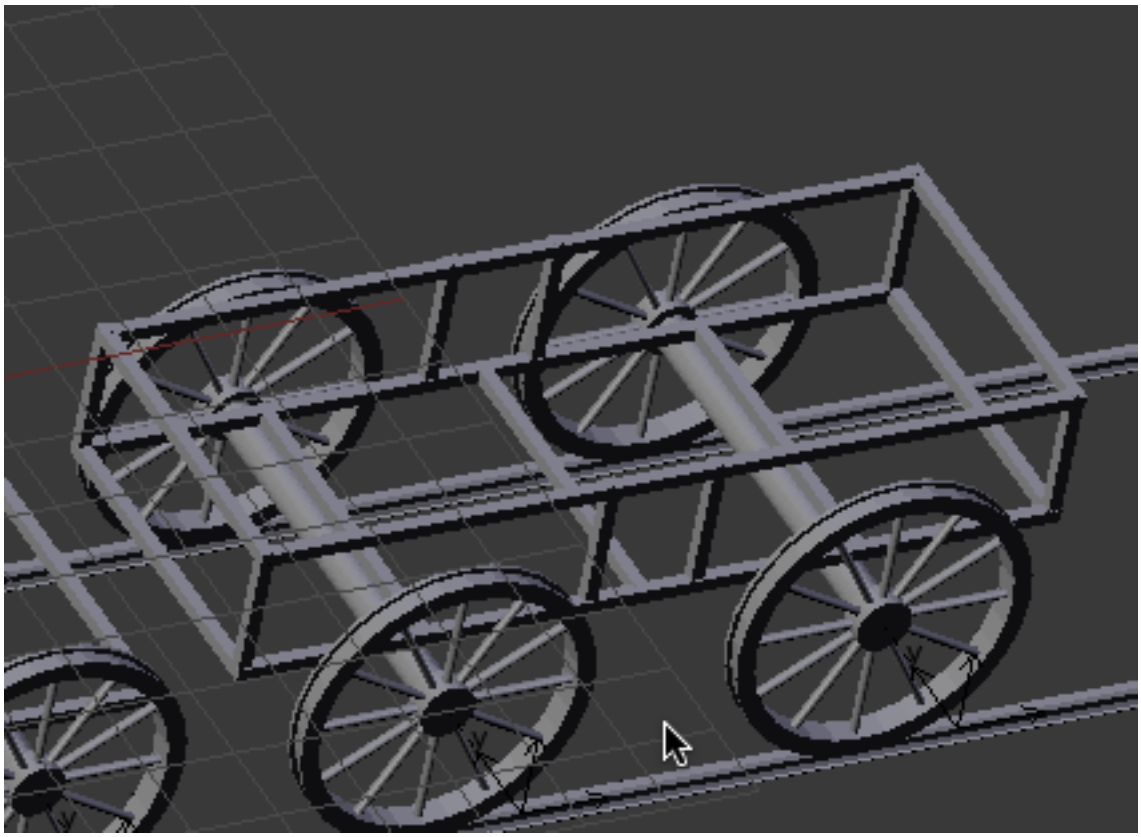


Save your Blender file.

Model another frame for the second train car as shown below. The frame is at the same height as the back end of the engine frame.




Now add some upright frame members and top frame member to make it look something like this.



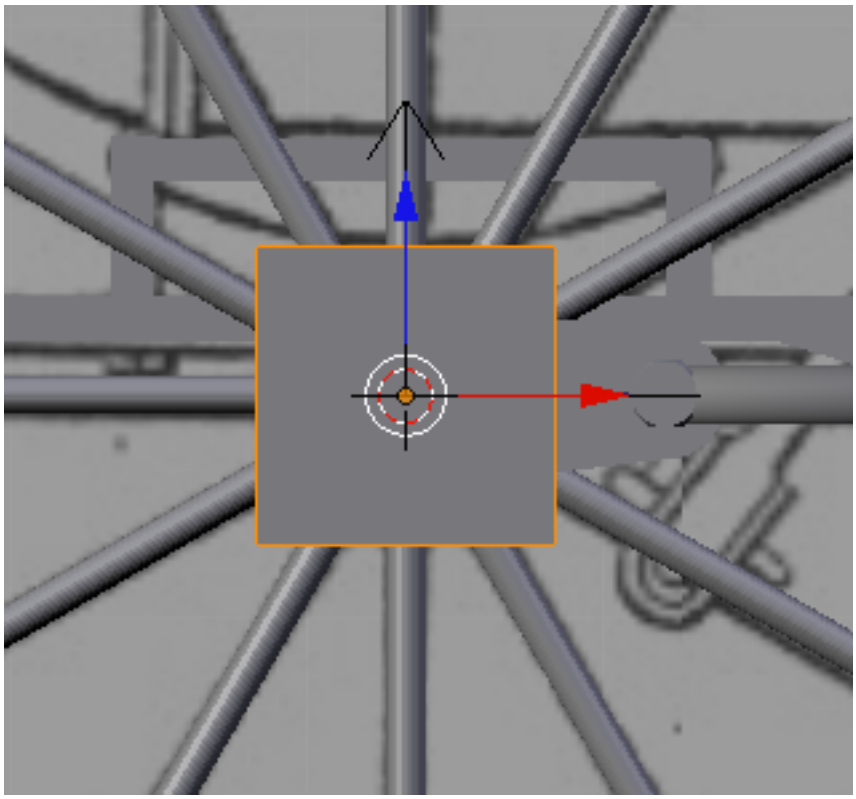
Select all of the framing pieces for the car and press CTRL-J and make them one object named Car Frame.

With the car frame object selected, press SHIFT-CTRL-ALT-C and select origin to geometry.

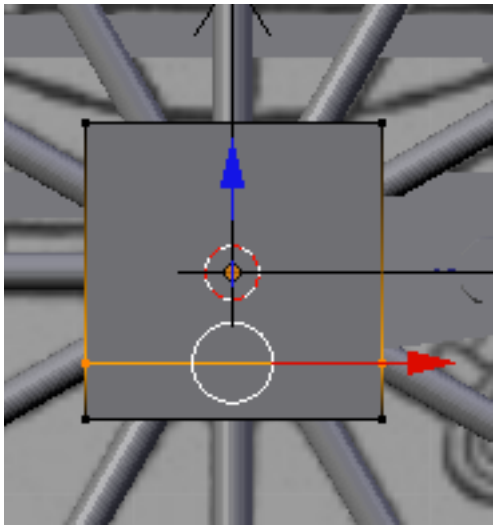
Save your Blender file.

We now will add some wheel bushings to support the axels. Go to front view. Select the wheel front left object and press SHIFT-S and snap your cursor to the selected object.

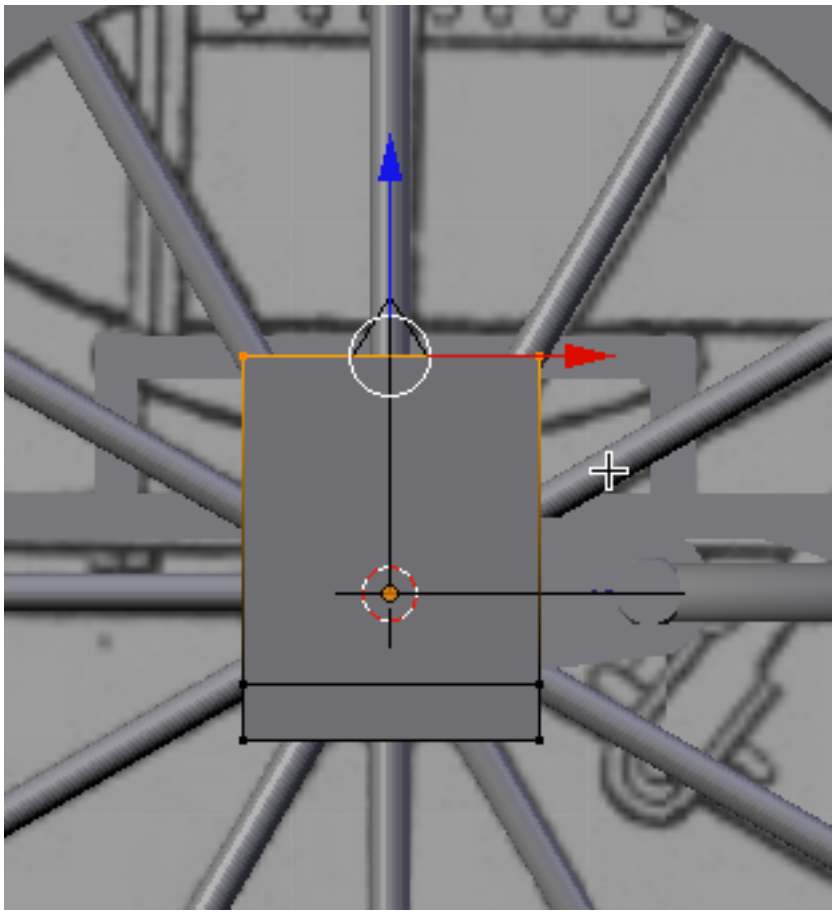
Press SHIFT-A and add a (capped) cube object. Scale down the cube to a little larger than the hub of the wheel as shown below.



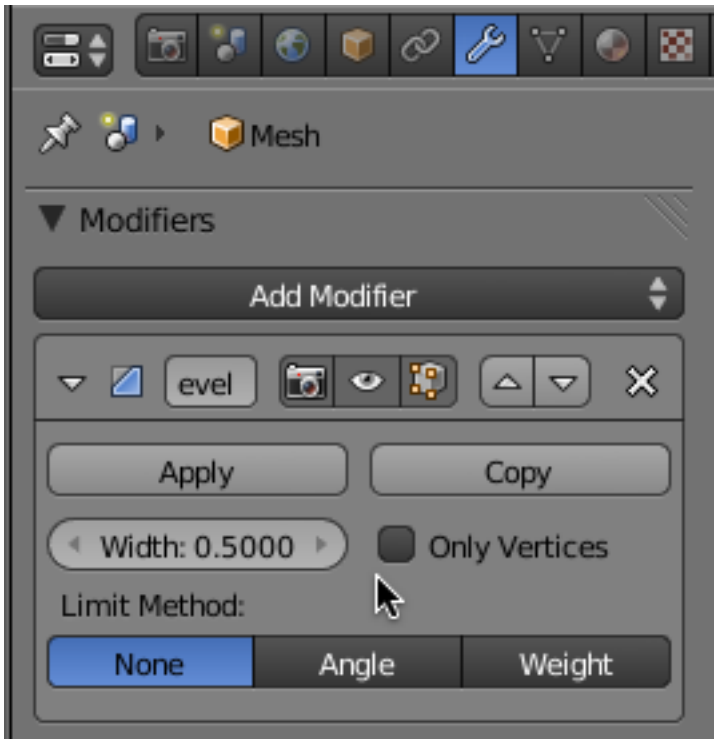
TAB into edit mode. With all the vertices selected, press the Loop Cut and Slide button located in the 3D editor viewport tool panel. Move your mouse around in the cube until you see a horizontal loop cut. Left click and slide the loop down as shown below.



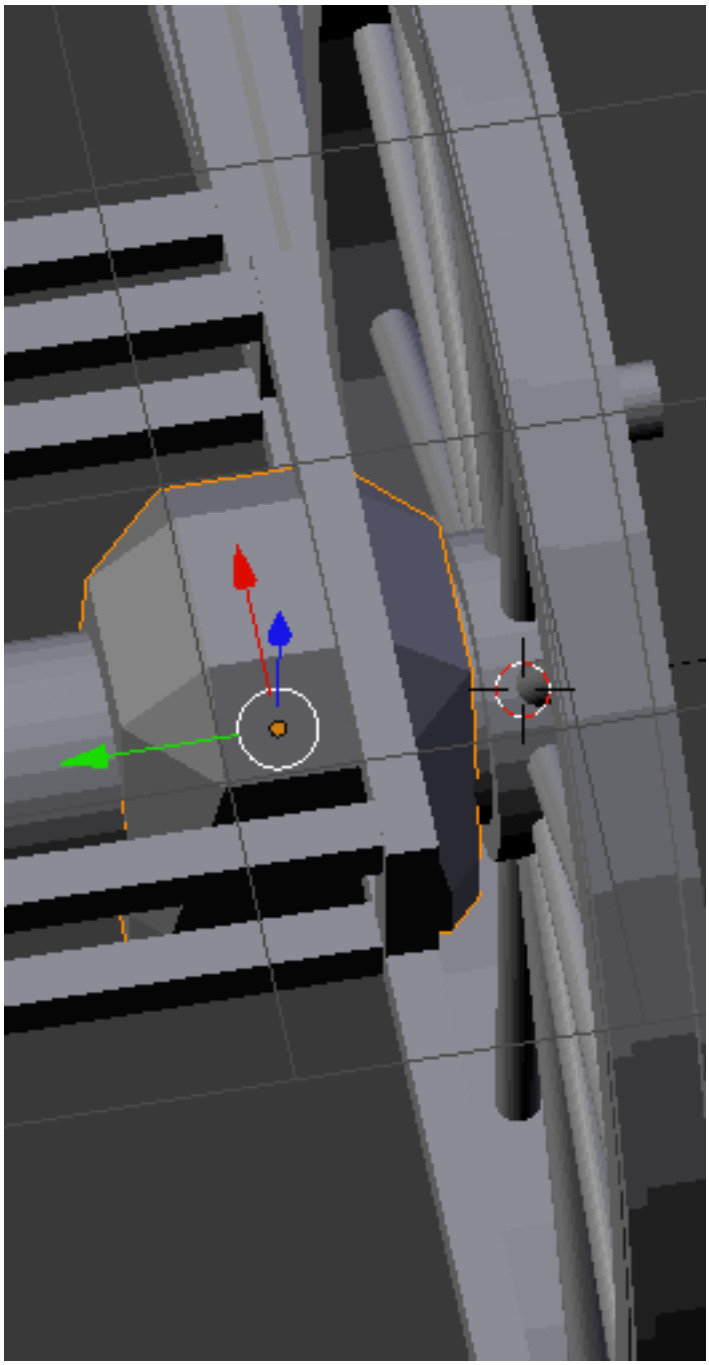
Deselect the vertices. Box select the top vertices and move them up into the frame as shown below.



TAB out of edit mode. Add a bevel modifier to the cube and set the width to .5

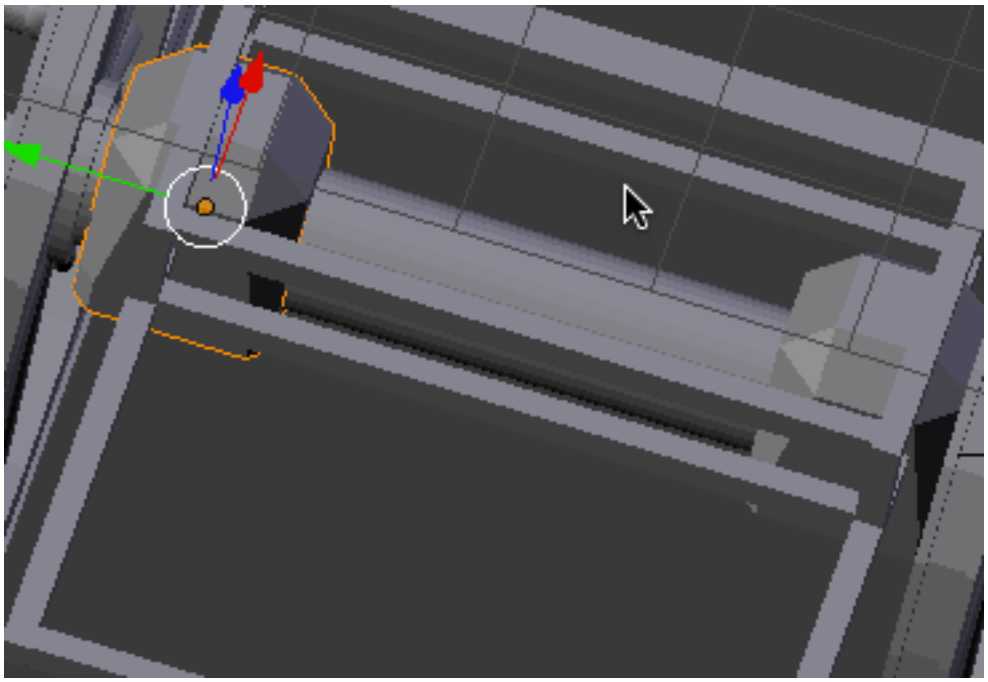



Rotate your view to a more dimensional view and move the object along the Y-axis so it is not touching the wheel hub as shown below.

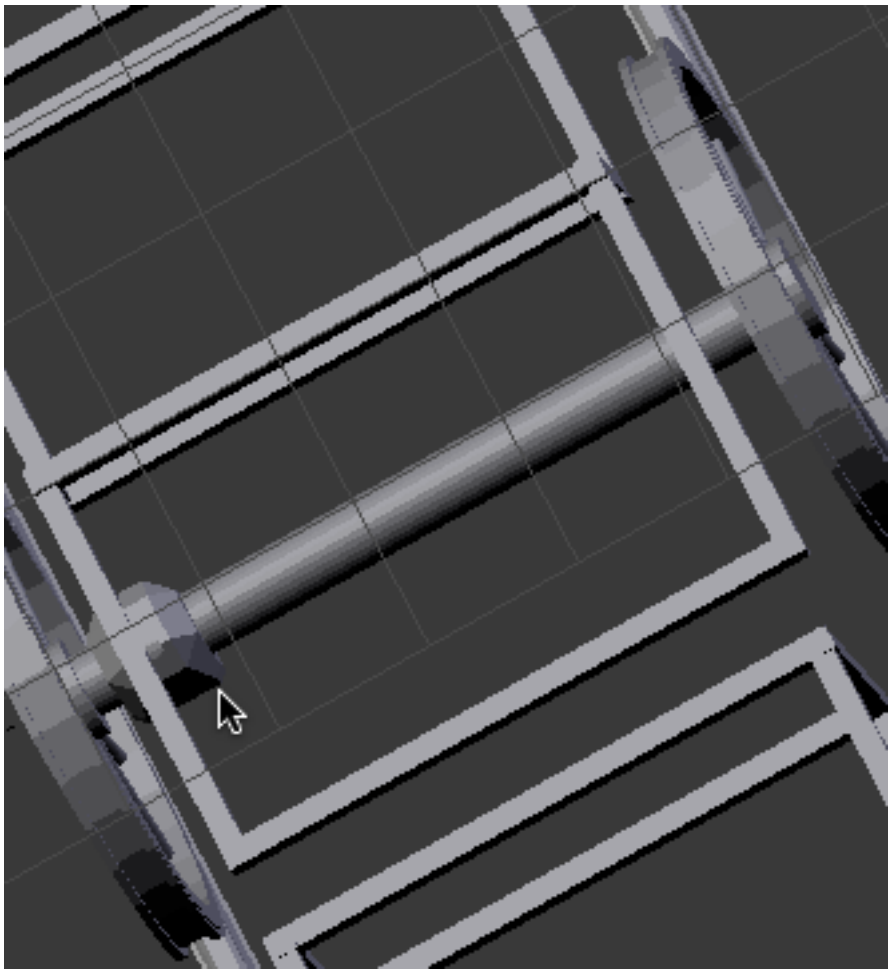


Name this object “Wheel Bushing”.

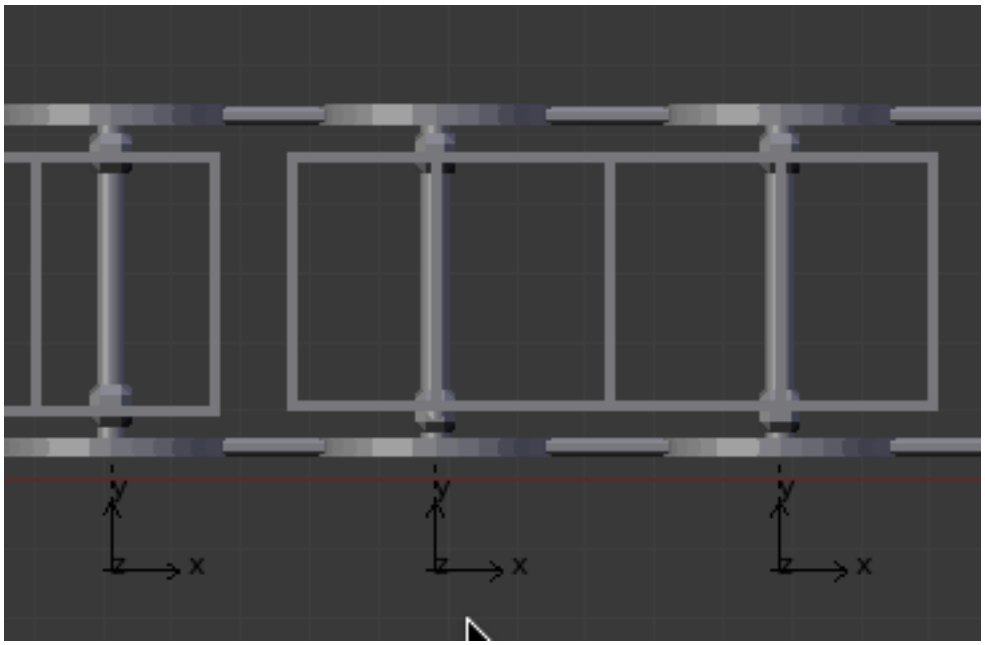
Make a duplicate copy and move it along the Y-axis and place it in similar fashion next to the other front wheel.



Make a duplicate copy of the bushing object, scale it down a bit and place it in the relative same position on one of the rear wheels as shown below.

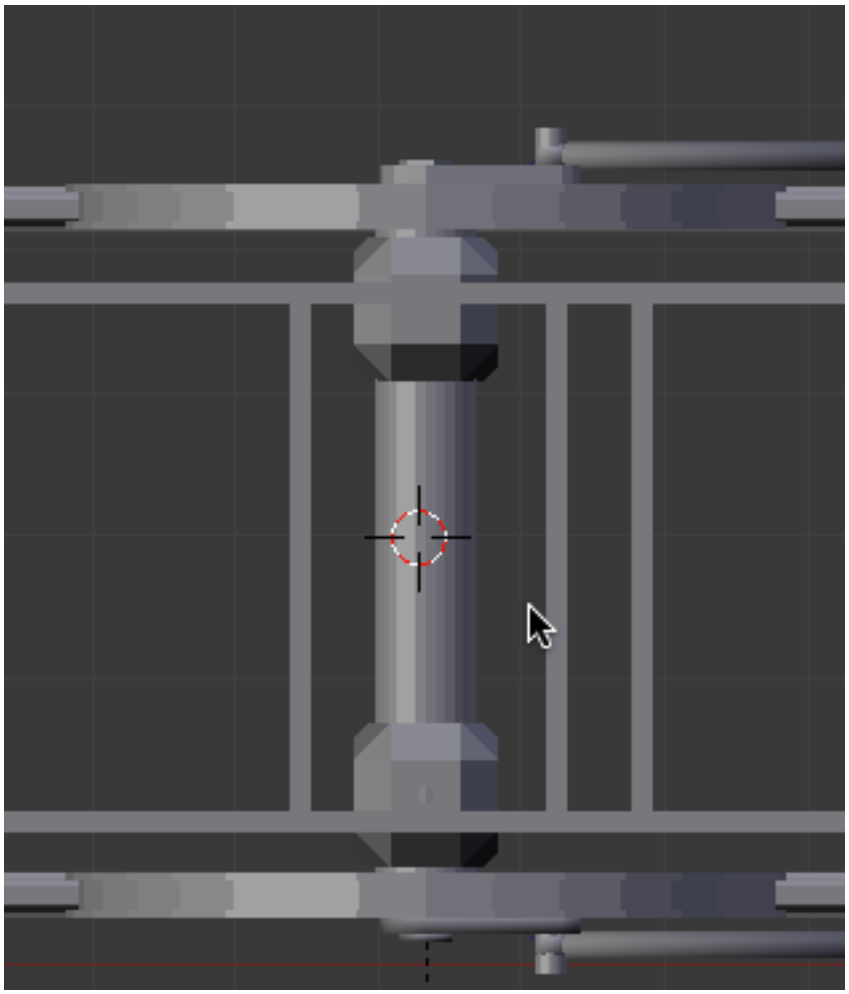


Make 5 more duplicate copies of this scaled bushing and place them in similar fashion by the rest of the models wheels.

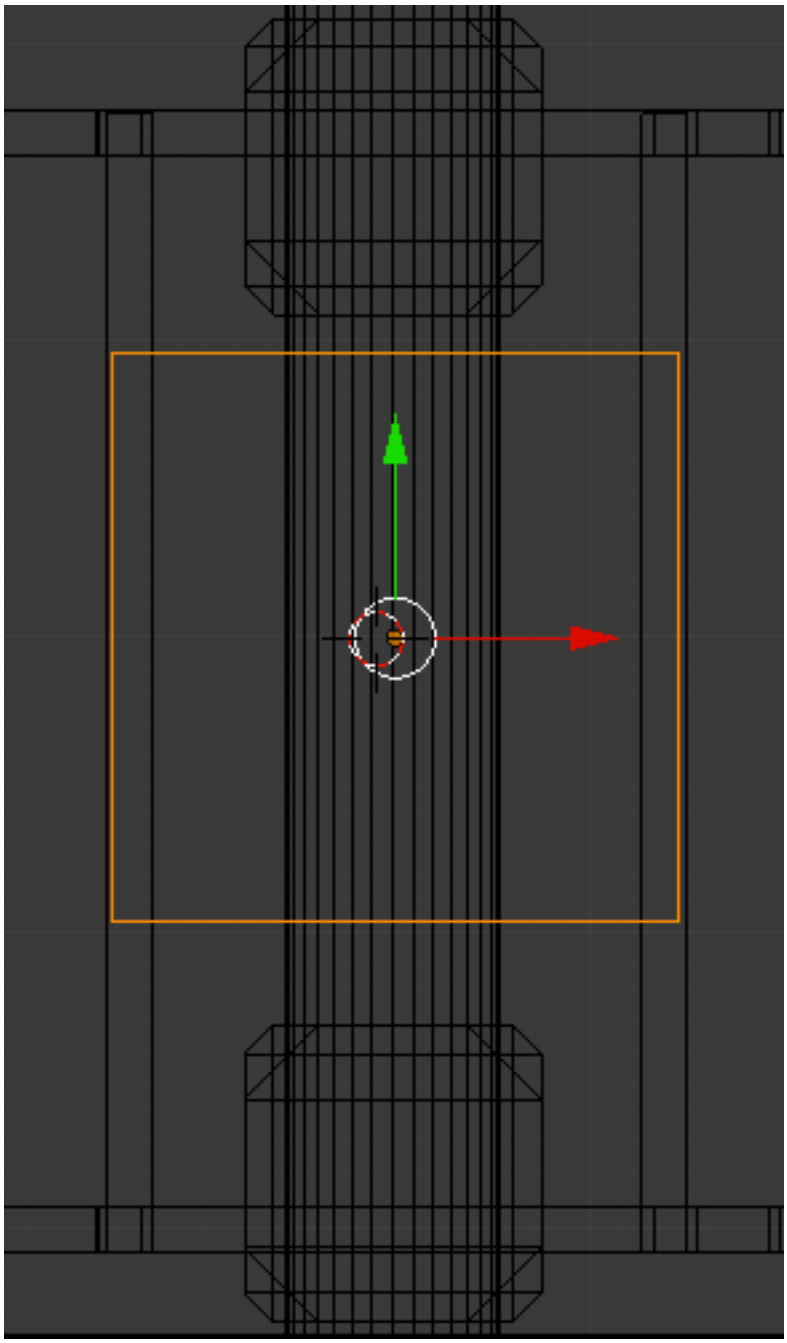


Select all 8 wheel bushings and press CTRL-J and join them into one object named “Wheel Bushing”

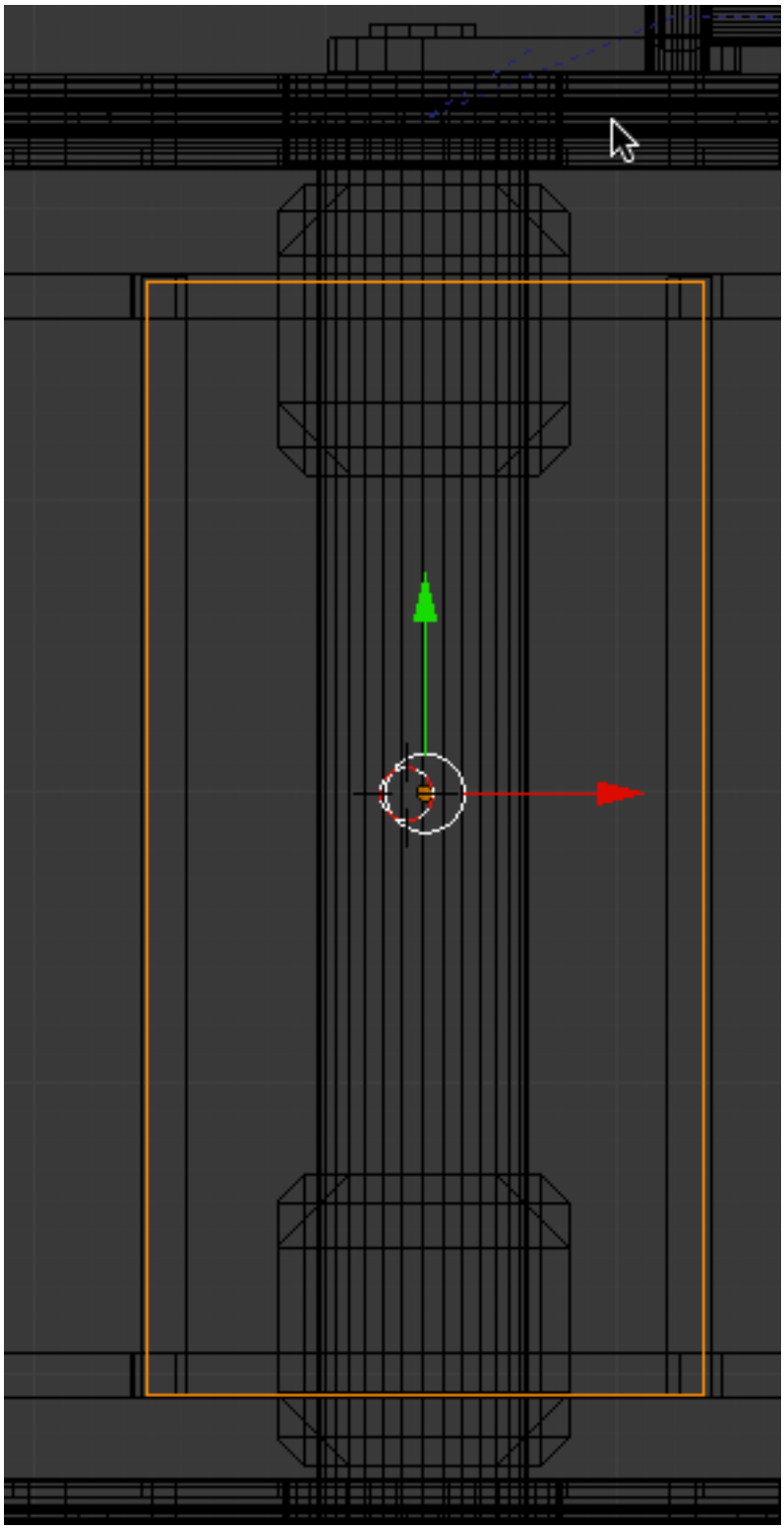
We need to add 3 metal sheets to the model.  Go to top view. Place your 3d cursor in the center of the frame above the front wheels as shown below.



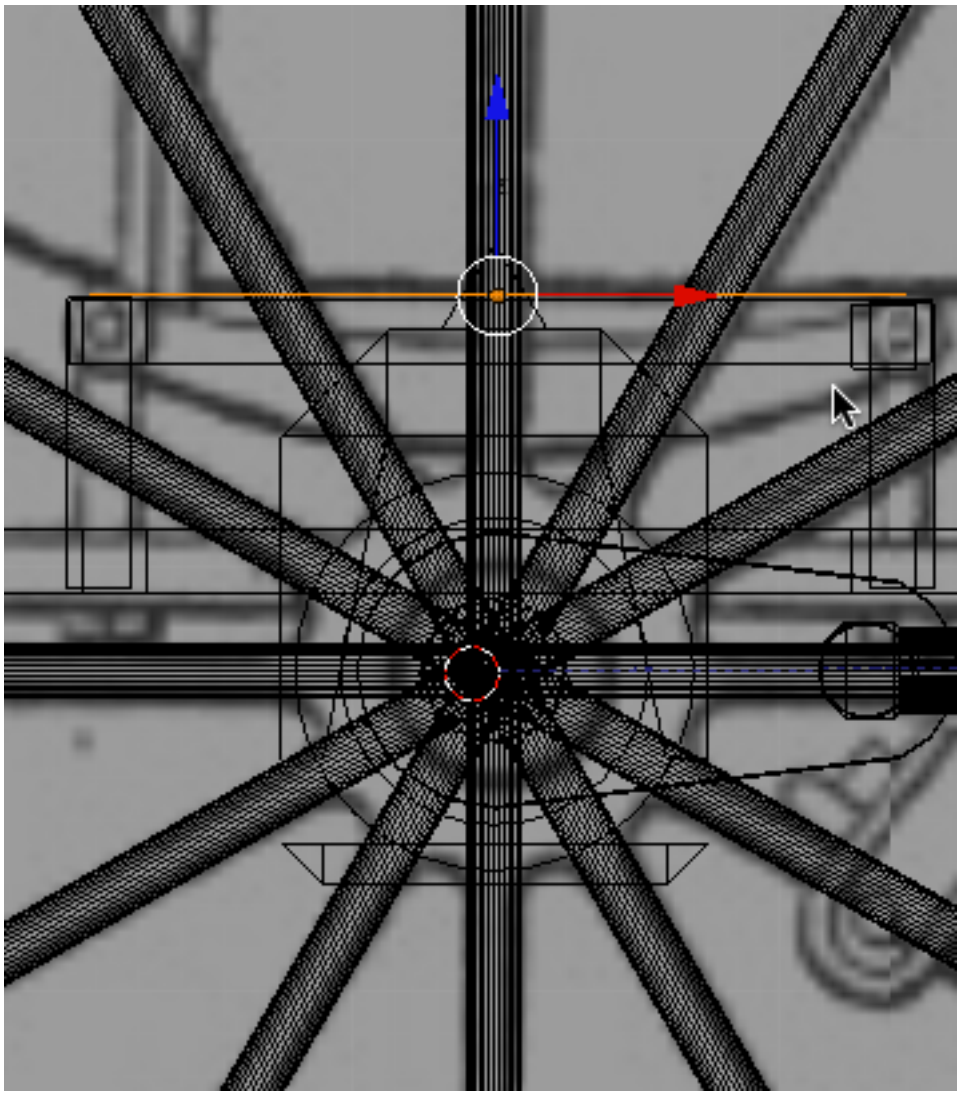
Press SHIFT-A and add a plane object. Scale the plane object to the width of the frame members as shown below.



TAB into edit mode and move the top and bottom vertices to the side of the frame as shown below.

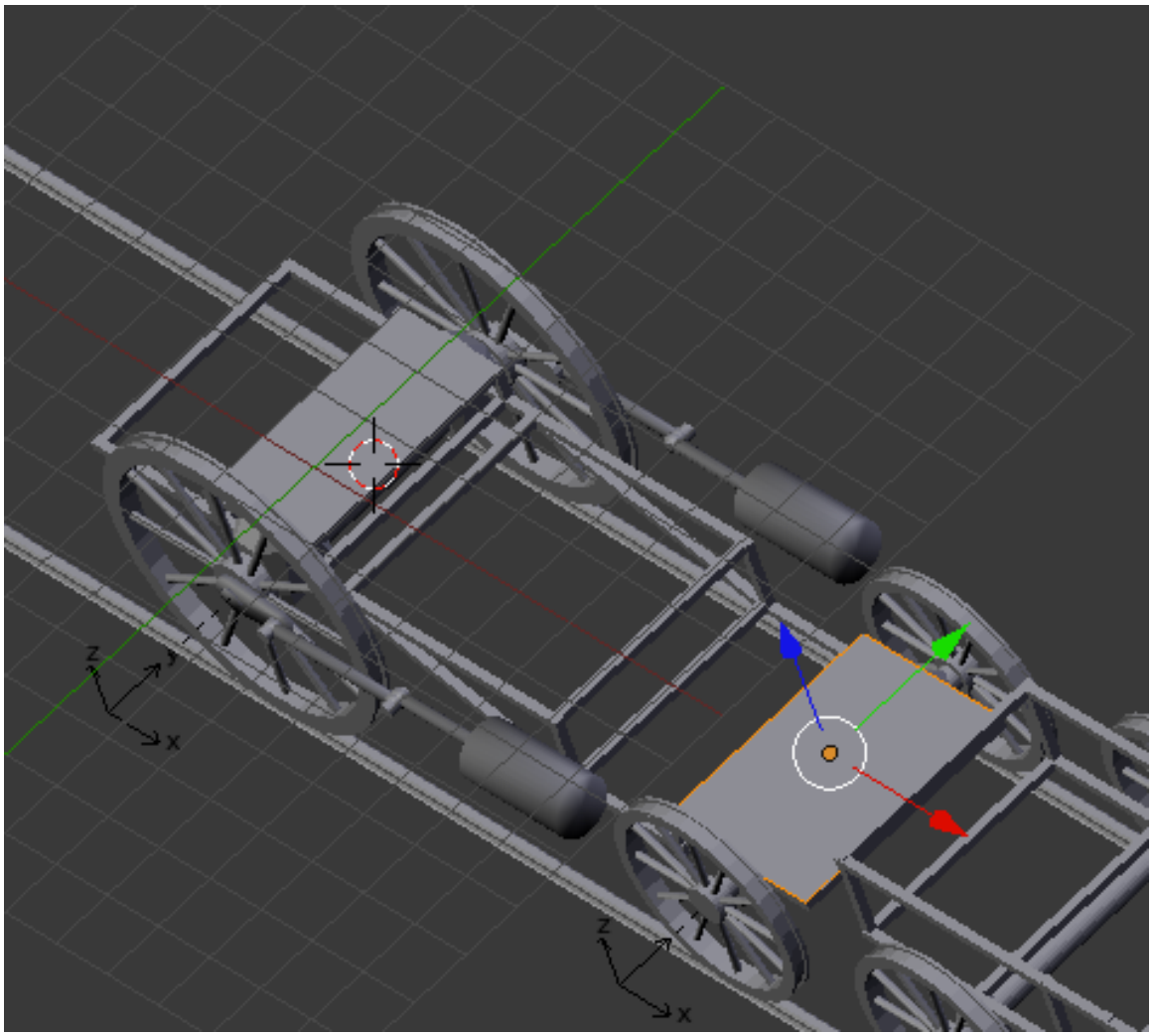


Go to front view and move the plate up along the Z-axis and position it on top of the frame as shown below.



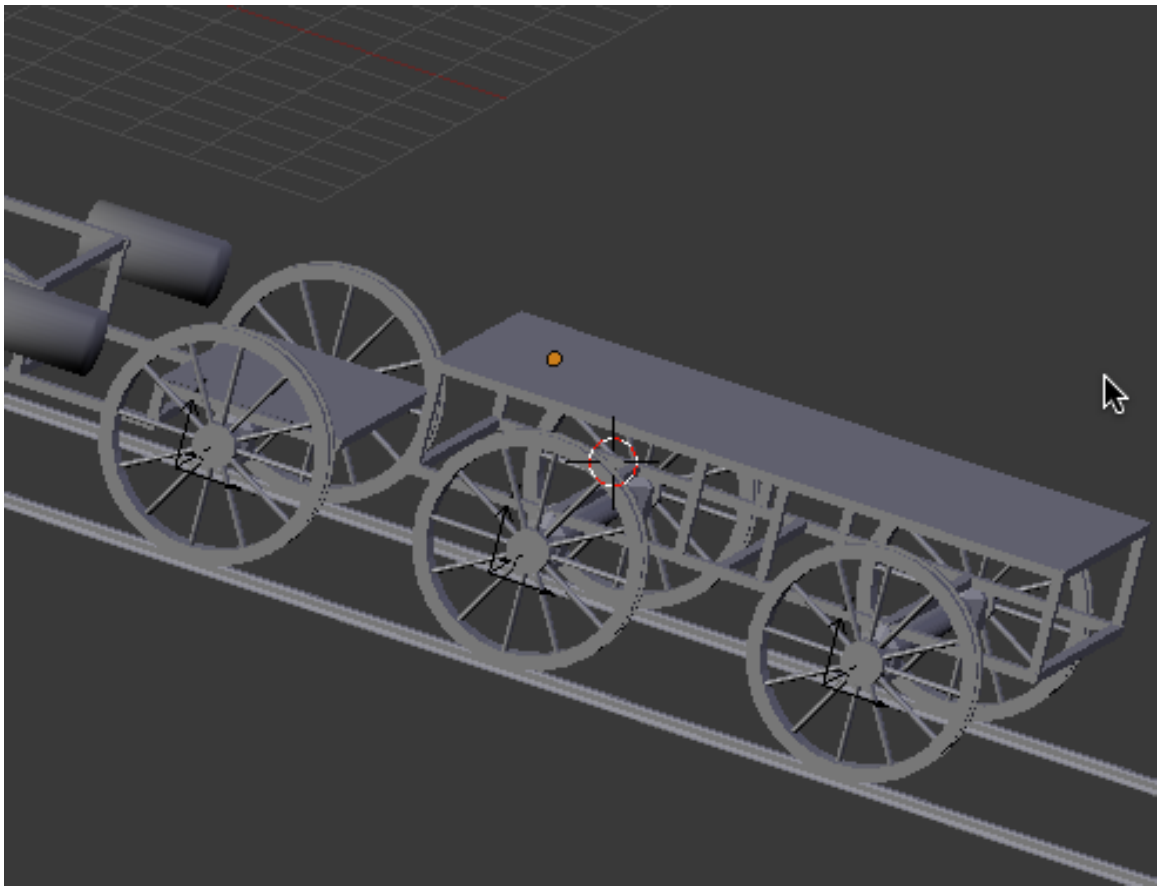
Name this object Plate 1.

Make a duplicate of the plate object and resize it and place it at the back of the engine frame as shown below.




Name this object Plate 2.

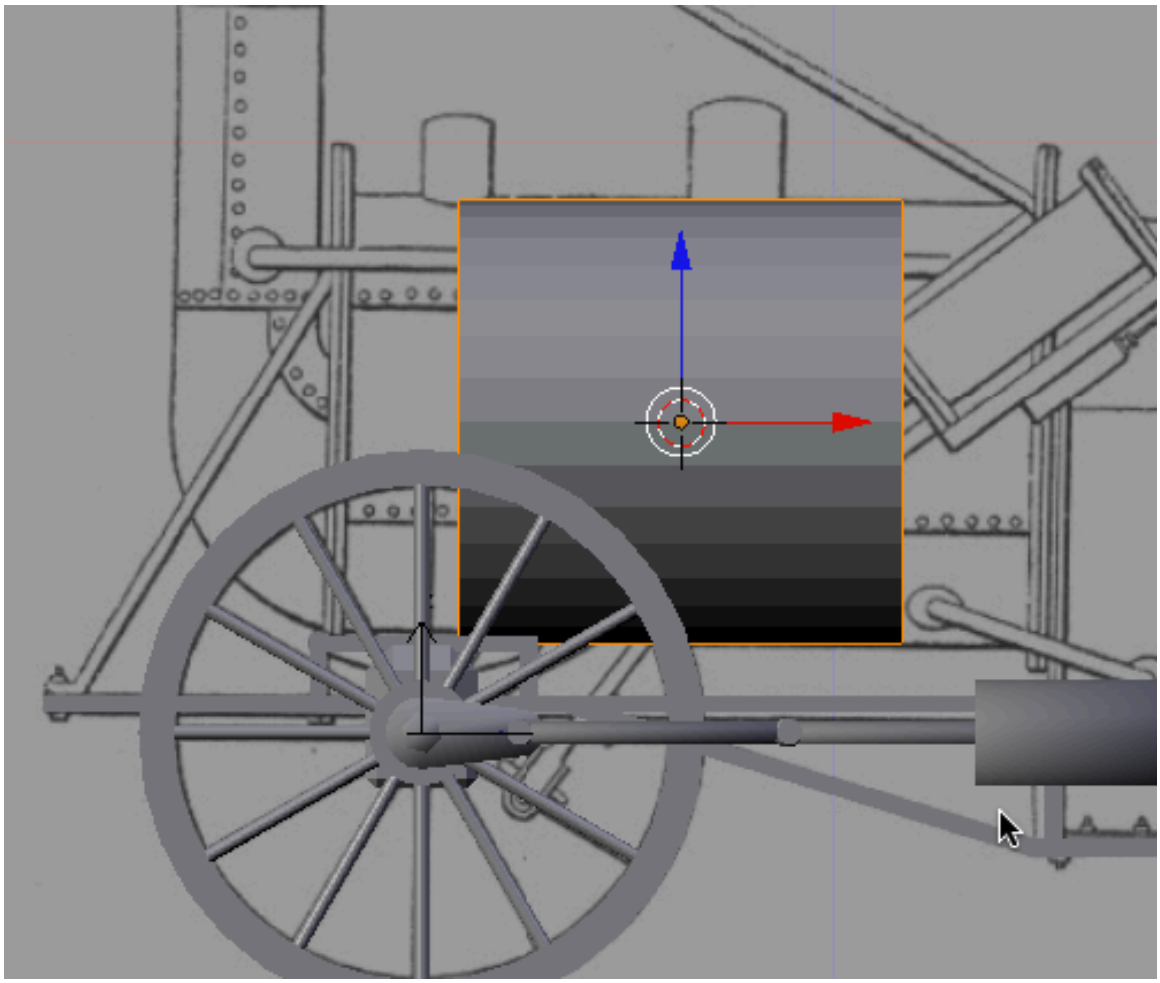
Make another duplicate plate object and resize it and place it on top of the second car as shown below.



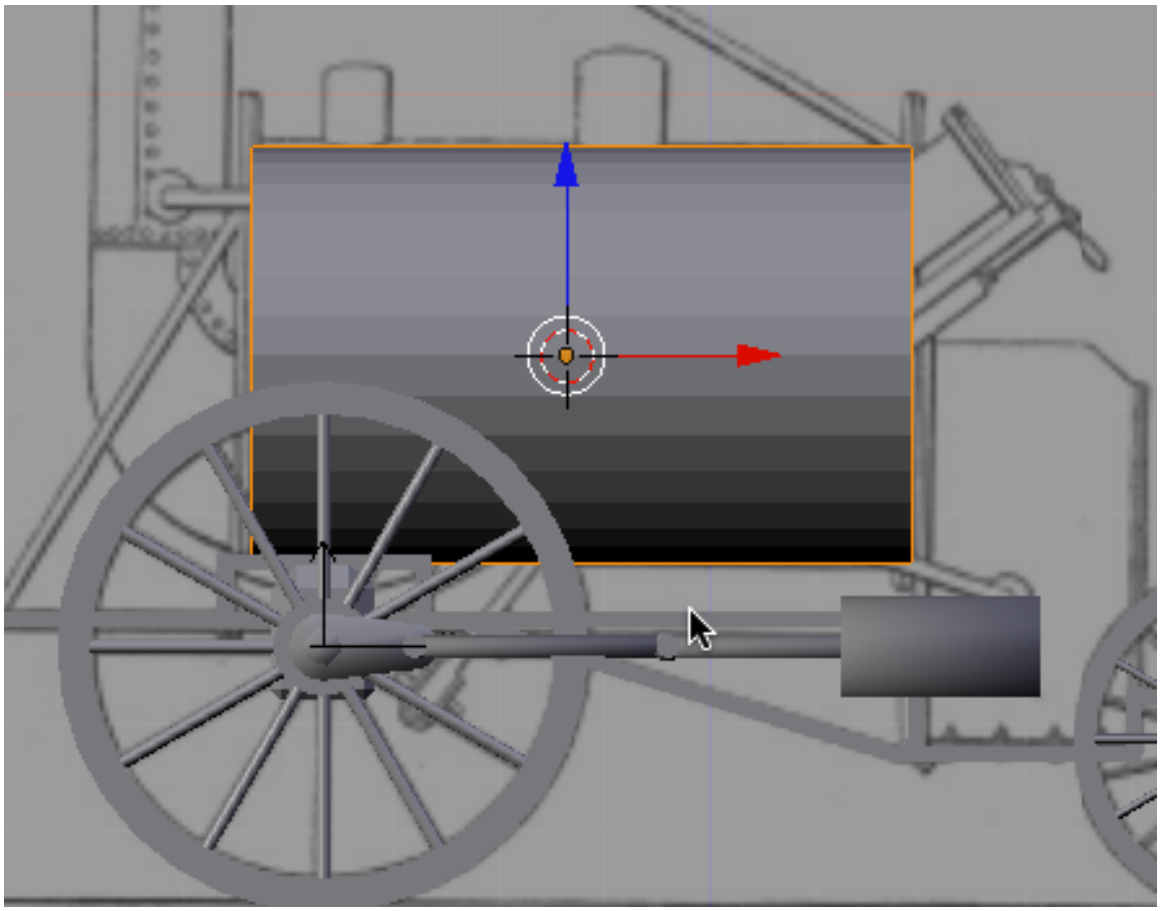
Name this object Plate 3.

Save your Blender file.

Go to front view. Place your cursor in the center of the engine boiler and press SHIFT-A and add an **UNCAPPED** tube object. Set the Y rotation to 90 degrees.

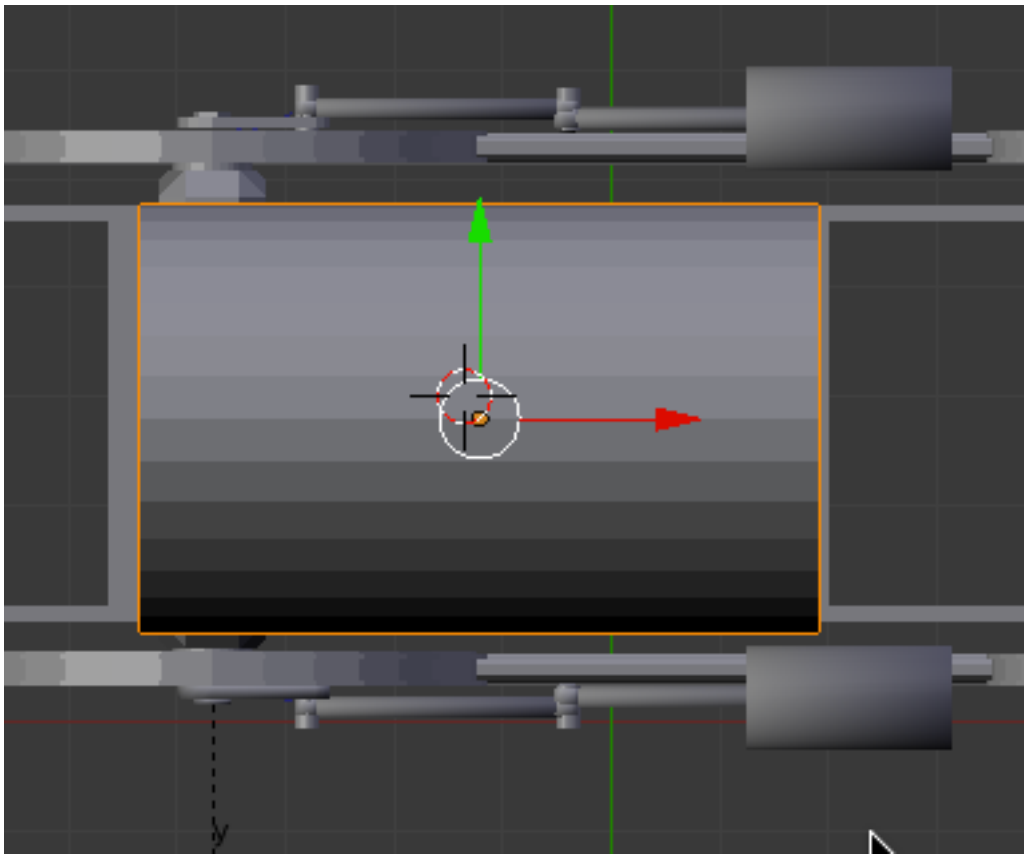


TAB into edit mode. Deselect the vertices.
Box select the side vertices and move them along the X-axis as shown below.
TAB out of edit mode.



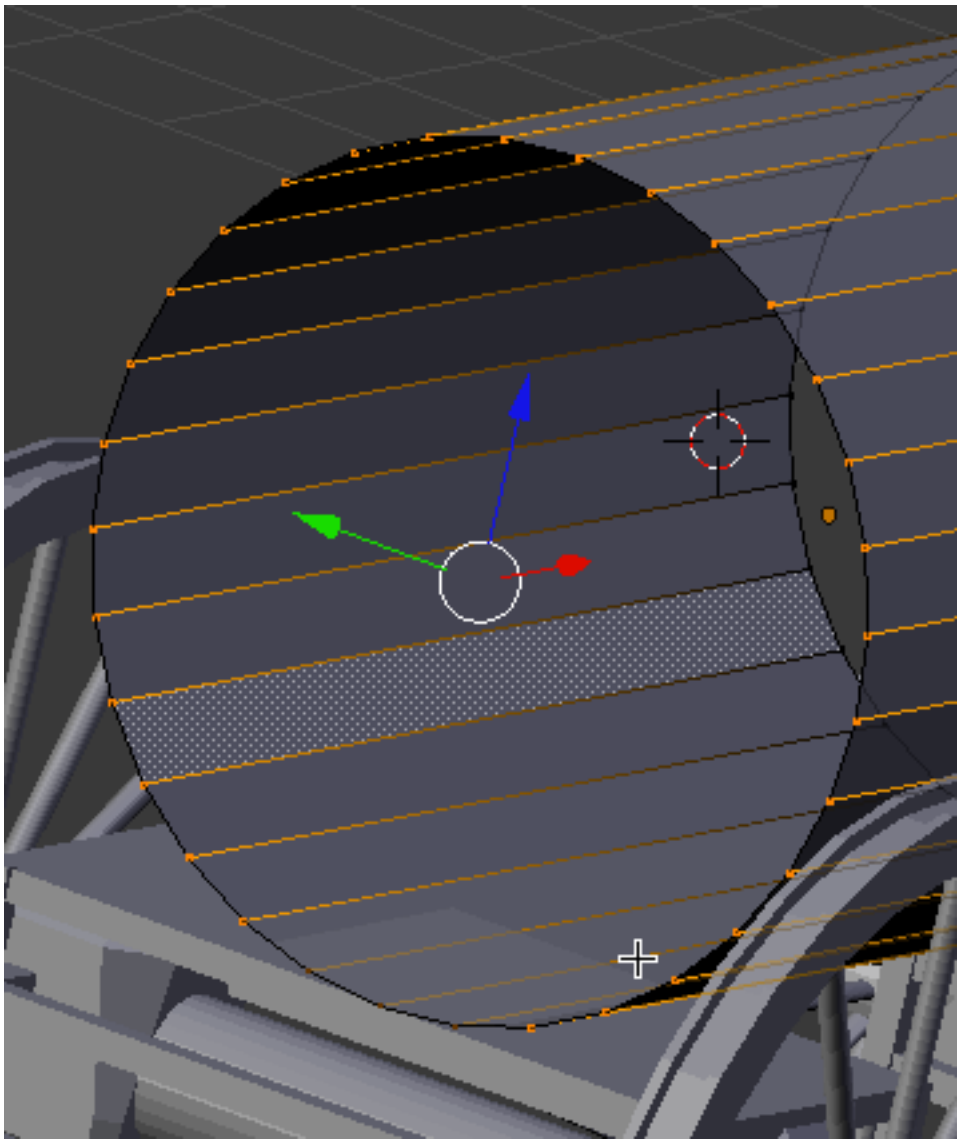
Name this object “Boiler”. With the boiler object selected, press SHIFT-CTRL-ALT-C and select origin to geometry.

Go to top view. Center the boiler on the frame.

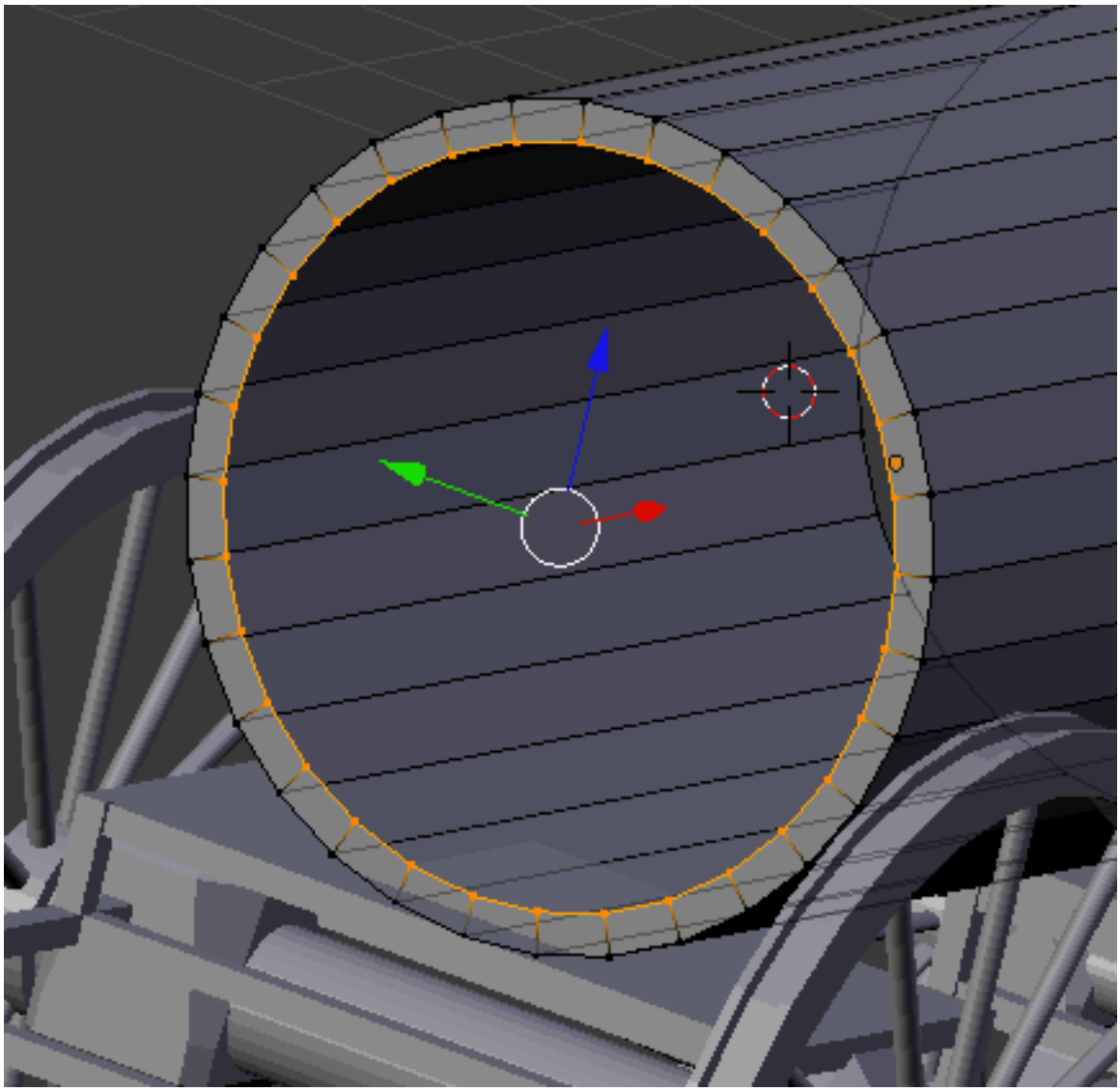


Go to side view. Press SHIFT-S and snap your cursor to the selected.

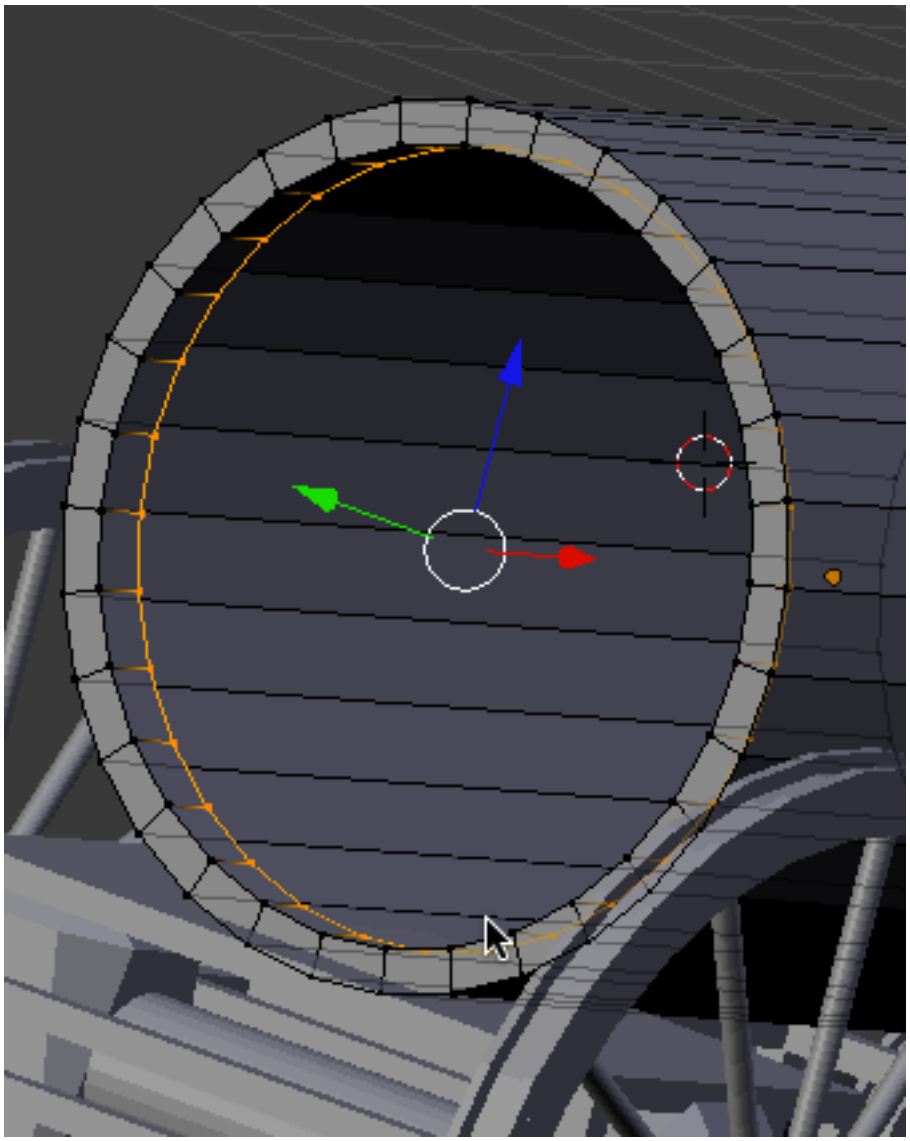
Rotate your view to get a better view of the front of the boiler. TAB into edit mode. Hold your ALT KEY down and select one of the front vertices. This will select the whole loop of vertices.



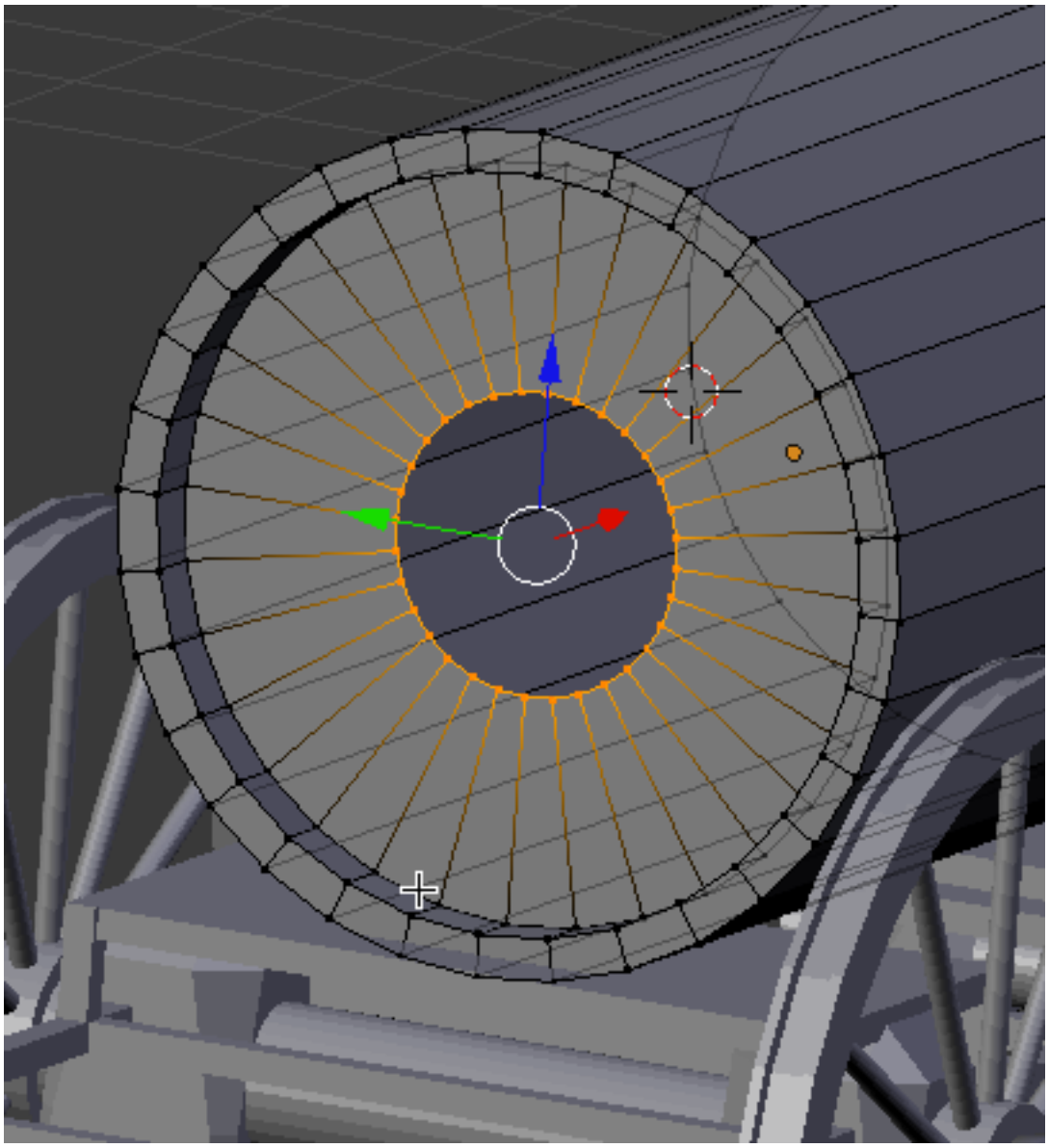
Press the EKEY followed by the SKEY and extrude/scale the vertices in as shown below.



Press the EKEY followed by the XKEY and extrude the vertices in a bit along the X-axis as shown below.

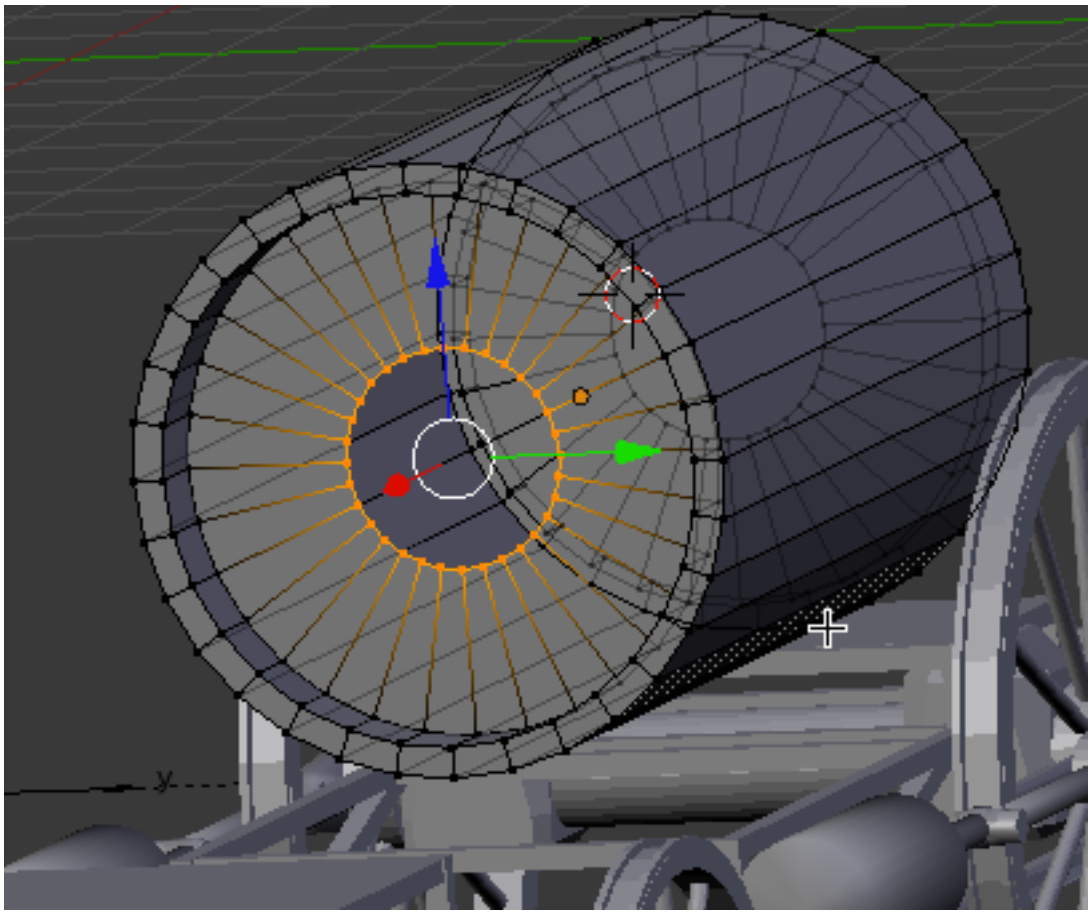


Press the EKEY followed by the SKEY and extrude/scale the vertices in a bit as shown below.



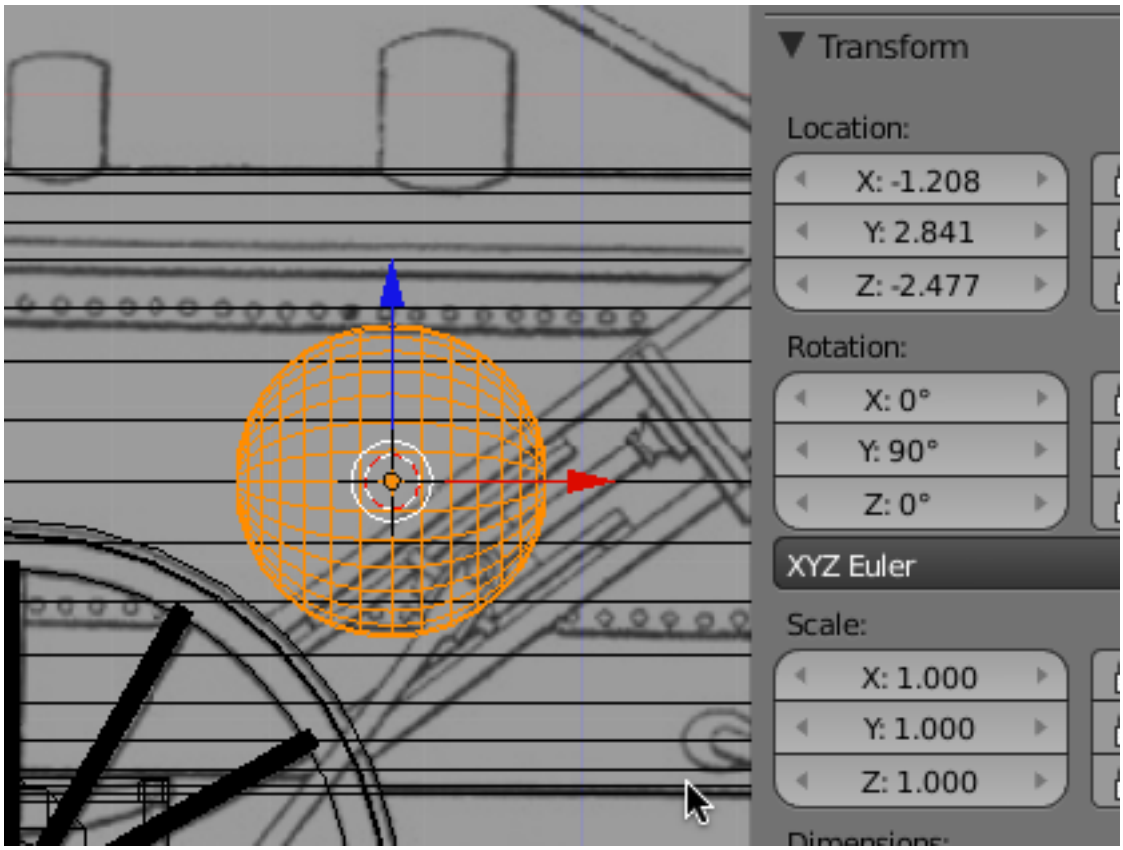
Deselect the vertices. TAB out of edit mode.

Do the same extrusion and scaling on the rear of the boiler object.

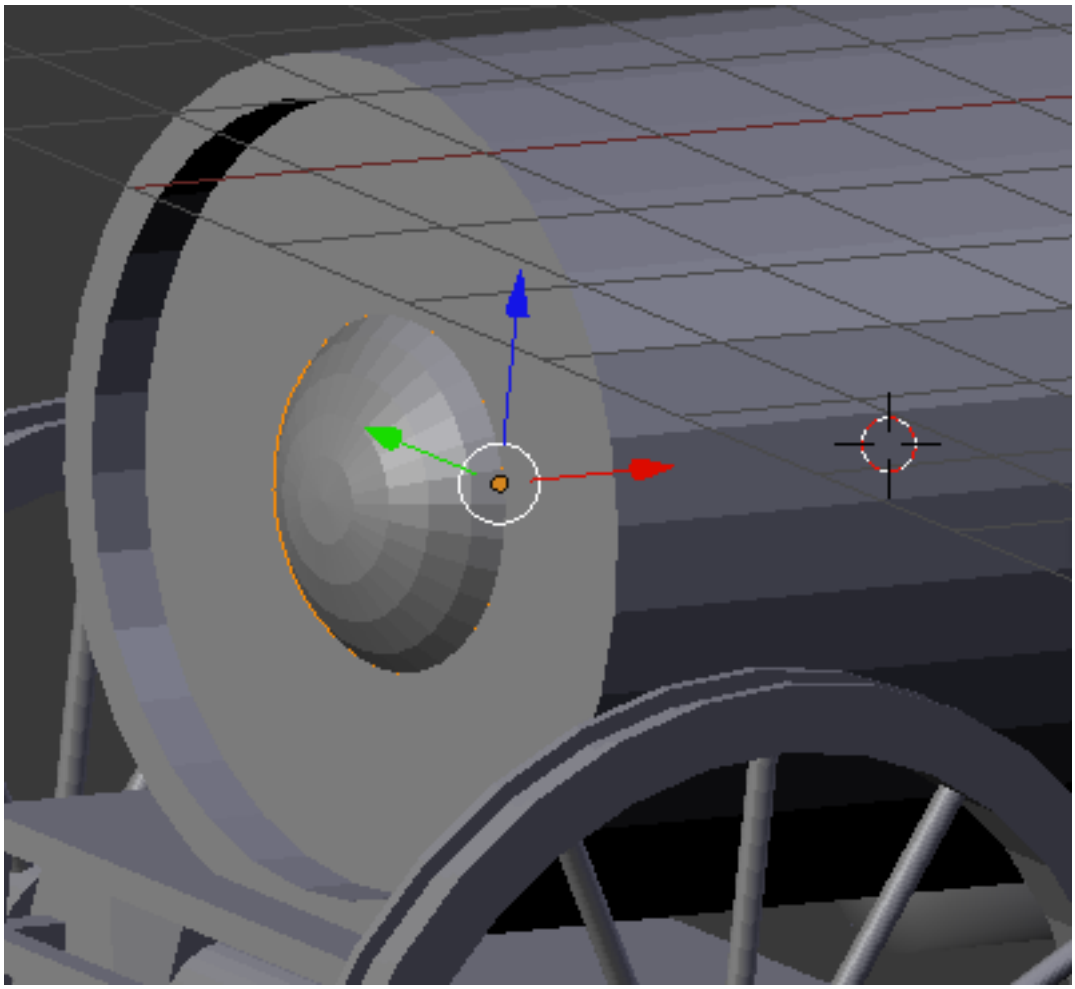


Deselect the vertices. TAB out of edit mode. Go to front view. Select the boiler object and press SHIFT-S and snap your cursor to the selected object.

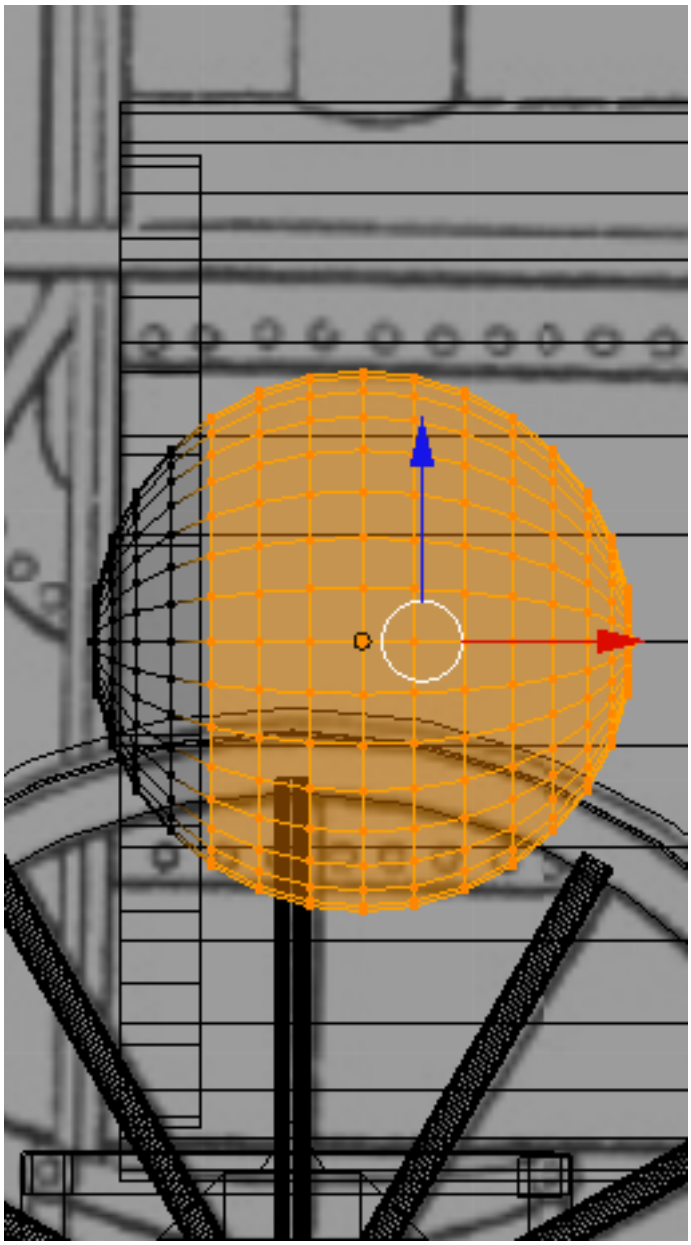
Go to wireframe view. Press SHIFT-A and add a UV Sphere object. Set the Y rotation to 90 degrees.



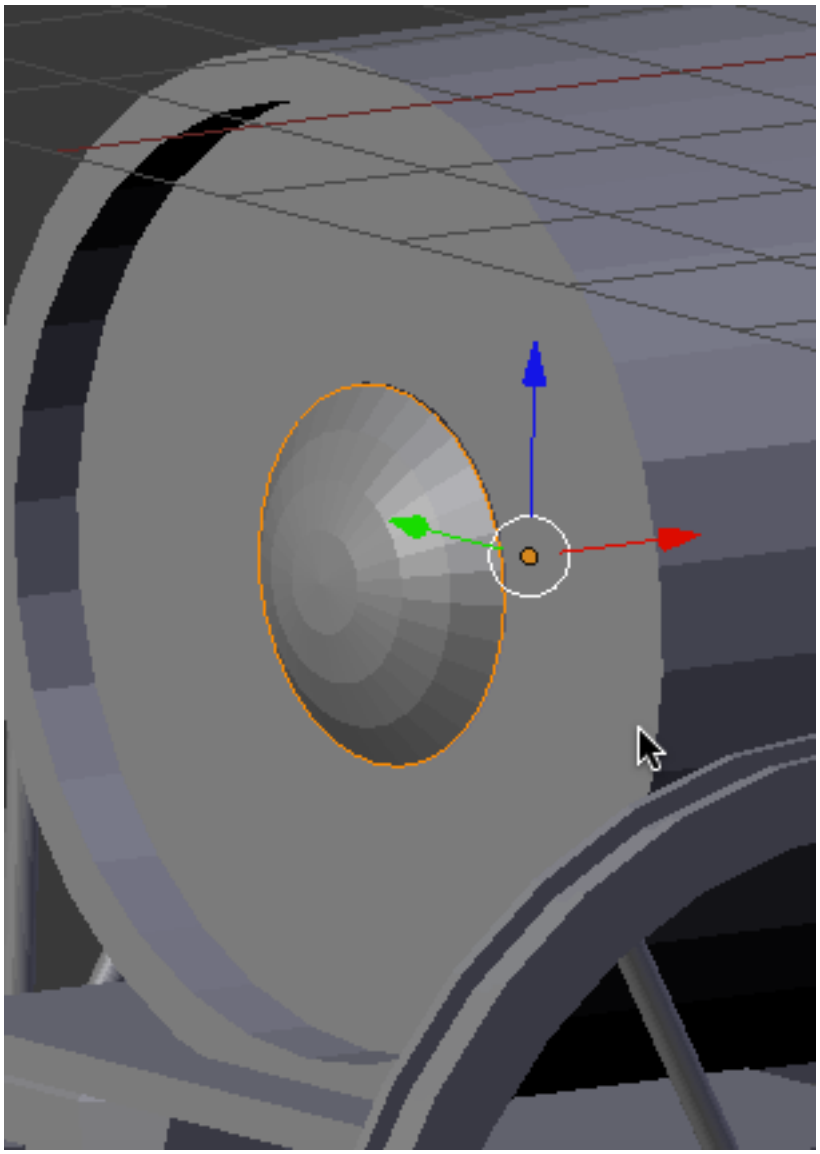

Move the sphere along the X-axis to the front of the boiler so that it just pokes through the front hole.



Go to wireframe mode. Go to front view. TAB into edit mode. Deselect the vertices. Box select the inside the boiler vertices as shown below.

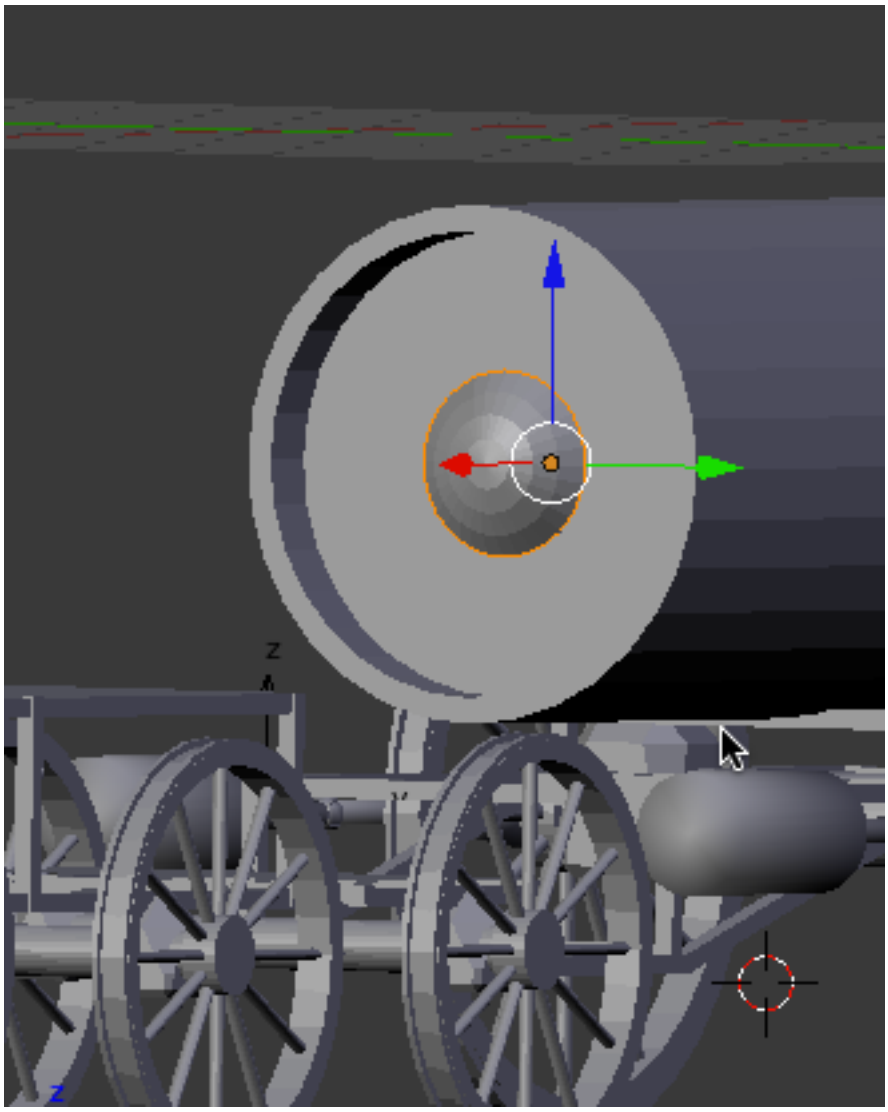


Press the XKEY and delete the vertices. TAB out of edit mode and move the object a bit back along the X-axis to plug the hole.



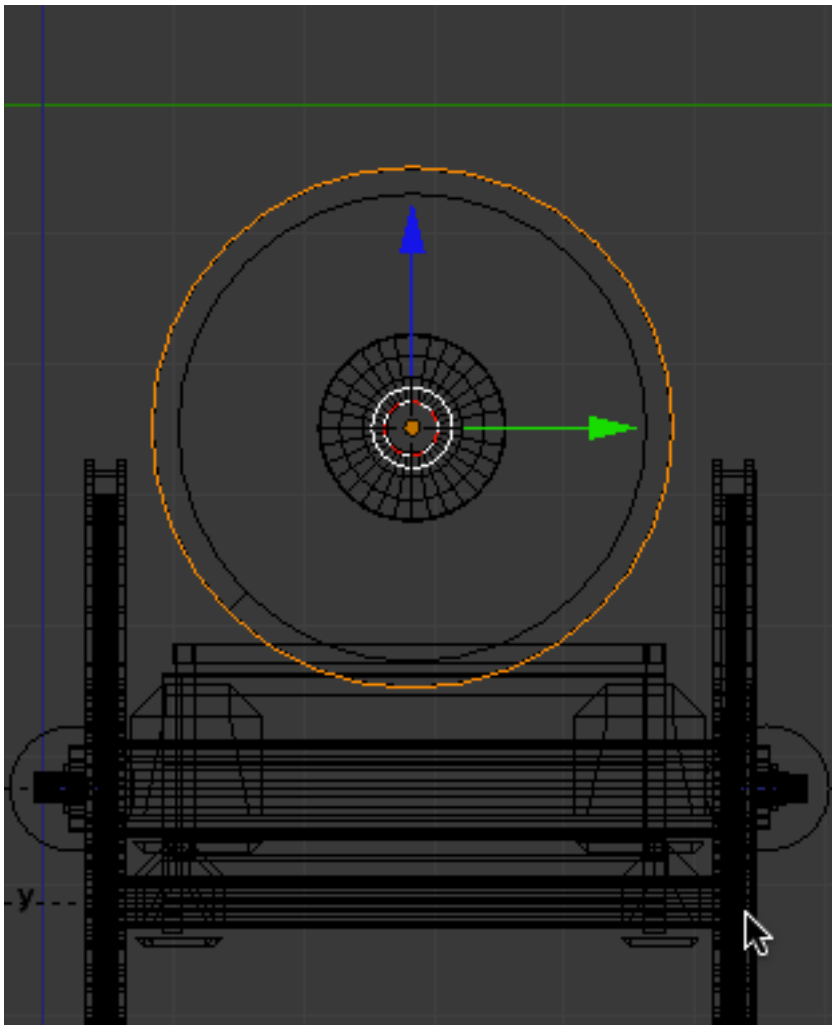
Name this object Boiler Head.

Make a duplicate copy of the boiler head object, set the Y rotation to 270 degrees and plug the hole on the rear end of the boiler as well.



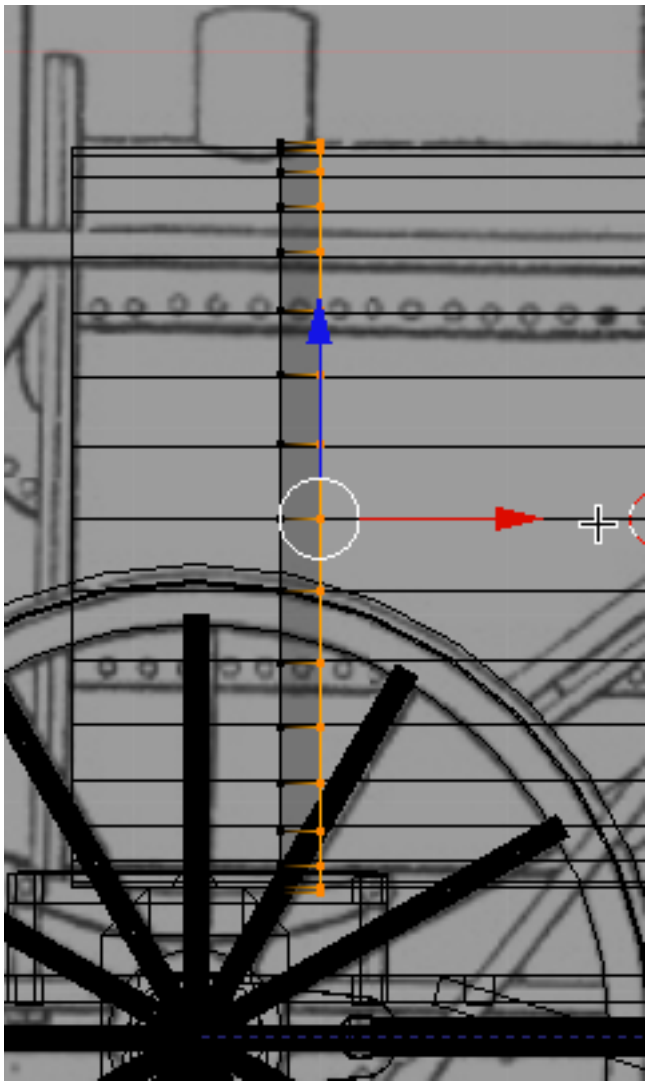
Go to side view. Go to wireframe mode. Select the boiler object. Press SHIFT-S and snap your cursor to the selected object.

Press SHIFT-A and add an UNCAPPED tube object. Set the Y rotation to 90 degrees. Scale up the tube object so it is the same width as the boiler object.

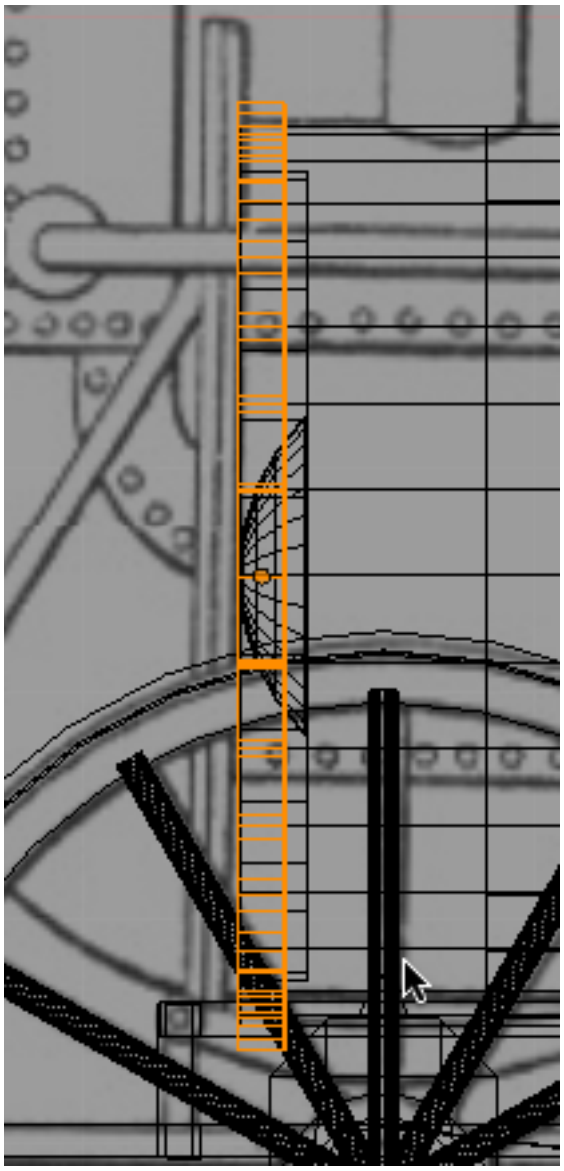


Go to front view. TAB into edit mode. Deselect the vertices.

Box select the right side vertices and move them to the left as shown below. We are modeling a band to fit around the boiler.

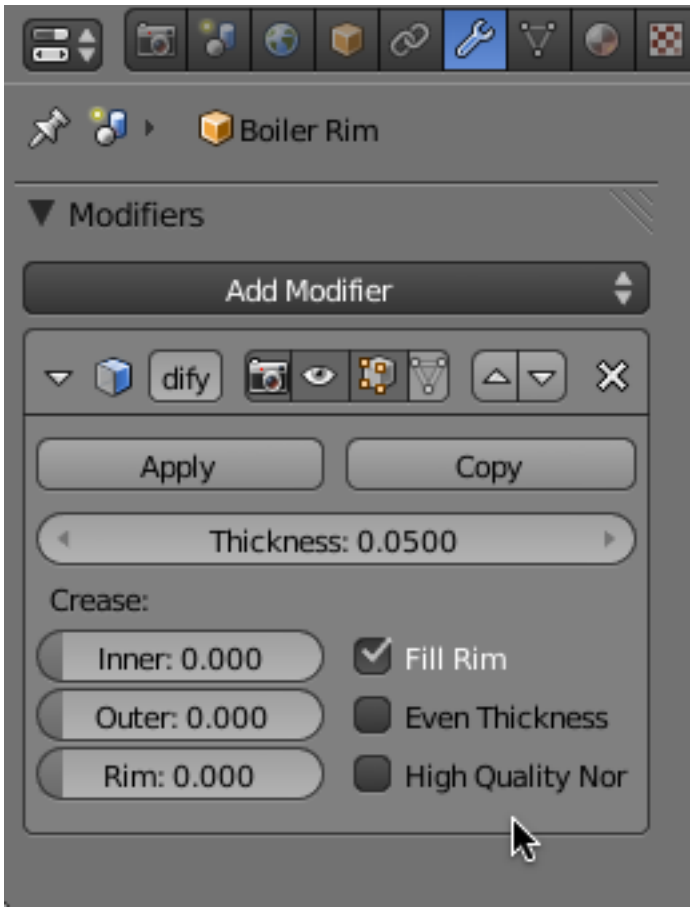


Deselect the vertices. TAB out of edit mode. Move the object to the front end of the boiler object.

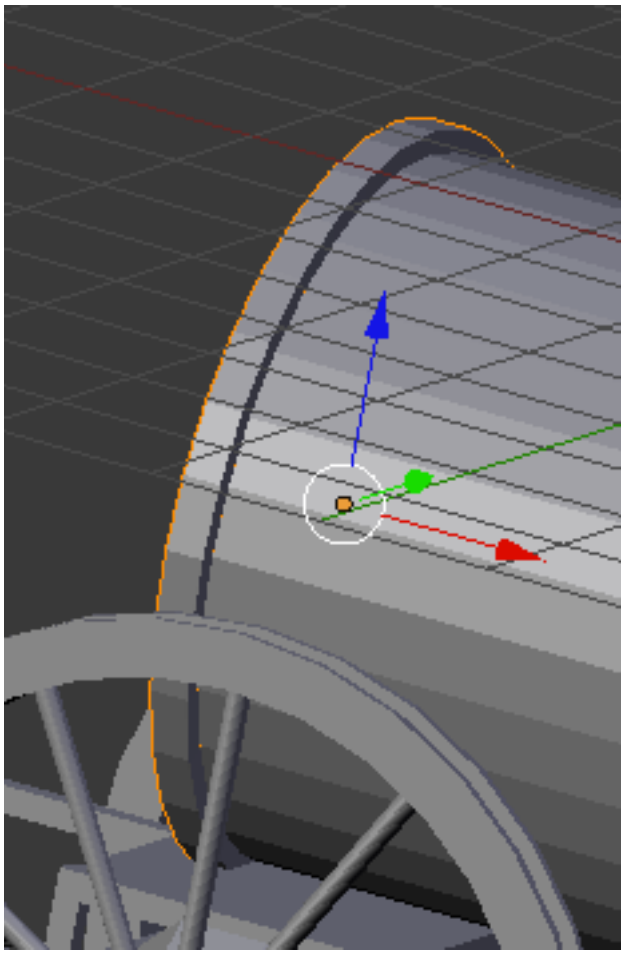


Name this object “Boiler Rim”. With the boiler rim object selected press SHIFT-CTRL-ALT-C and select origin to geometry.

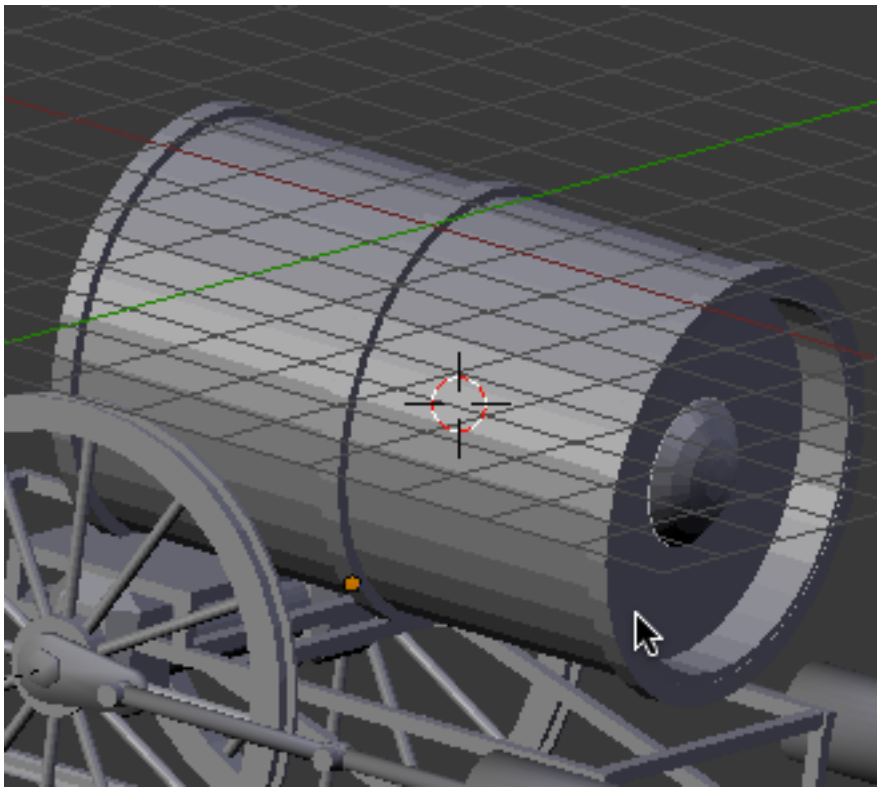
Add a Solidify modifier to the boiler rim object. Set the thickness to .05




This will give the rim some thickness.

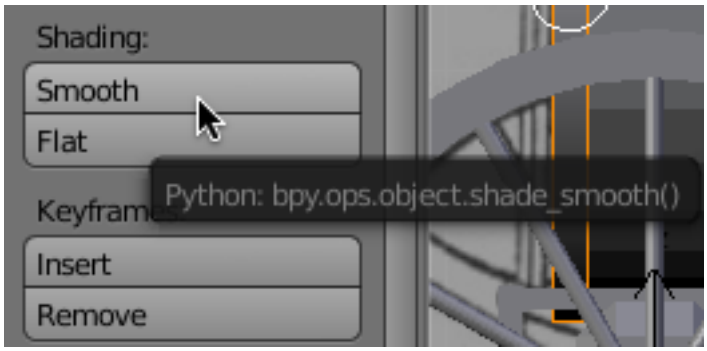


Go to front view. Make two duplicates (SHIFT-D) of the boiler rim object placing one in the middle of the boiler and one at the rear end.



We will accept the default object names (.001 and .002).

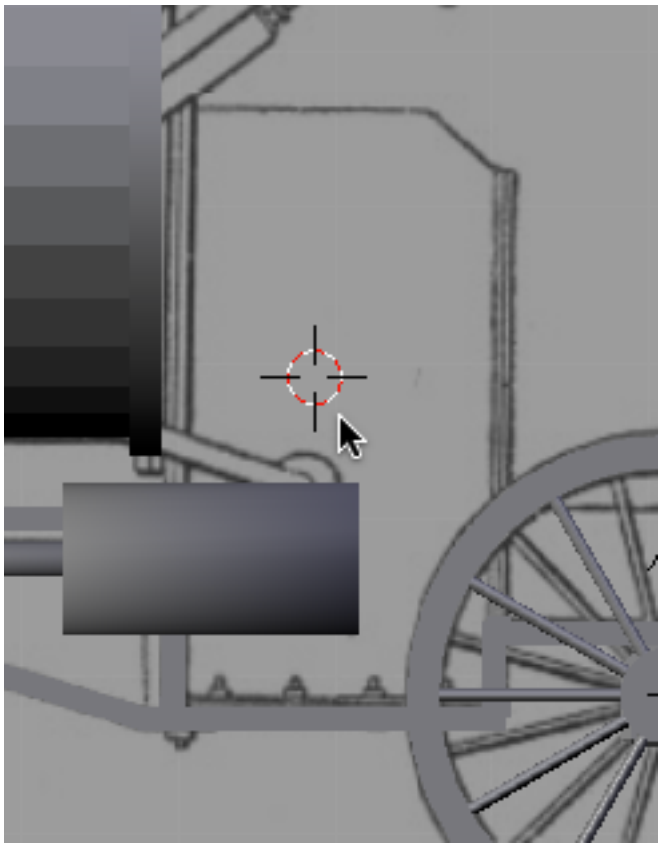
Select the Boiler Rim object. Press the Smooth button in the 3D editor viewport tool panel. This will smooth out the faceted edges.



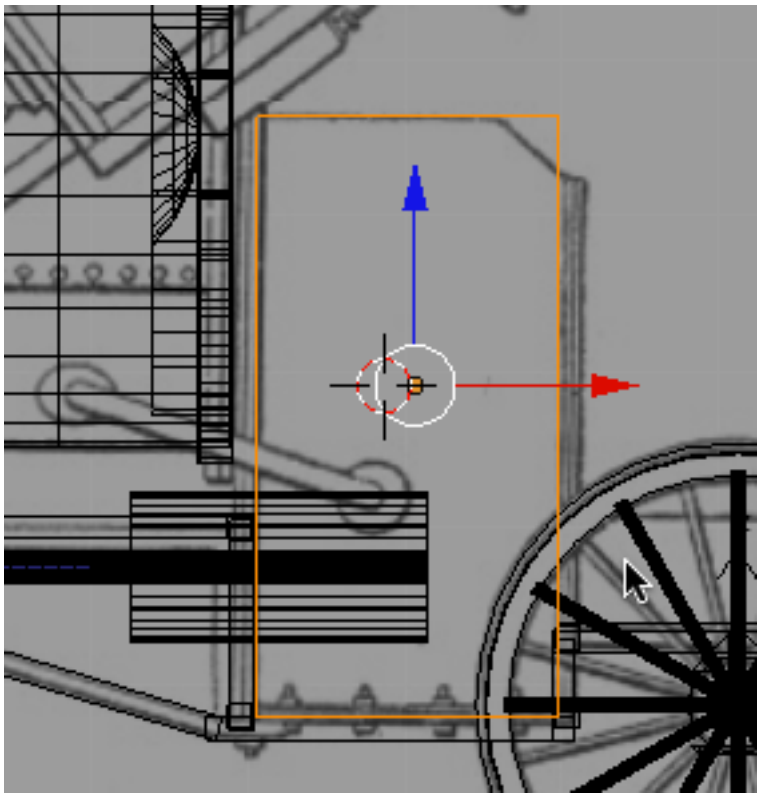

Smooth the boiler rim.001, boiler rim.002, boiler head and boiler head.001 objects as well.

Save your Blender file.

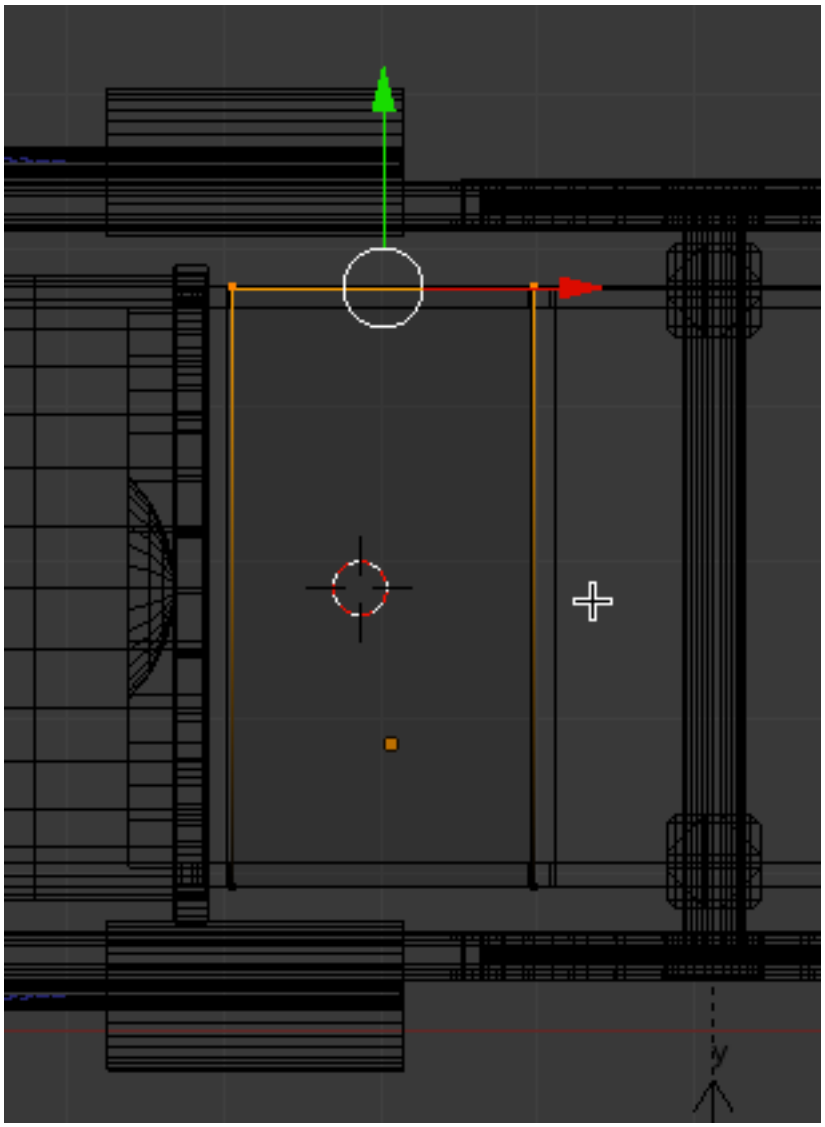
Go to front view. Place your 3D cursor in the center of the coke furnace box as shown below.



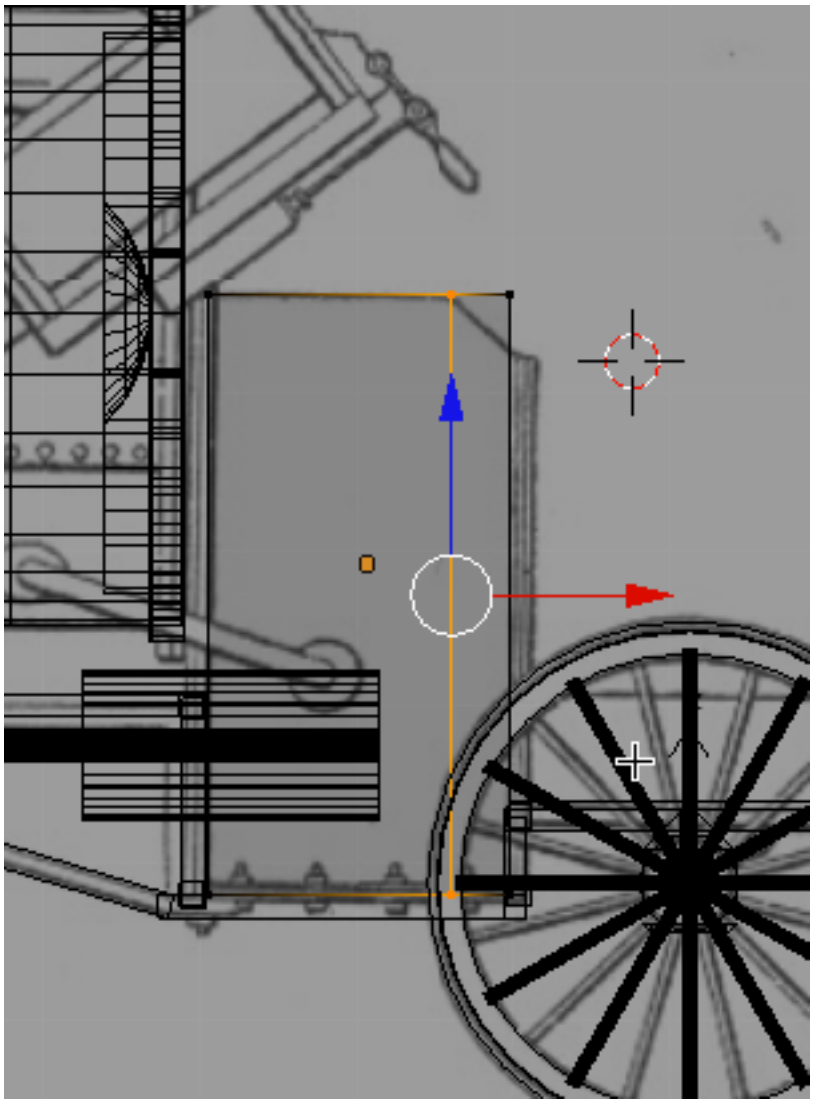
Press SHIFT-A and add a cube object. Scale and move the cube vertices to the size shown below.



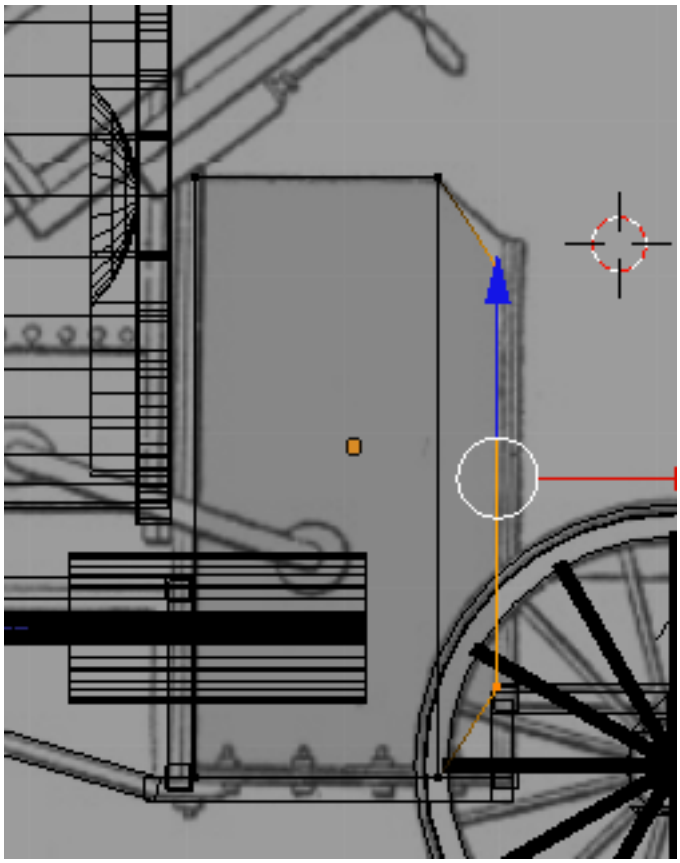
Go to top view. Move the furnace to the edge of the frame then TAB into edit mode and move the cube vertices to the other end of the frame as shown below.



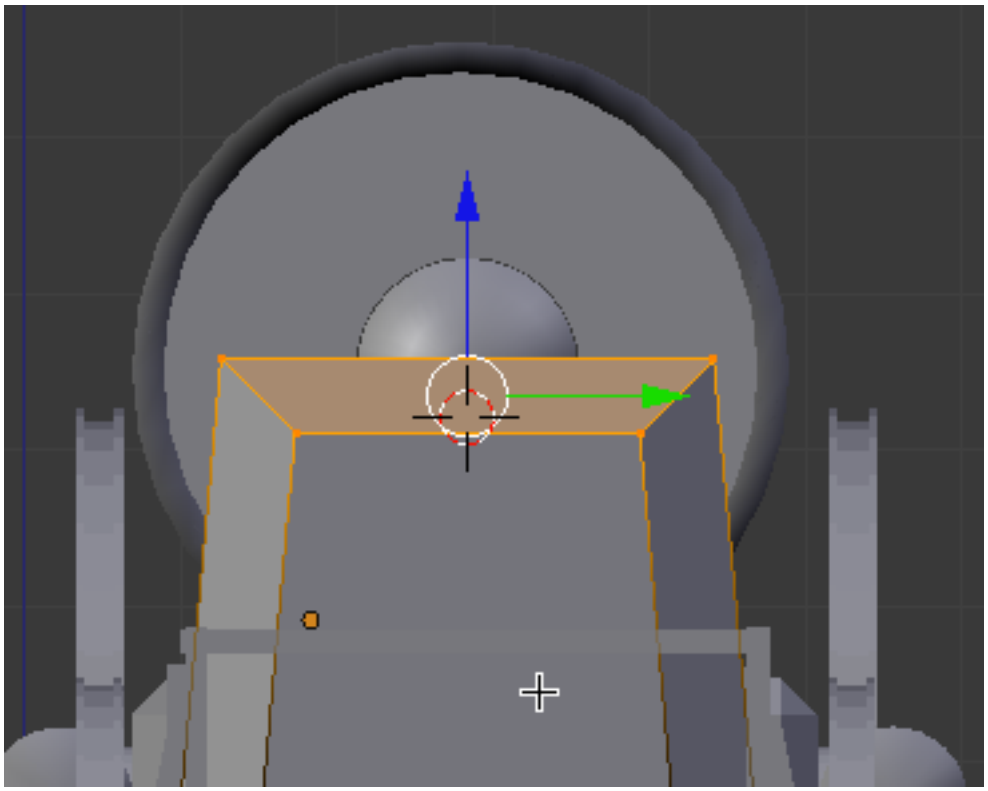
Go to front view. With all of the cube vertices selected, press the loop cut and slide button in the 3d editor viewport tool panel.  Move your mouse around the cube until you see a vertical loop cut. Left-click and slide the vertical loop to the right and left-click to place it as shown below.



Deselect the vertices. Box select the right set of vertices and scale them down as shown below.



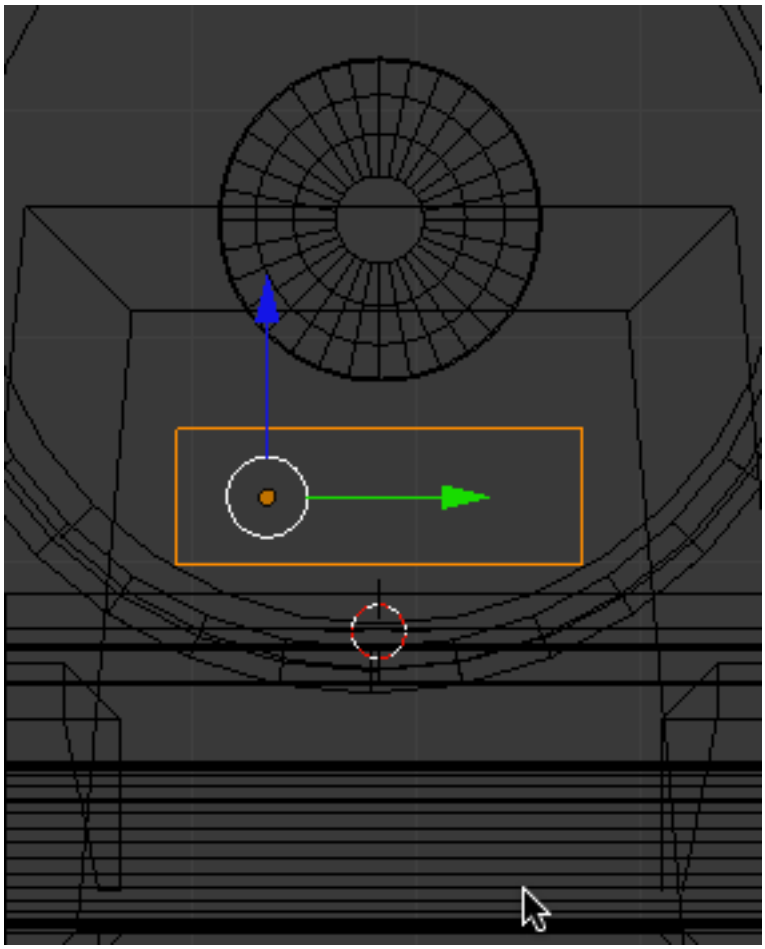
Go to side view. Select the top sets of vertices and scale them in a bit as shown below.



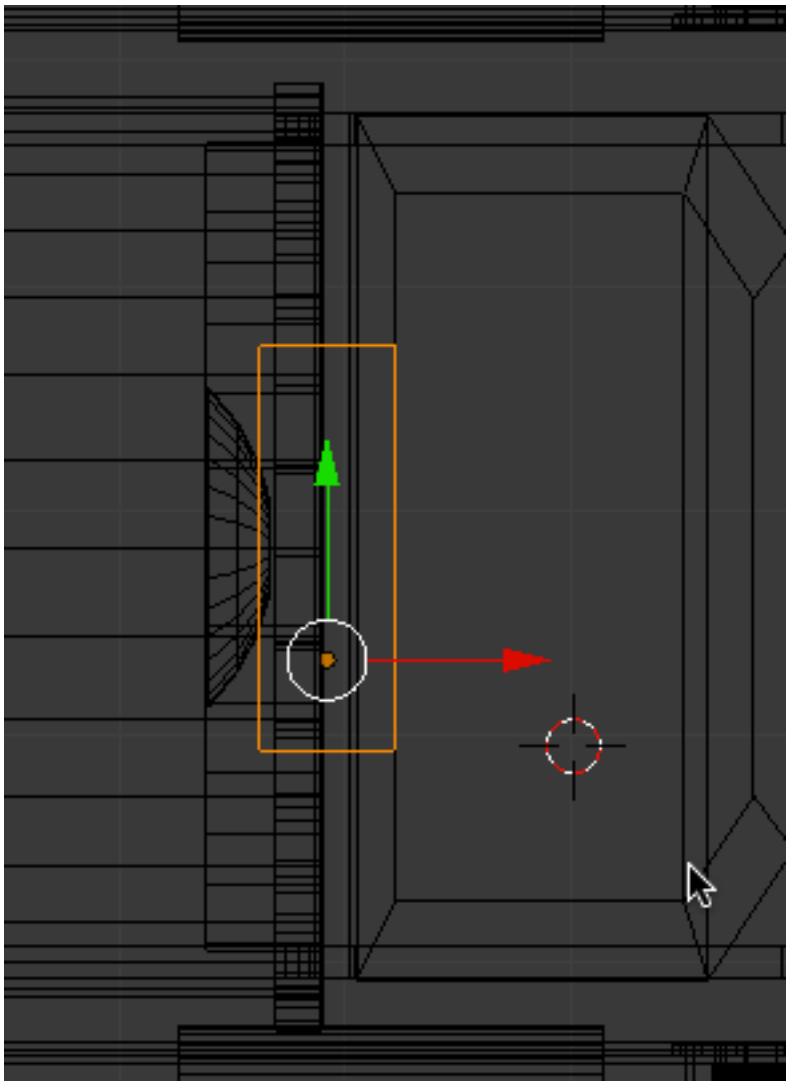
TAB out of edit mode. Name this object Furnace. With the furnace object selected, press SHIFT-CTRL-ALT-C and the origin to geometry.

Press SHIFT-S and snap your cursor to the selected (furnace) object.

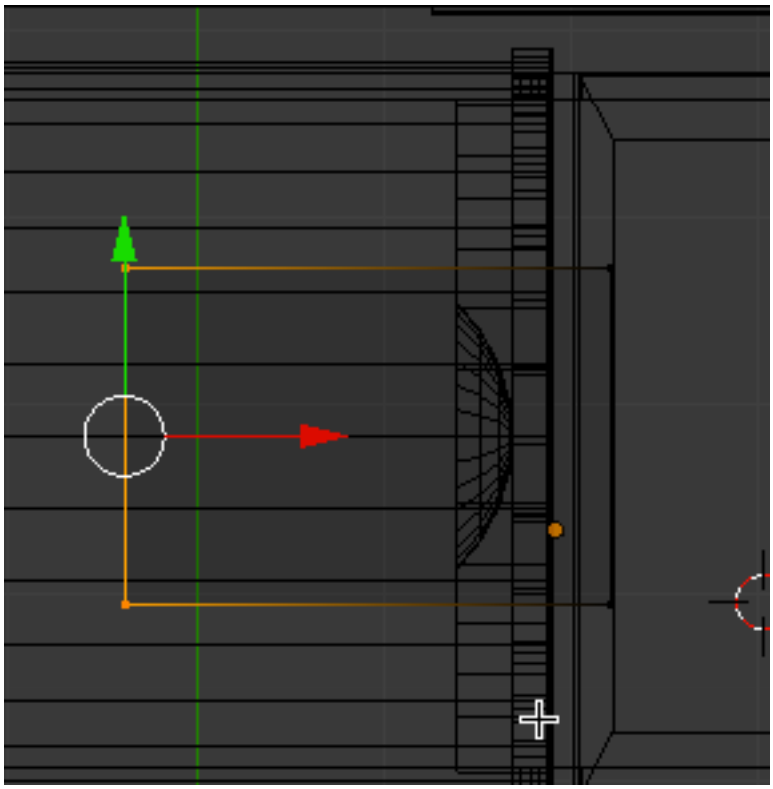
Press SHIFT-A and add a cube object. Position/scale/move the vertices of the cube so that it is placed as shown below.



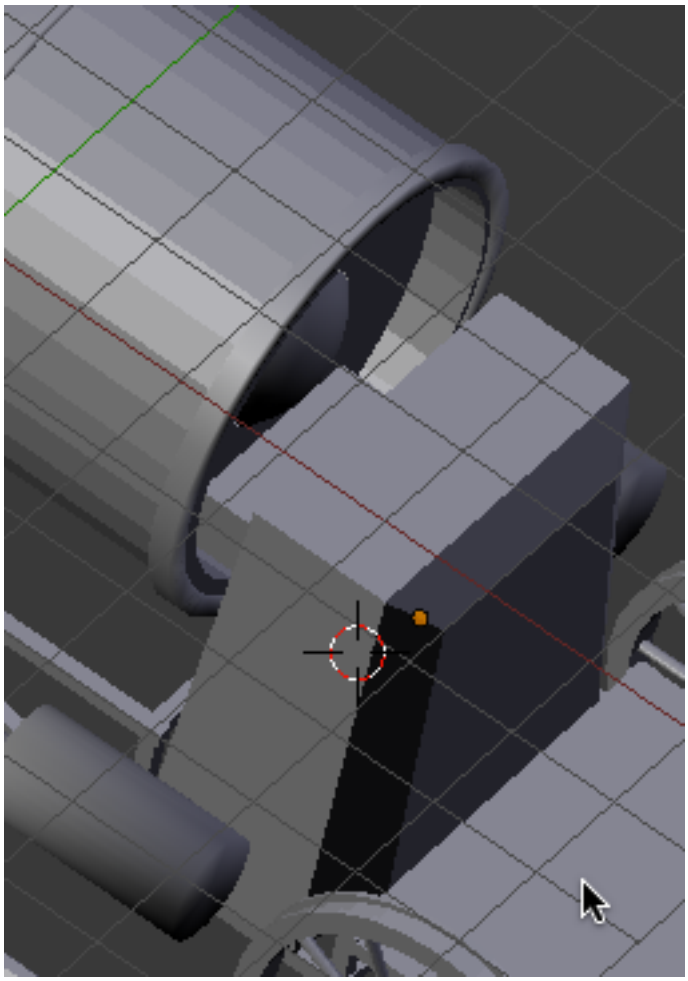
Go to top view. Position the cube object as shown. This is the connection between the furnace and the boiler.



TAB into edit mode and move the left set of vertices along the X-axis into the boiler as shown below.

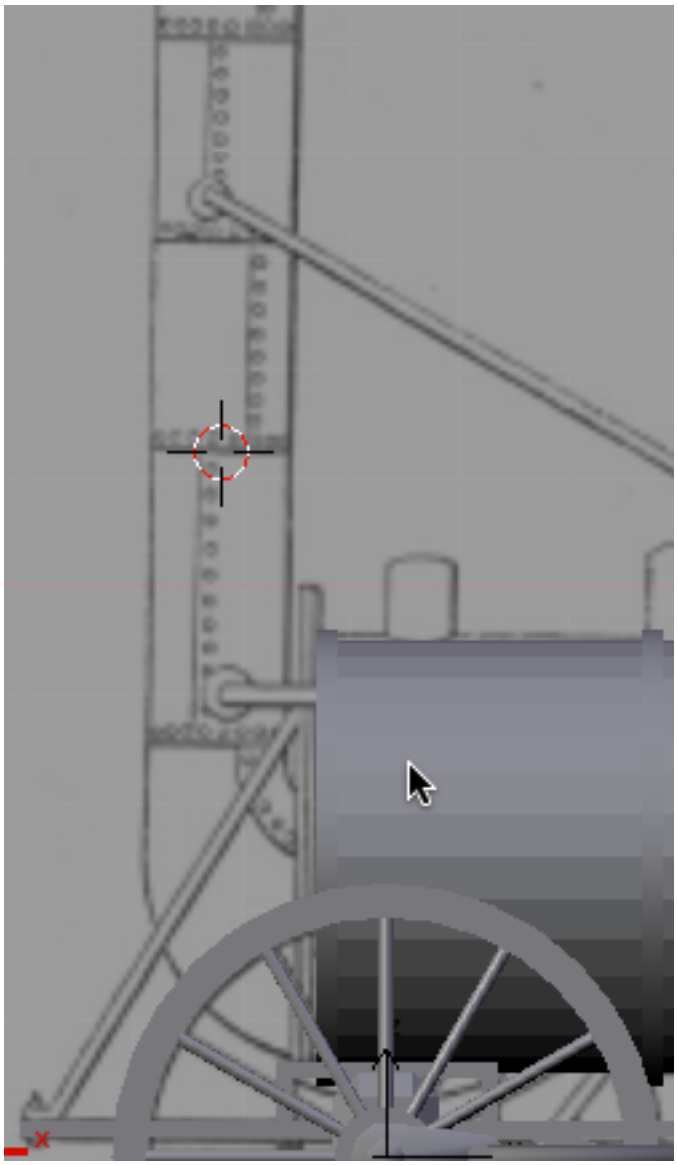


Deselect the vertices. TAB out of edit mode. With the cube object selected, add the furnace object to the selection then press CTRL-J and join the objects into one (named Furnace).

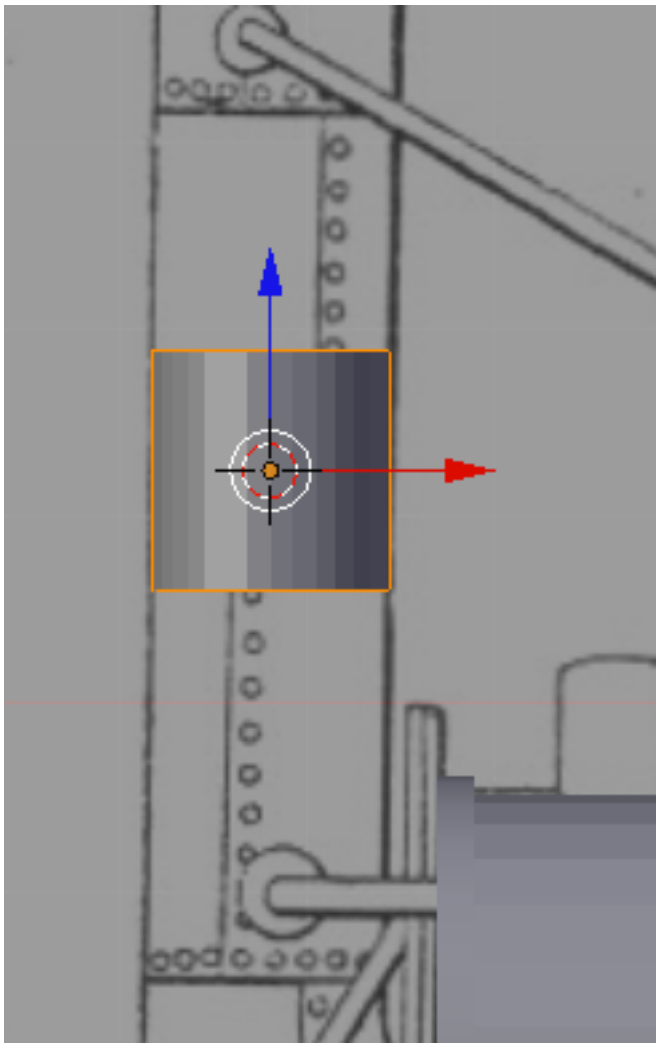


Save your Blender file.

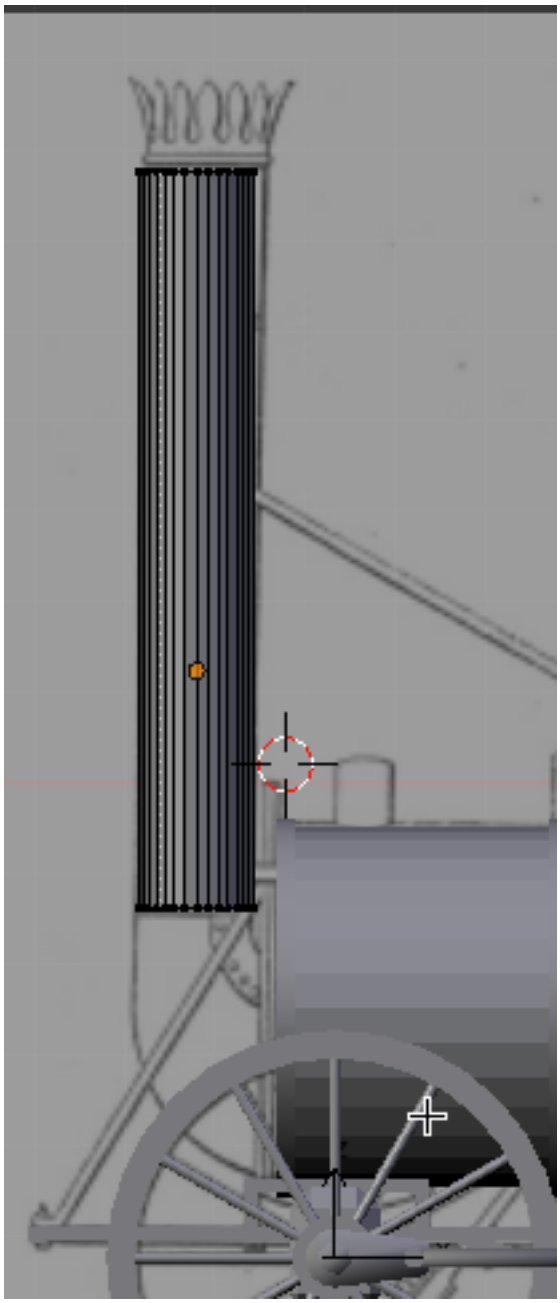
Go to front view. Place your cursor in the center of the smoke stack as shown below.



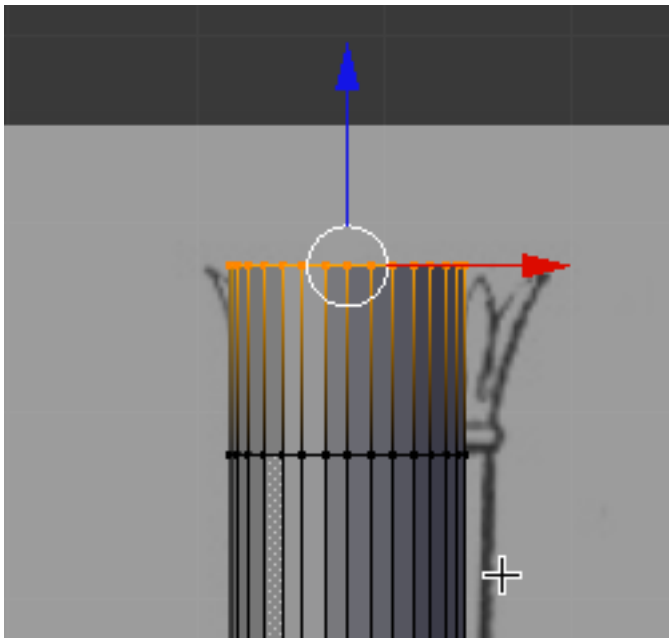
Press SHIFT-A and add an UNCAPPED tube object. Scale it down to the diameter of the smoke stack.



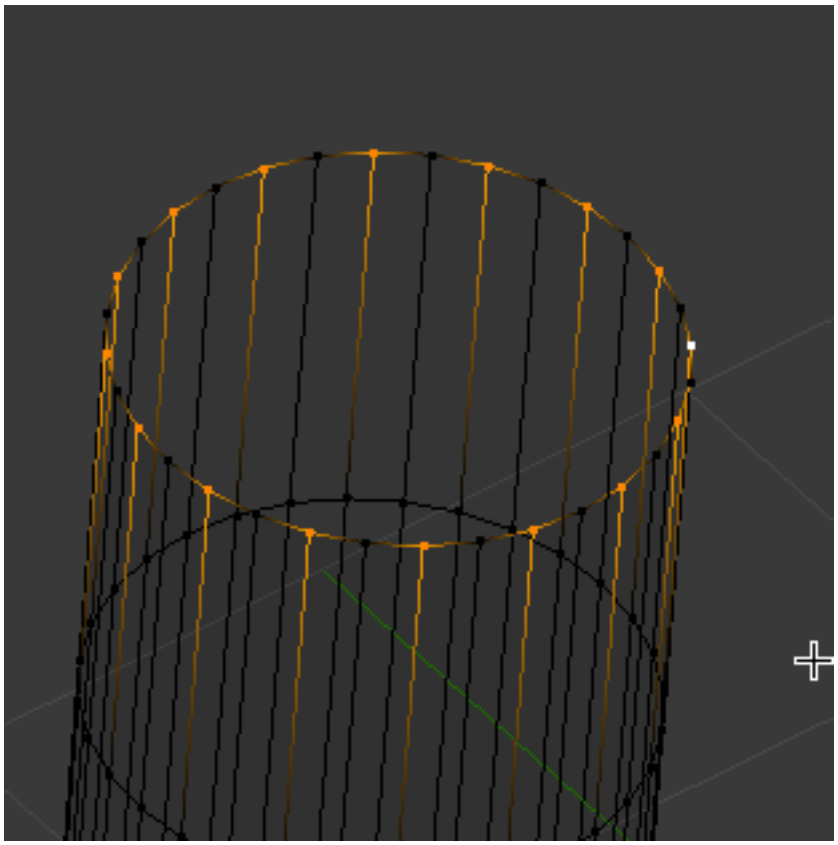
TAB into edit mode and move the top set of vertices up and the bottom set of vertices down as shown below.



Re-select the top set of vertices, press the EKEY followed by the ZKEY and extrude them up a bit as shown below.

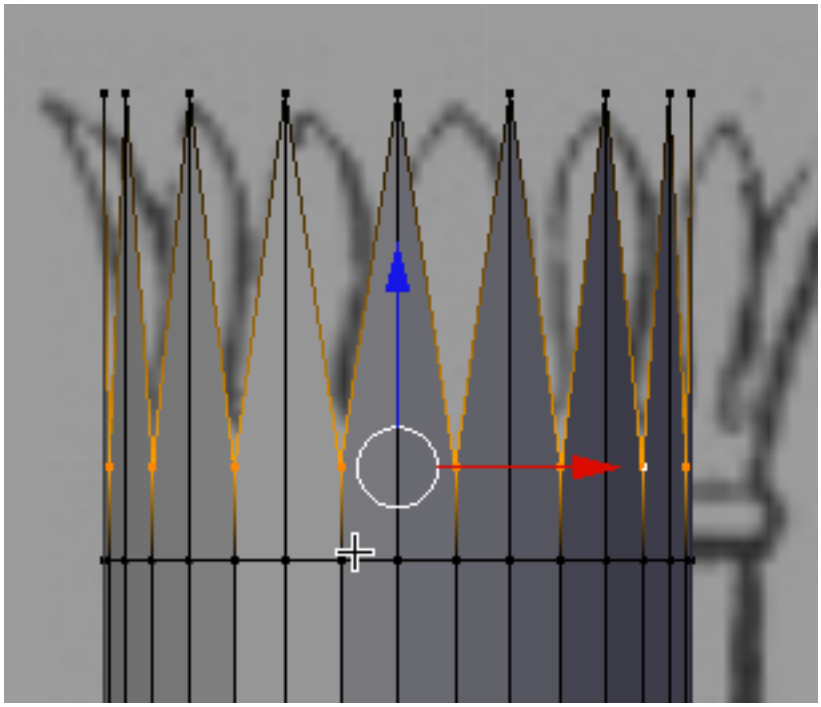


Rotate your view so you can see the top of the smoke stack dimensionally. Select every other vertex in the top ring as shown below (you may have to temporarily turn off your transform widget to clearly see the selected vertices.

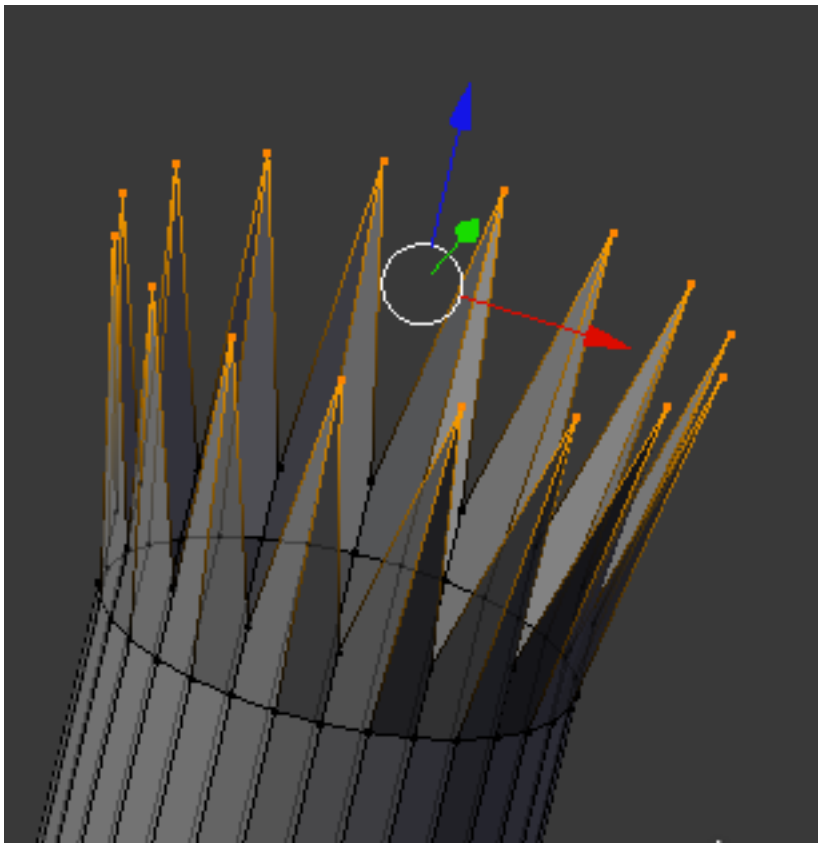


In front view, move these vertices down along the Z-axis as shown below.

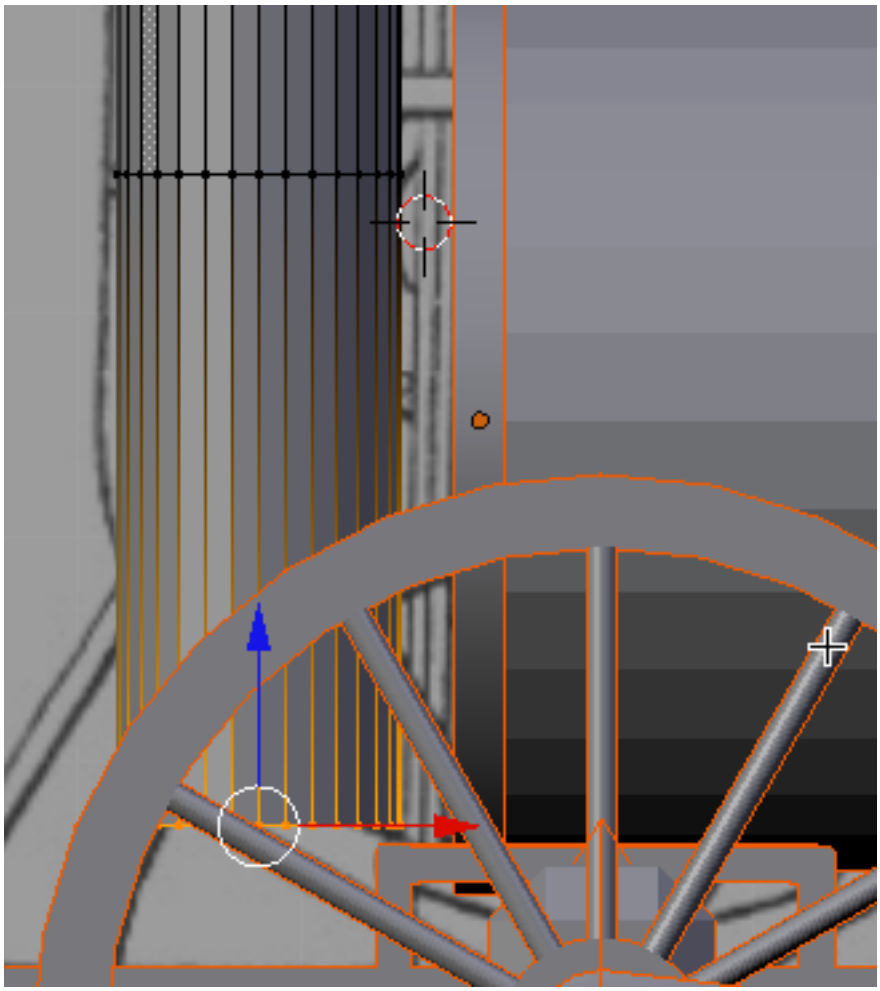
NOTE: If you are having difficulty moving things precisely, click on the translate arrow for the direction you want to move it, then hold your SHIFT key down and move your mouse. The movement will be constrained.



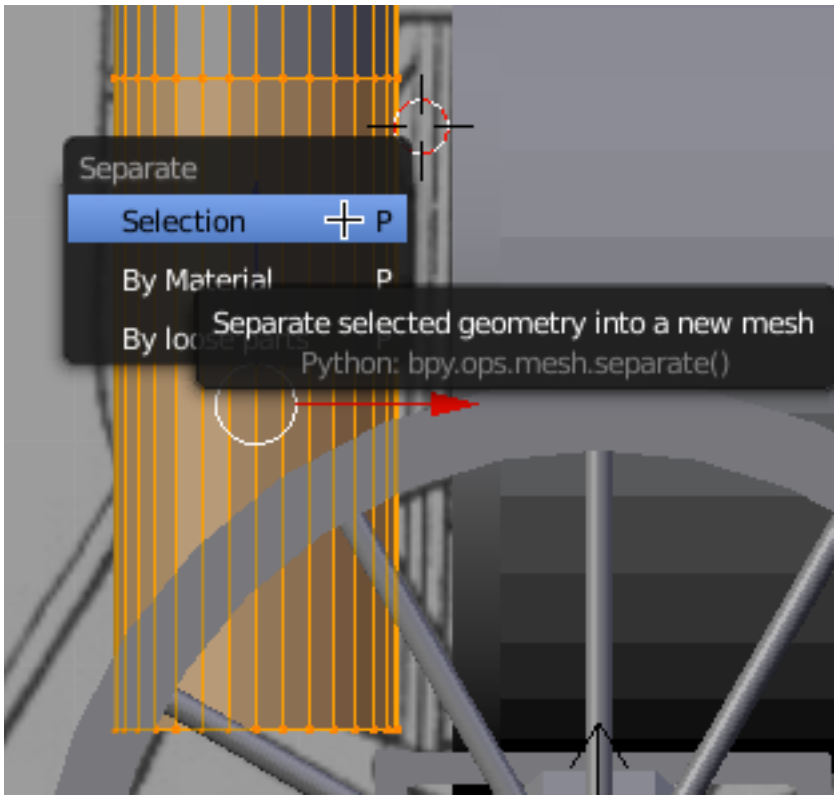
Select the top set of vertices and scale them out a bit as shown below.



Deselect the vertices. Select the bottom set of vertices and press the EKEY followed by the ZKEY and extrude the vertices down along the Z-axis as shown below.

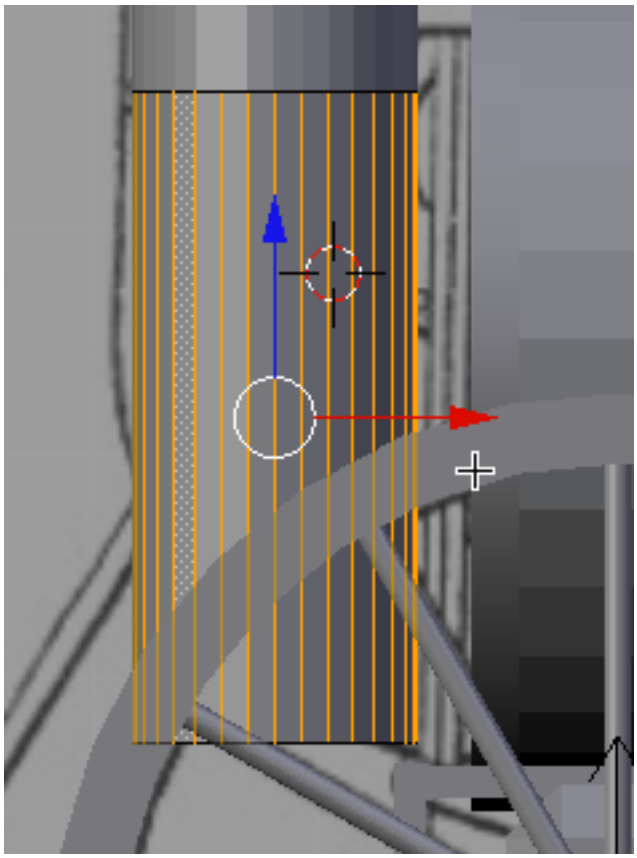


Select the bottom 2 sets of vertices and press the PKEY, which will separate the vertices from the smoke stack and make it its own object.

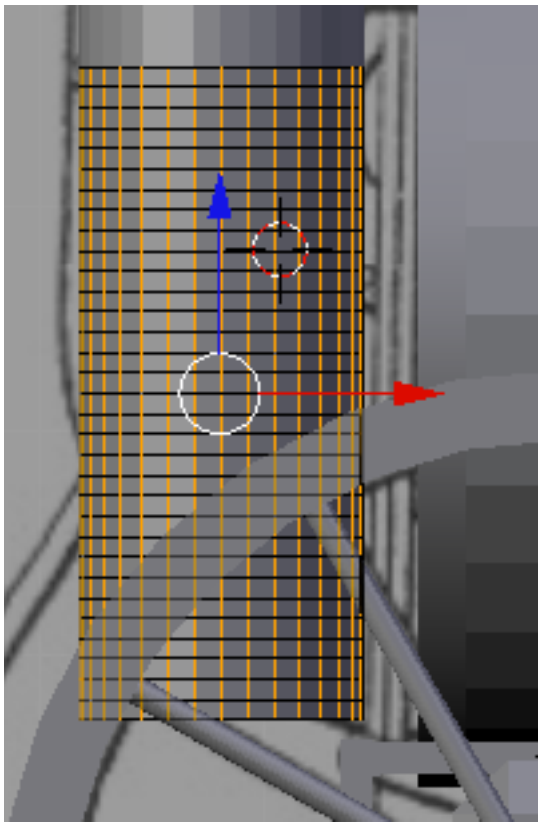



TAB out of edit mode and select the newly separated object. This object will be modified to make the bend from the straight smoke stack section to the boiler object.

TAB into edit mode and deselect the vertices. Press CTRL-TAB and go to edge selection mode.  Box select the center edges.



We need lots of vertices to smoothly make the bend. With the edges selected press the subdivide button in the 3D editor tools panel 5 times.



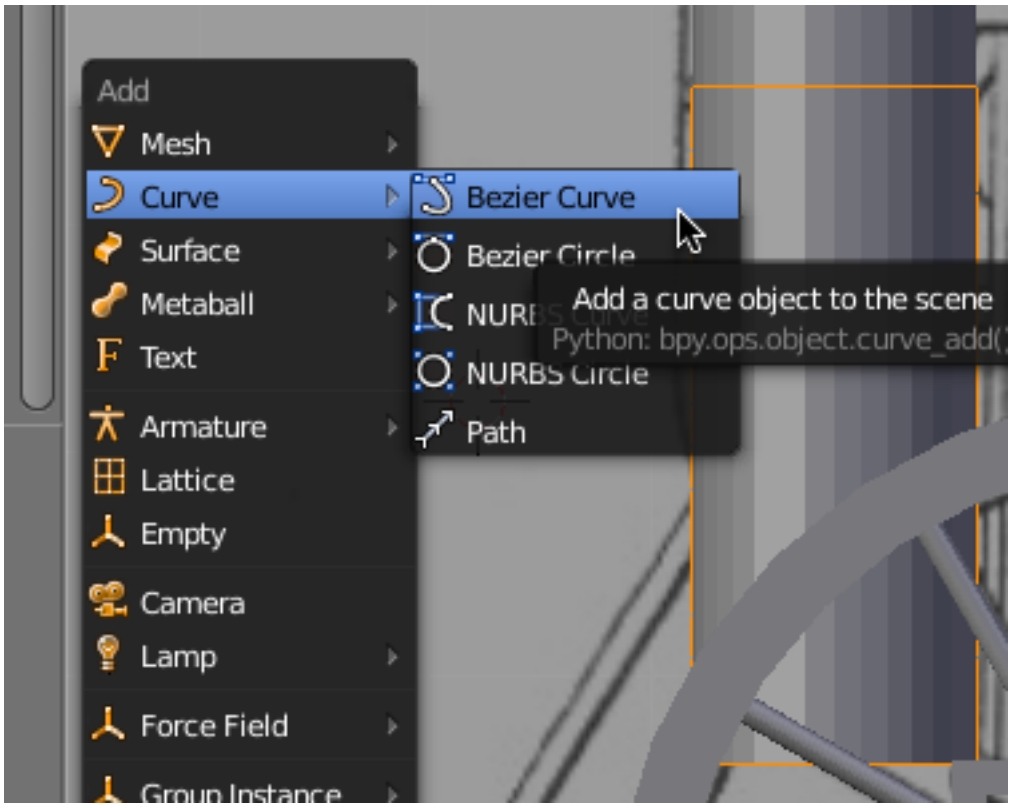
Press CTRL-TAB and go back to vertex select mode. TAB out of edit mode.

Press SHIFT-CTRL-ALT-C and set the origin to the geometry.

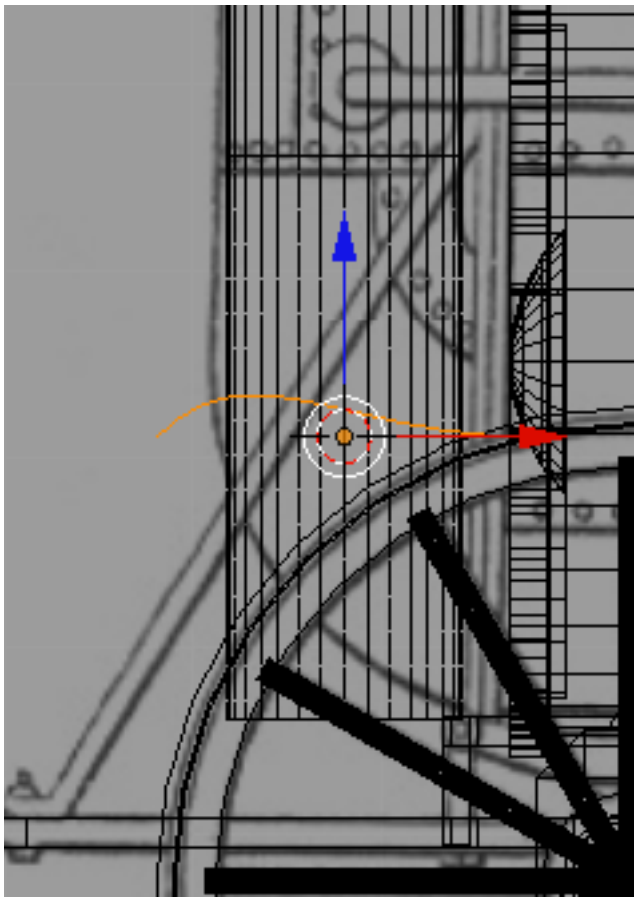
We will add a Curve modifier to the separated object to transition from the vertical stack to the horizontal boiler.

To do this we will first need a curve object to use as the target of the bend modifier. With the separated object still selected, press SHIFT-S and snap your cursor to the selected object.

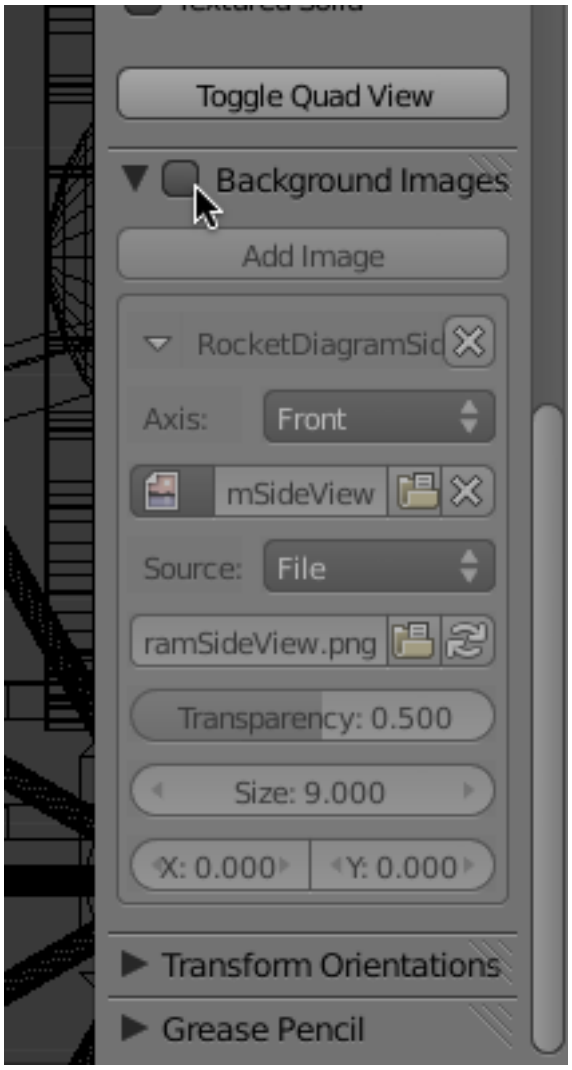
Press SHIFT-A and add a Bezier curve object.



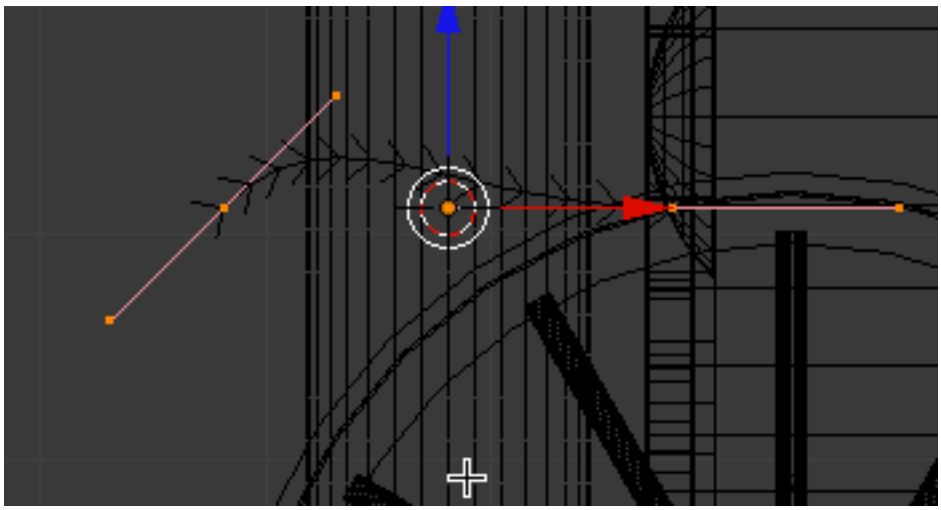

Set the X rotation of the Bezier curve object to 90 degrees. Go to wireframe display mode.



Uncheck the background image display box in the 3d editor properties panel so we can see this better.

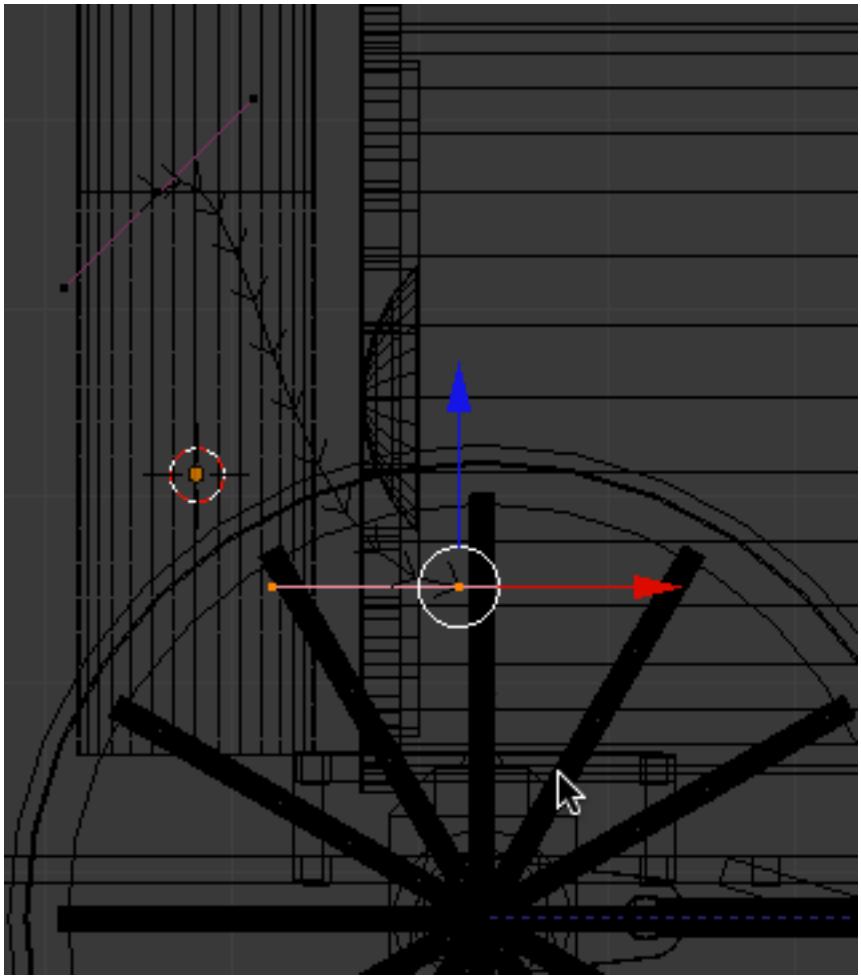



TAB into edit mode.

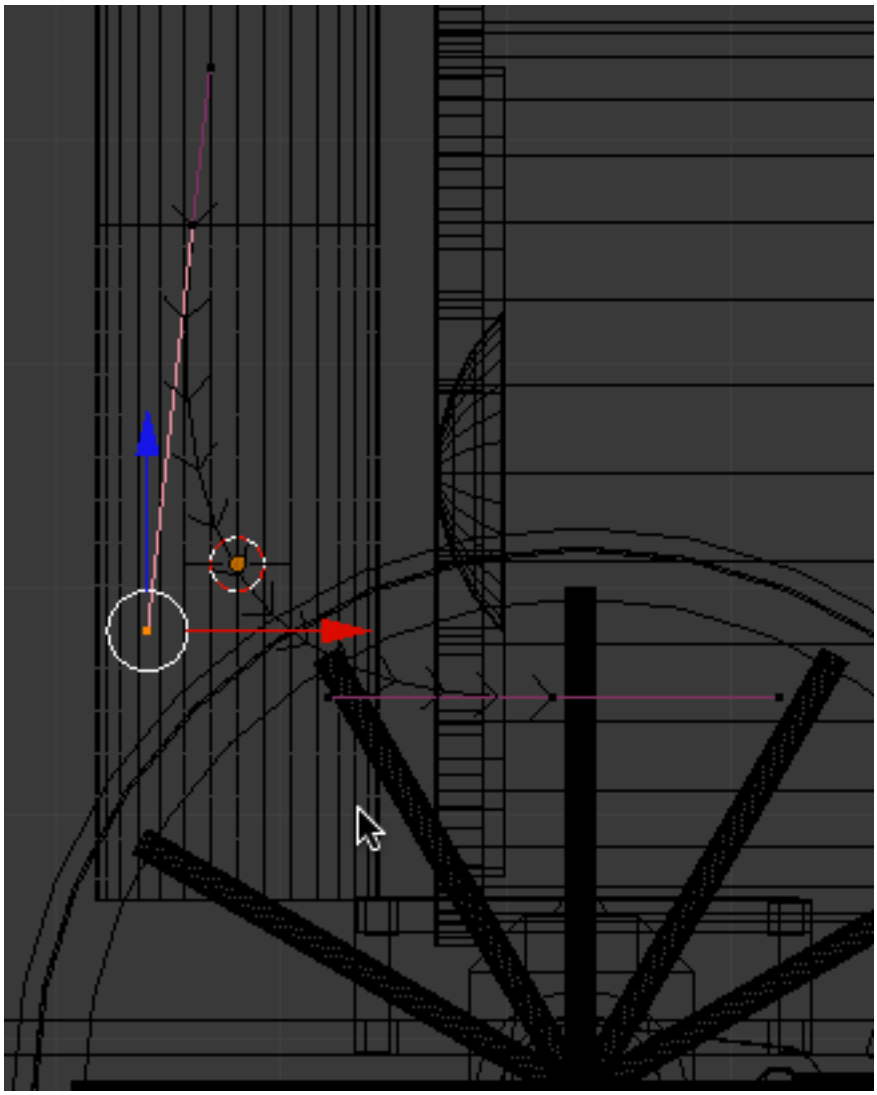


The Bezier curve has two end control vertices and each of them has two extended “arms” that control the curve going into and out of the control vertex.

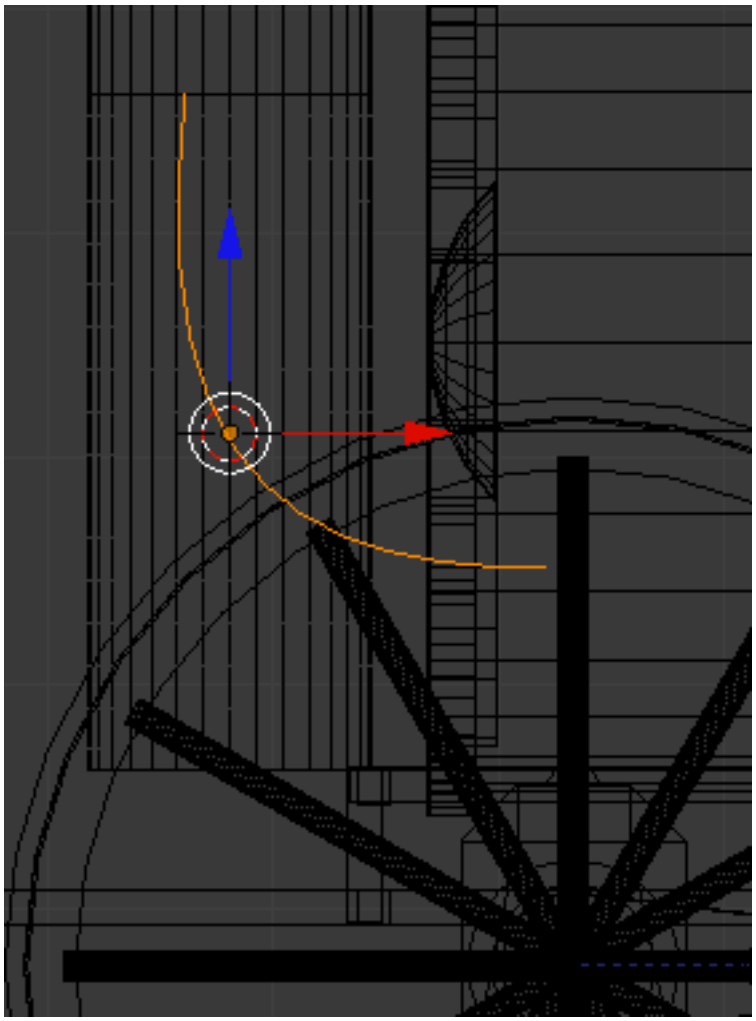
Grab the top control vertex and place it a little to the upper left and grab the lower control vertex and place it a little to the lower left.



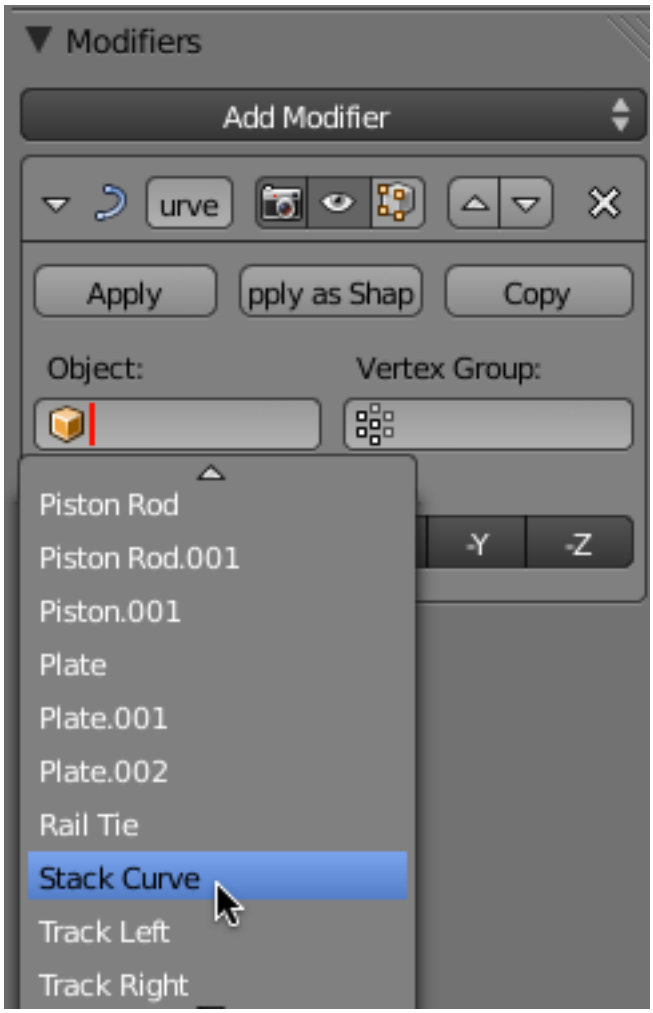
Move the extended arms and/or the control vertices to get a curve shape something like this. (All I did to get this shape is grab the upper extended arm control and move it down and to the left)



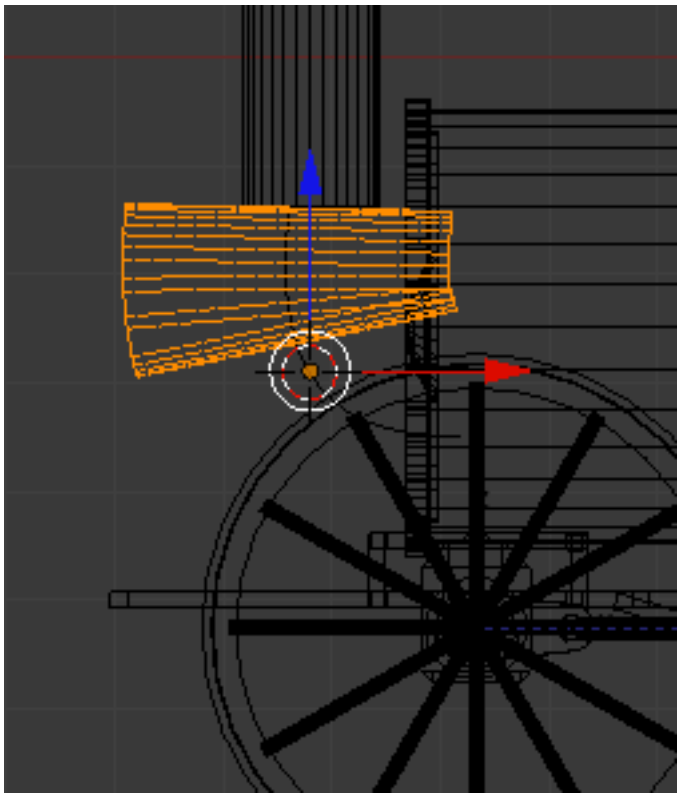
TAB out of edit mode and name this object “Stack Curve”.



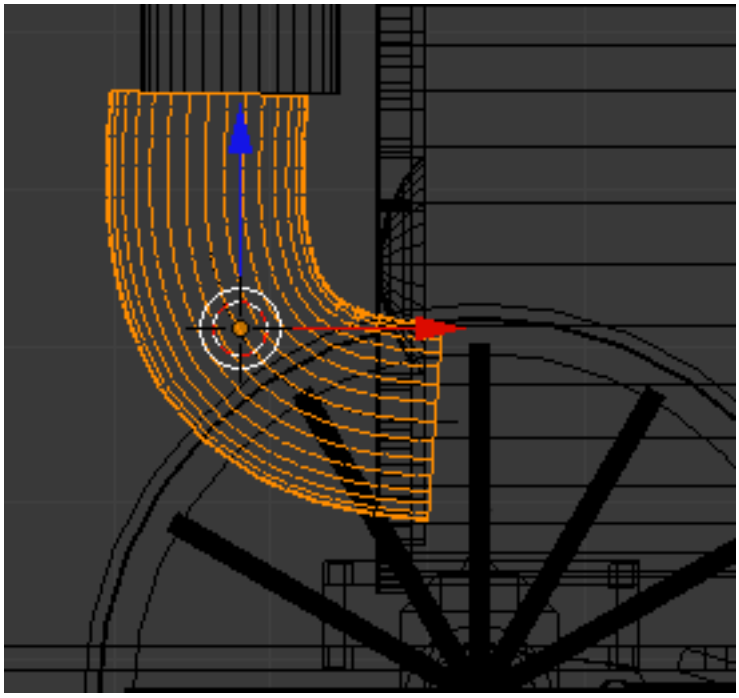
Select the separated object. Add a Curve modifier to the object. Click on the Object box and select the Stack Curve as the object.




Note the separated object will look a bit twisted.

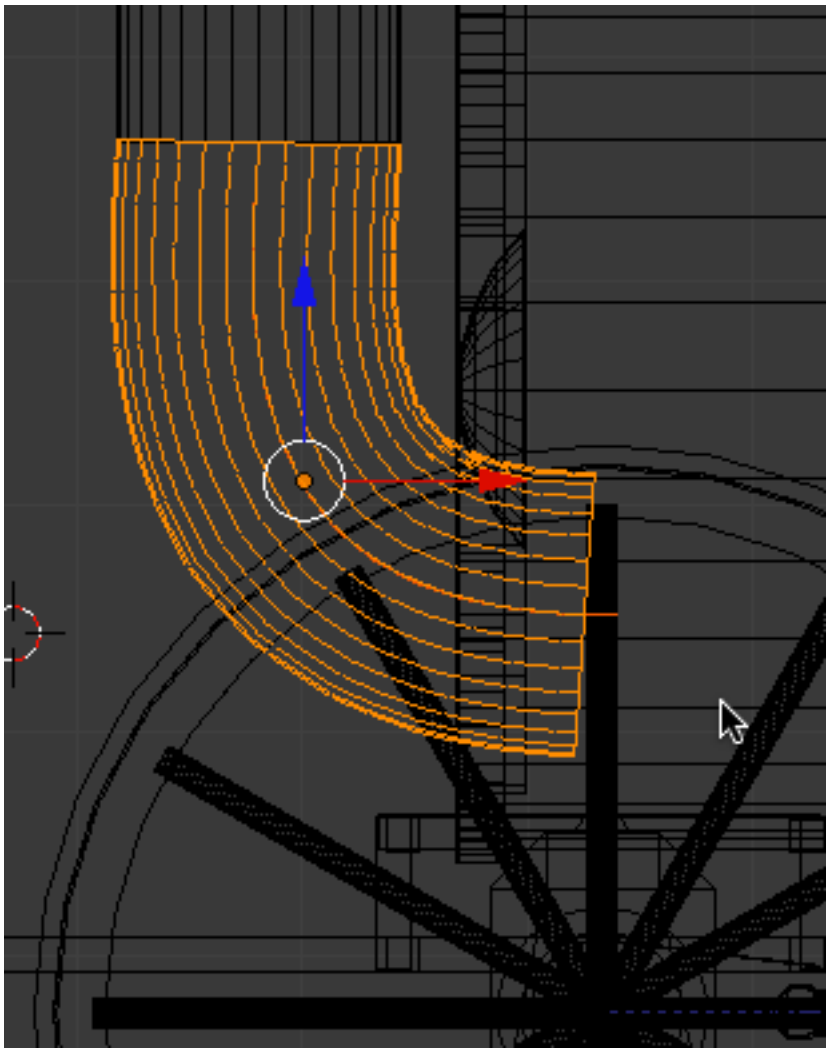


In the modifier panel, select “Y” as the deformation axis.



The curve of the separated object is controlled by the location and shape of the Stack Curve object. We can select the target stack curve object and TAB into edit mode and alter the curve and the separated object will reflect those edits.

All we should have to do here is deselect the objects, then select the stack curve object and then add the separated object to the selection and move them to the right a bit.



Note: Depending on the shape you created with the stack curve object, you may have to edit the stack curve object a bit to get this result. Just remember that if you move the separated object you will need to move the stack curve along with it.

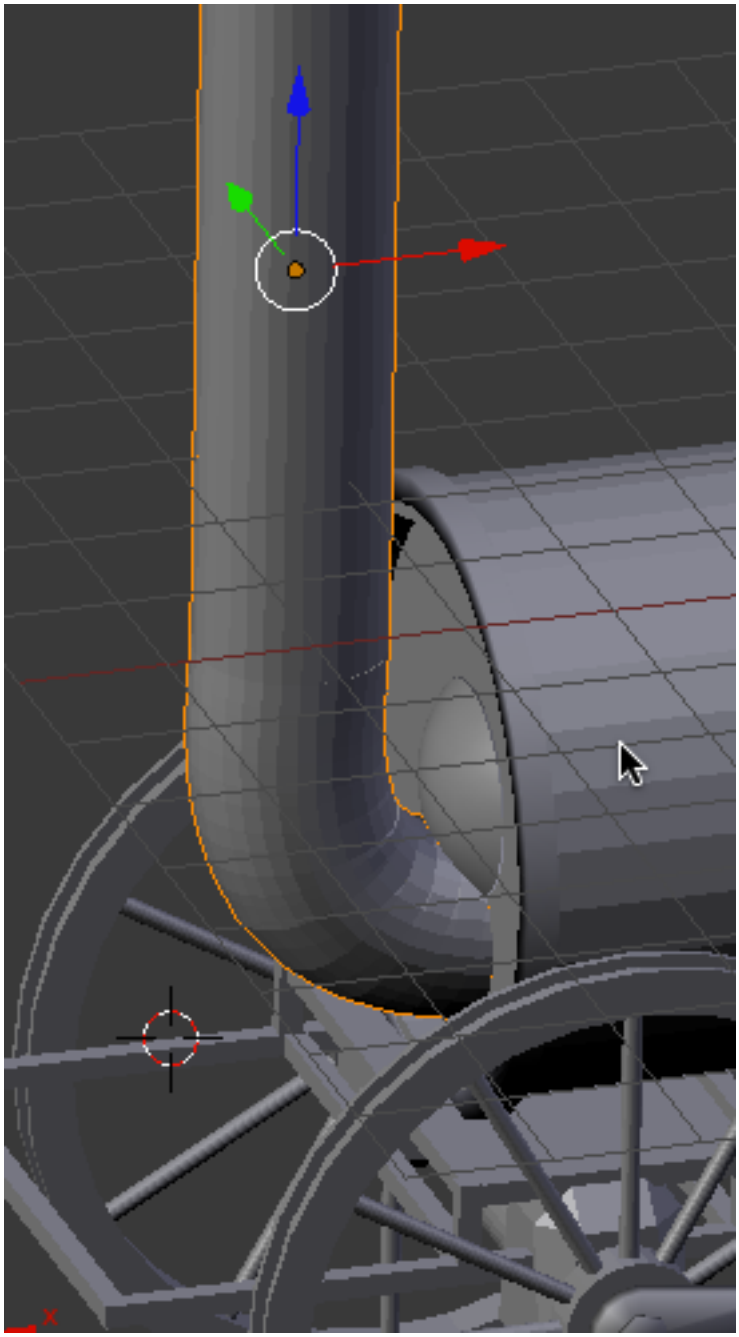
Once you get the shape and bend the way you want it, click on the APPLY button in the modifier stack. This will set the curve on the separated object.

We can then select the stack curve object and delete it.

After you have APPLIED the modifier and deleted the stack curve, select the separated object and add the upper smoke stack object to the selection and press CTRL-J and join them into one object.

Name this object “Smoke Stack”.

Then go to top view and move the smoke stack object along the Y-axis so it is centered in the boiler object.

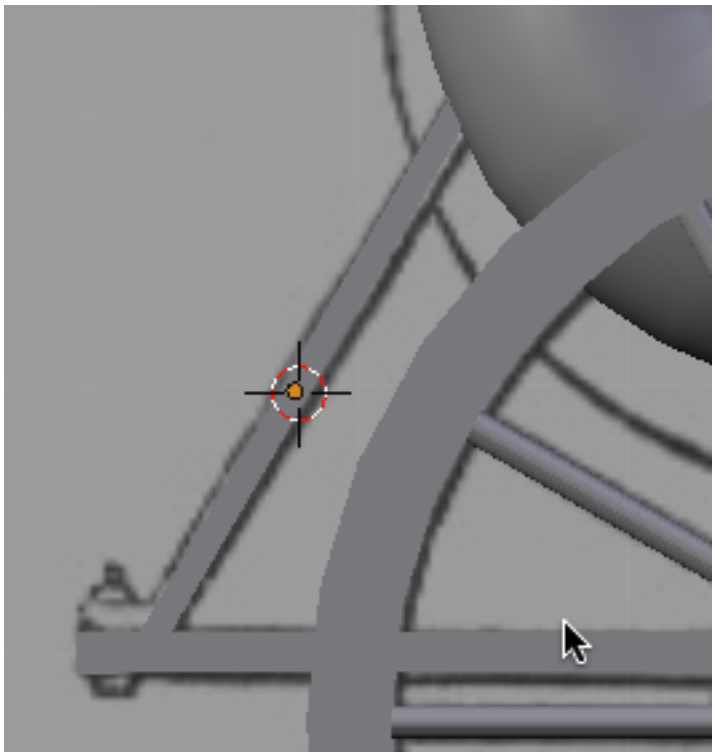


With the smoke stack object selected press the smooth button in the 3d editor viewport tools panel.

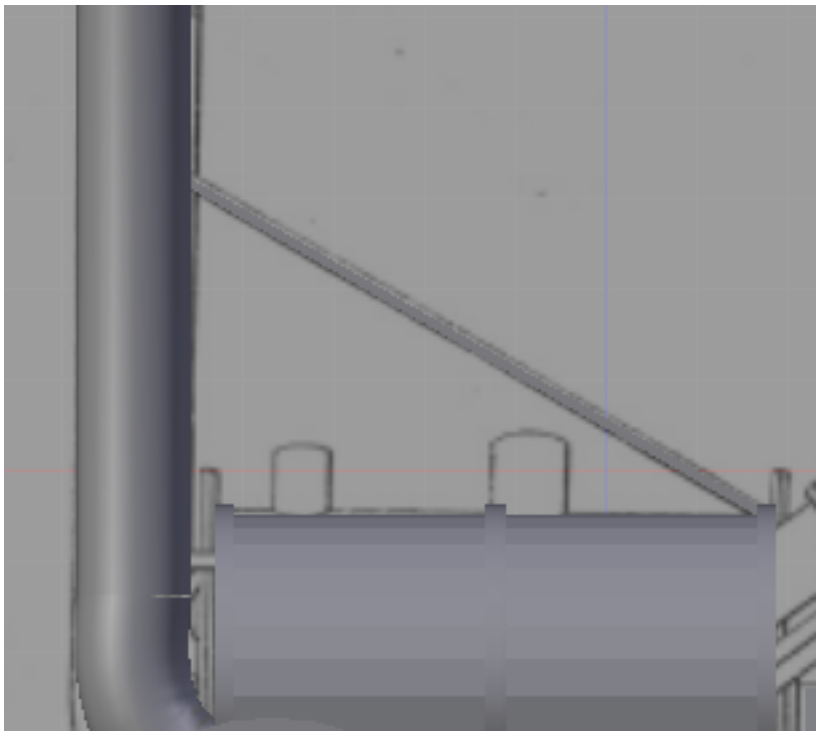
Save your Blender file.

Go to front view and turn back on the background image by checking the checkbox.

Next, model the 2 frame supports for the smoke stack from cubes dimensioned at .1 x .1 x .1  The first one is at the very front here.



And the second is on the top here.

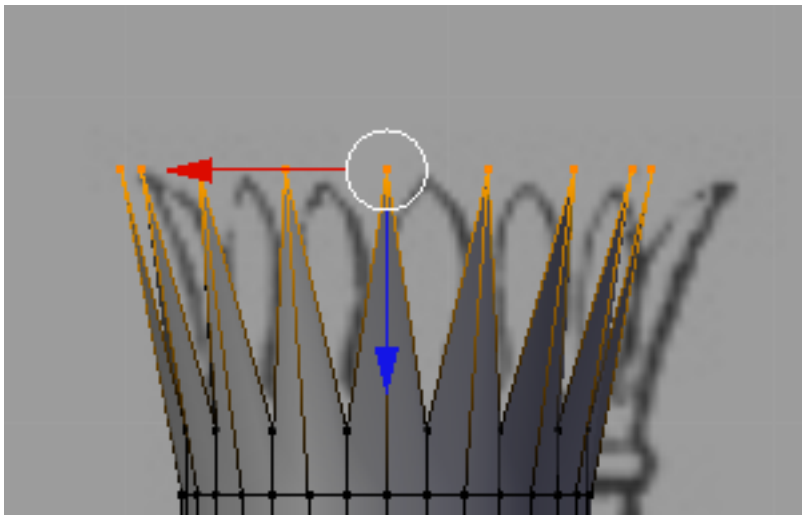


Name these objects “Support Rod” 1 and “Support Rod 2”

We will model some collars for the smoke stack. Select the smoke stack object.

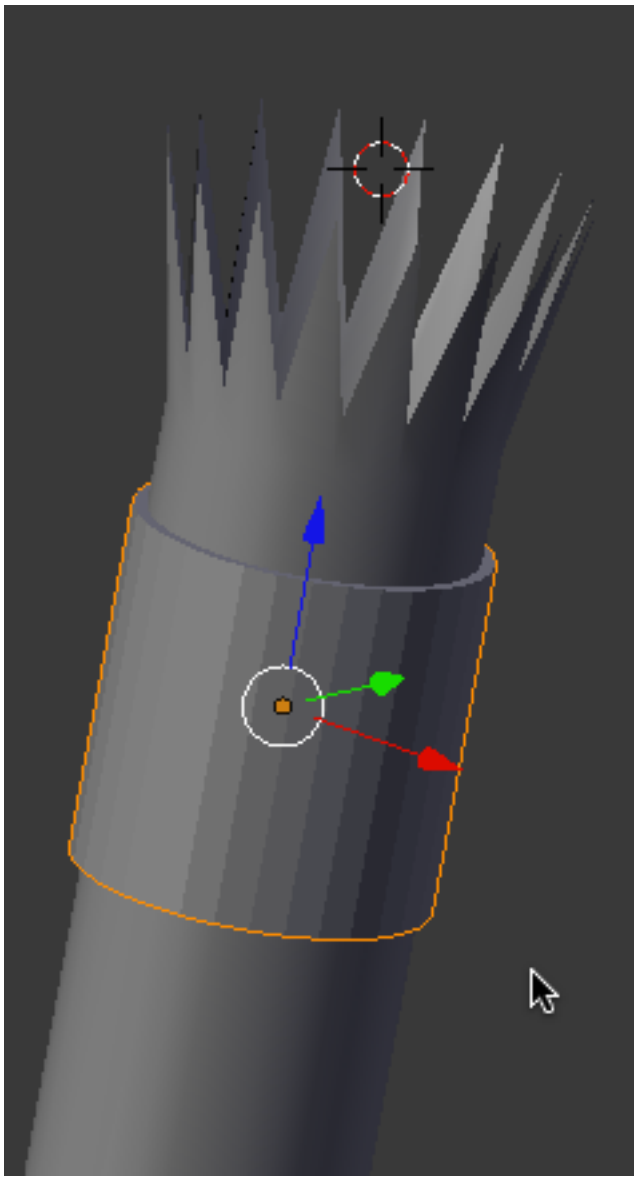
We want to find the very center of the upper smoke stack. However, centering the origin to the geometry will not work this time because the lower portion of the stack bends off into the boiler.

Instead, TAB into edit mode. Deselect the vertices. Box select the very top set of vertices

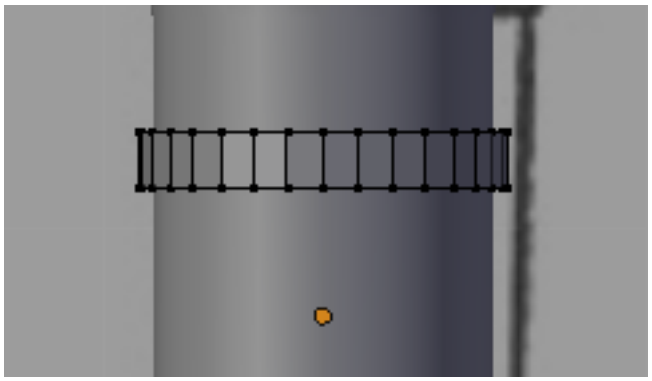


Next press SHIFT-S and snap your cursor to the selected vertices. This places the cursor in the very center of the upper stack.

TAB out of edit mode.  Press SHIFT-A and add a capped tube object. Move the tube down along the Z-axis a bit and then scale the tube down so it is just slightly wider than the stack.



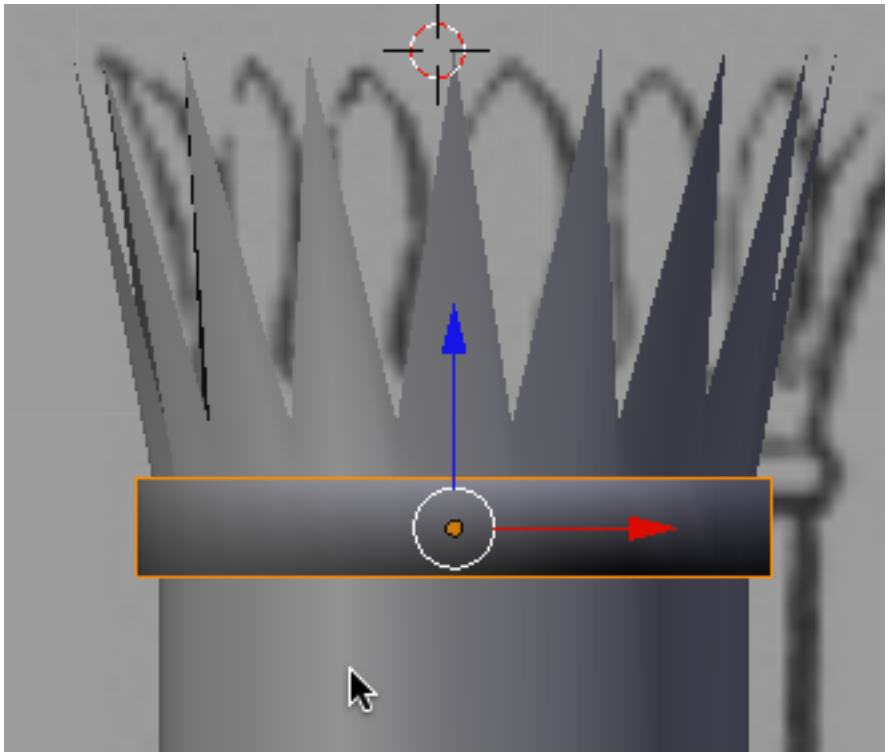
TAB into edit mode and box select the lower set of vertices and move them up to set the collar size.



TAB out of edit mode. Press SHIFT-CTRL-ALT-C and select origin to geometry. Name this object “Stack Collar”.

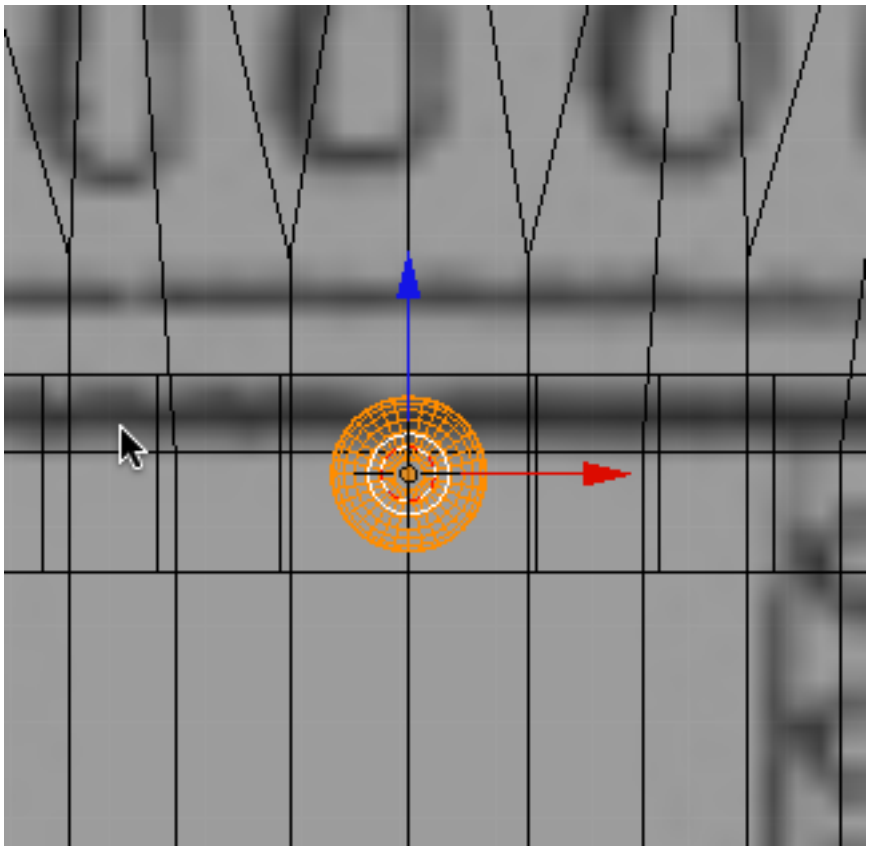
Press the Smooth button to smoother the collar object.

Move the stack collar up smoke stack to just below the crown.

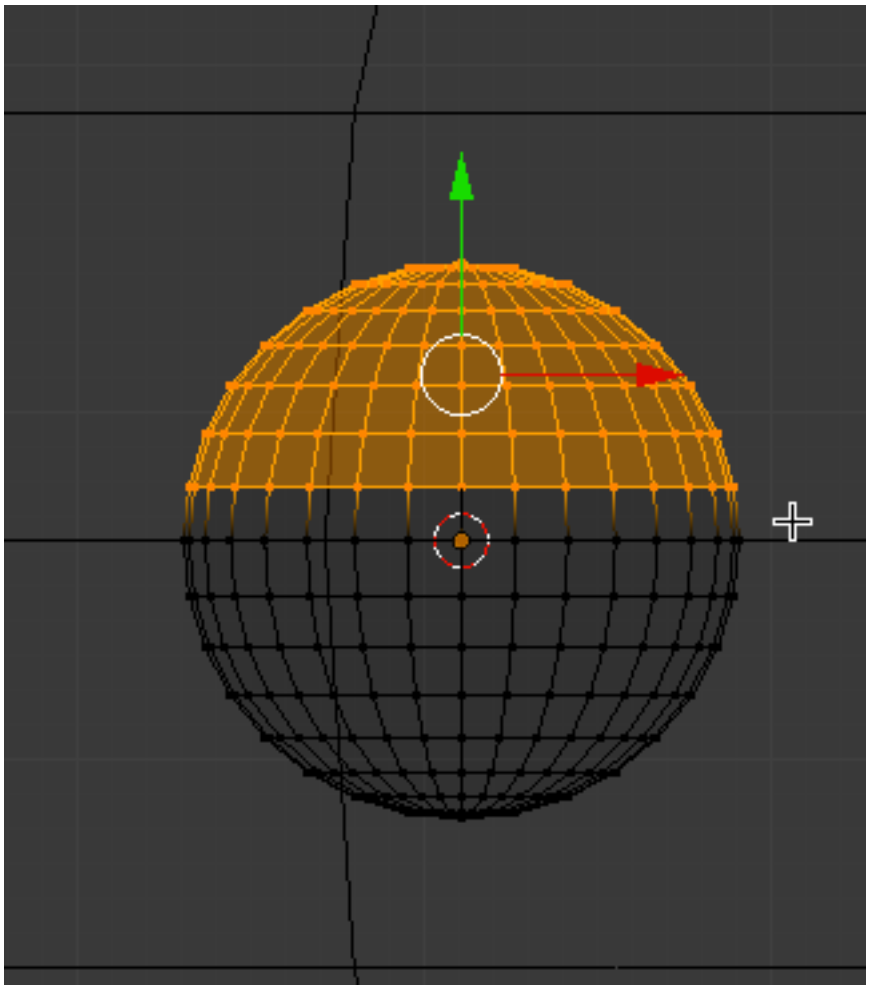


We will next model some rivets that ring the collar object. With the stack collar object selected, press SHIFT-S and snap your cursor to the selected object.

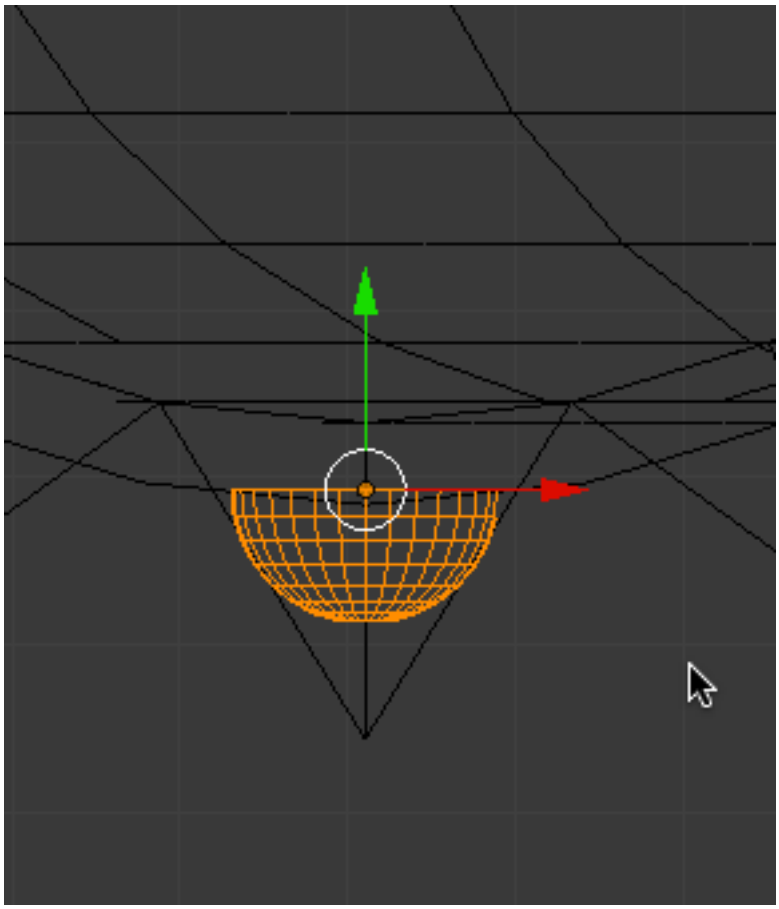
Go to front view. Press SHIFT-A and add a UV Sphere object. Go to wireframe display mode. Set the X rotation to 90 degrees. Scale the sphere down to a size that fits inside the height of the collar object as shown below.



Go to top view. TAB into edit mode. Deselect the vertices. Box select the top half of vertices as shown below.

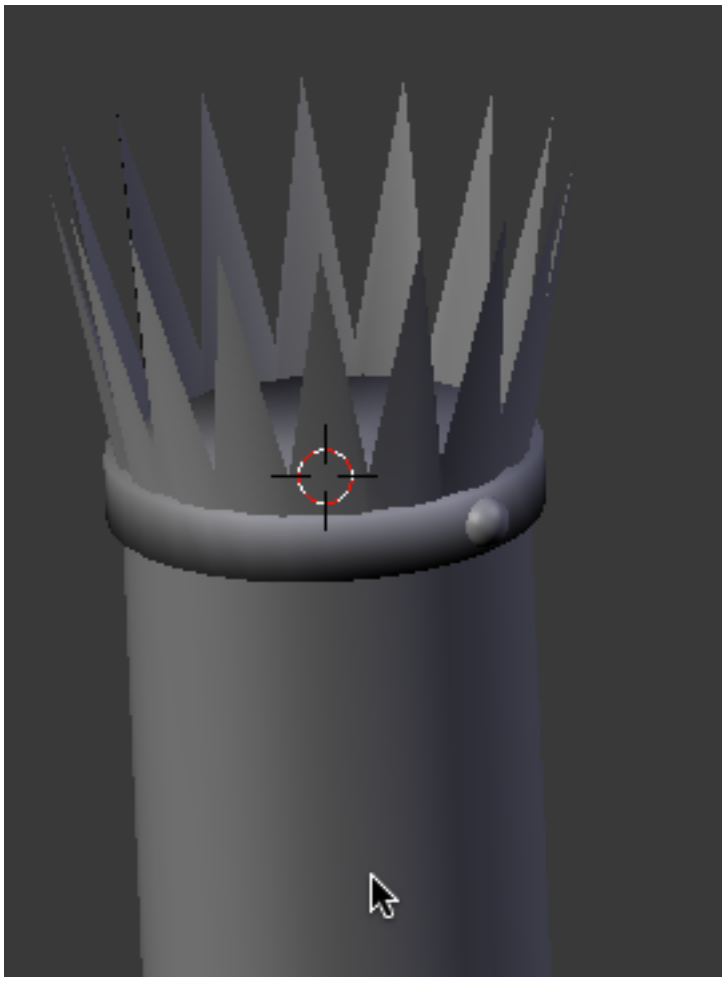


Press the XKEY and delete the vertices.  TAB out of edit mode. Select the object and move it down along the Y-axis so that it is just outside of the collar object as shown below.



Name this object “Collar Rivet”.

Press the Smooth button to smooth the object.

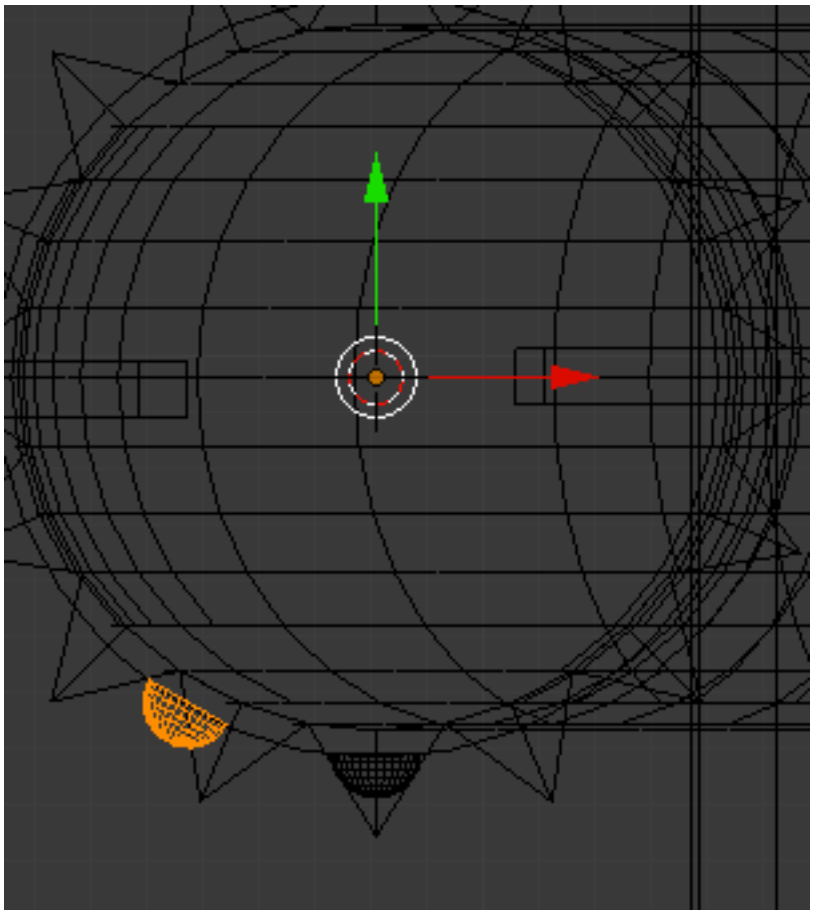


We will add some duplicate rivets. Select the stack collar object. Press SHIFT-S and snap your cursor to the selected.

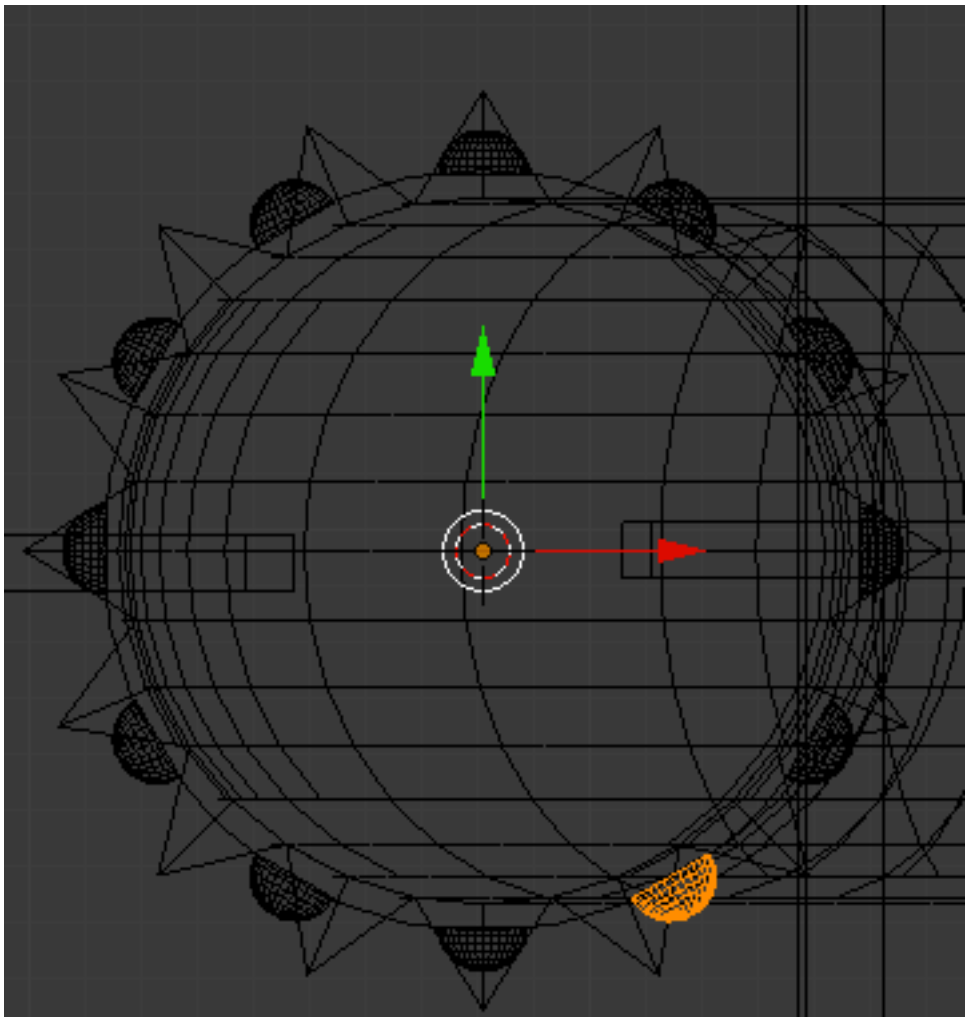
Then select the Collar Rivet object and press SHIFT-CTRL-ALT-C and select ORIGIN TO 3D CURSOR. This will place the rivets origin point at the center of the stack.

Press SHIFT-D, then the RKEY then the ZKEY then 30 then ENTER.

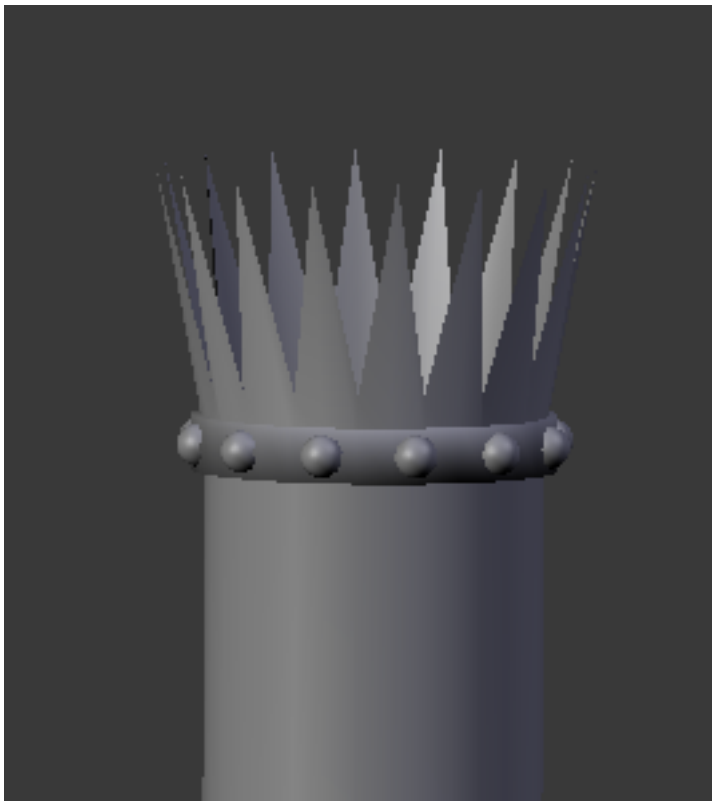
This places a duplicate rivet object 30 degrees around the collar.



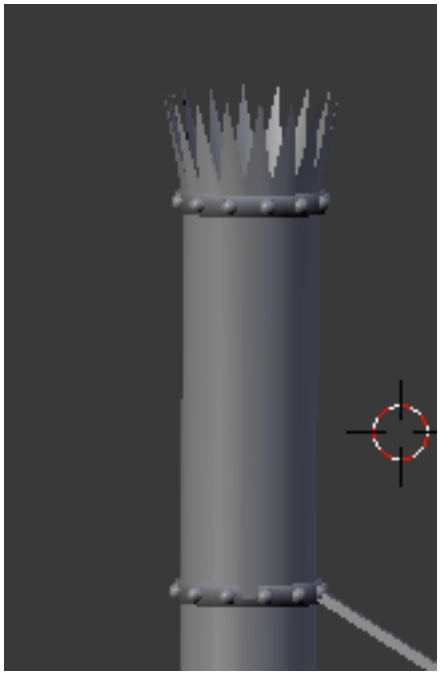
Repeat this 10 more times.



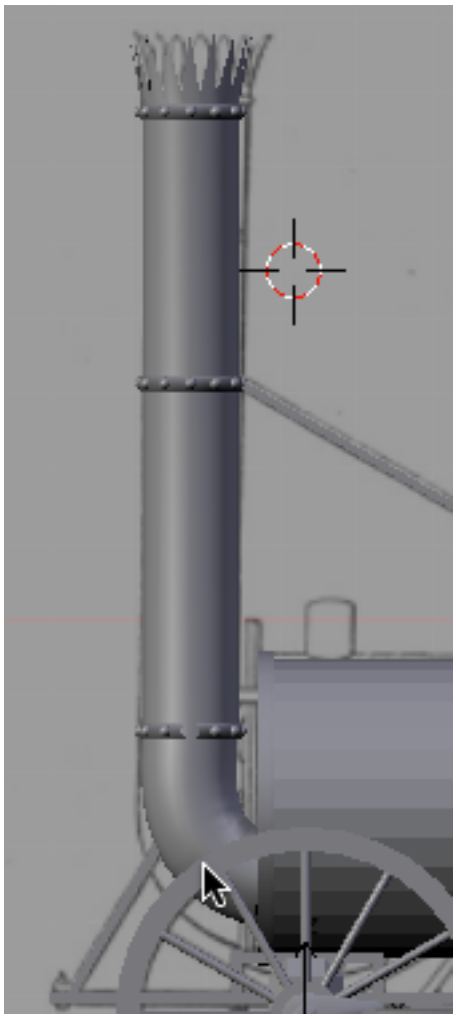
Select all 12 rivet duplicates and press CTRL-J and join them into one object named “Collar Rivet”.



Go to front view. Select the Stack Collar and the Collar Rivets objects and press SHIF-D and make a duplicate of both objects. Move the duplicate objects down the stack along the Z-axis as shown below.

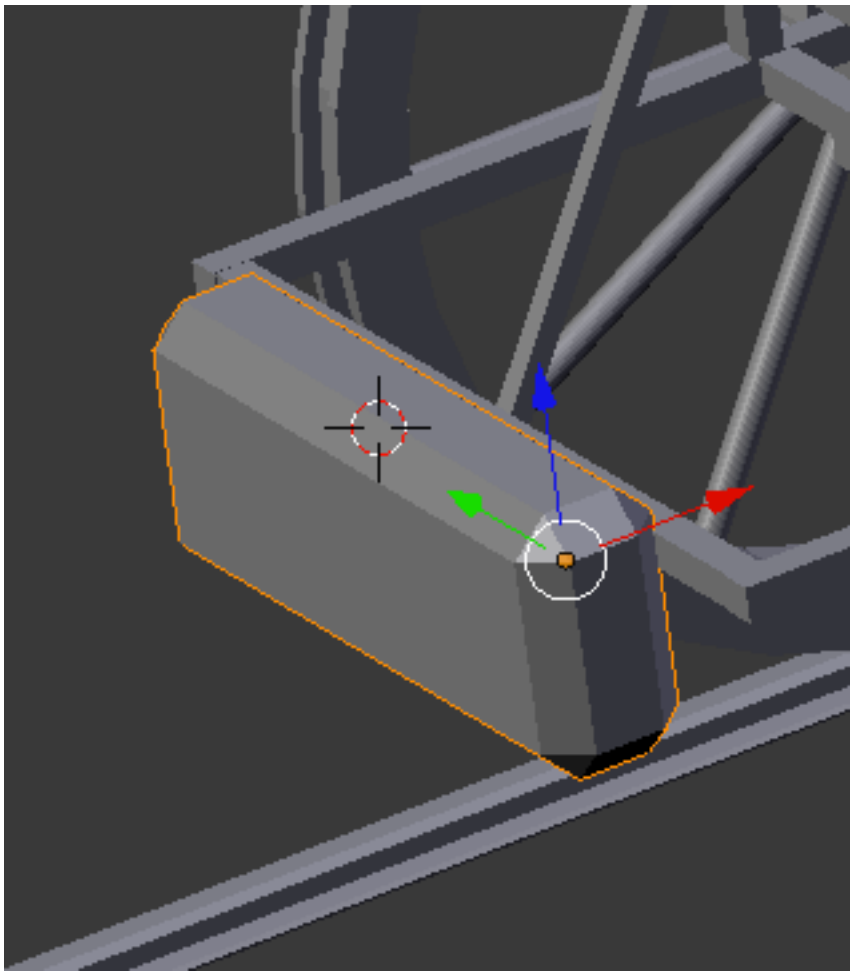


Make another duplicate set and place it at the joint created by the smoke stack bend as shown below.

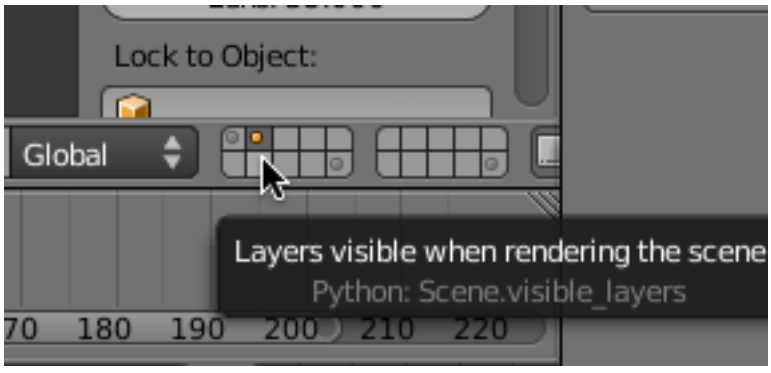


Save your Blender file.

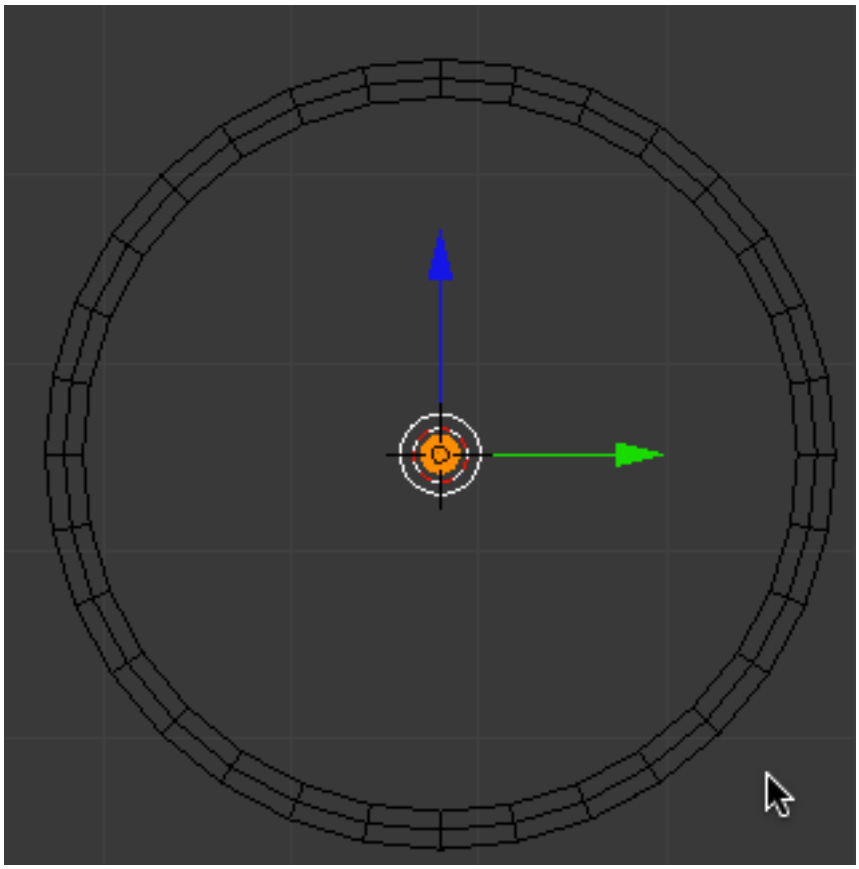
We will add a front bumper to the engine. Model a rectangular cube and then apply a bevel modifier with the width settings set to .5  Name this object Front Bumper and place the object as shown below.



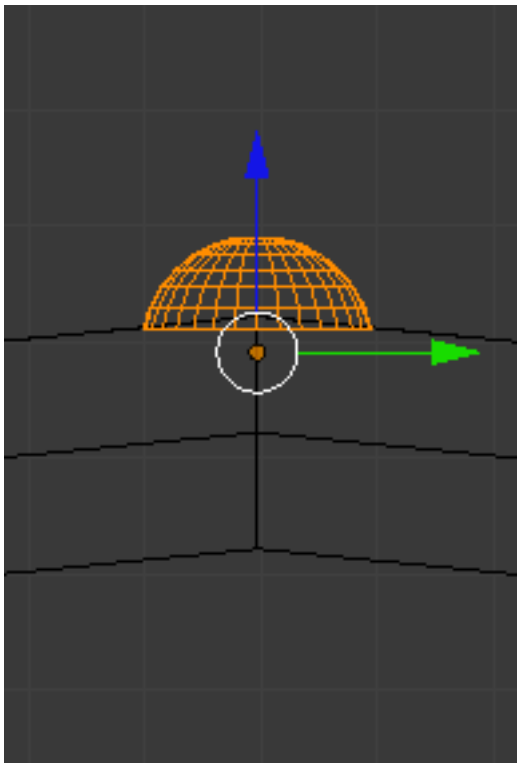
Select the Boiler Rim object that we created earlier. We will add a series of rivets to this object as well. With the Boiler Rim object selected press the MKEY and place it on layer 2 to isolate it. Then go to layer 2.




Go to side view. Press SHIFT-S and snap your cursor to the selected object. Press SHIFT-A and add a UV Sphere object. Go to wireframe mode. Scale the UV sphere object down quite small as shown below.



TAB into edit mode. Deselect the vertices. Box select the bottom half of the vertices and delete them. TAB out of edit mode. Move the object up along the Z-axis until it is just outside of the rim object as shown below.

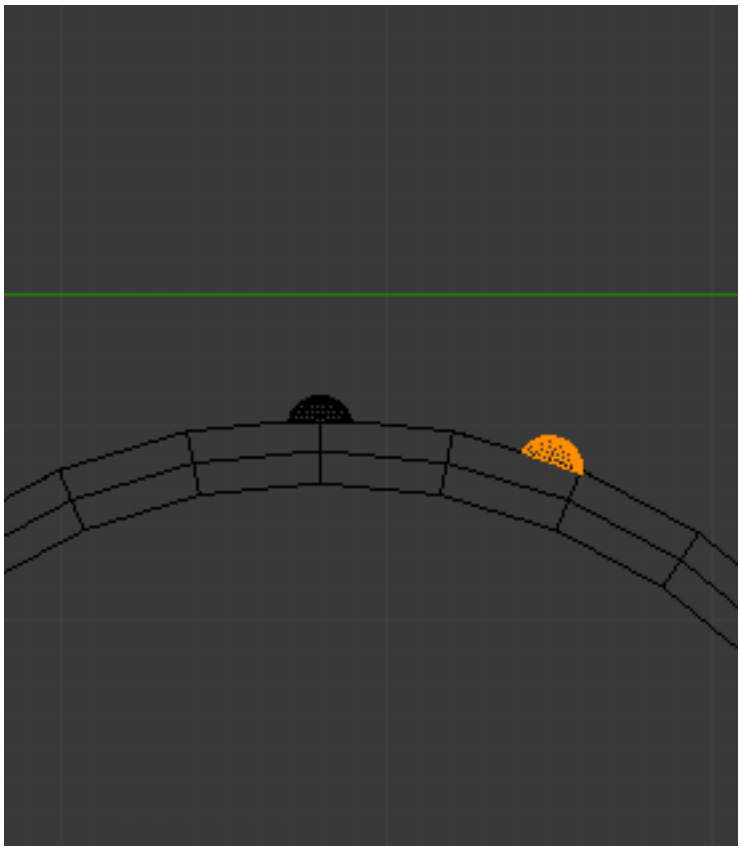


Press the Smooth button in the 3d editor viewport tools panel to smooth the object. Name this object “Rim Rivets”.

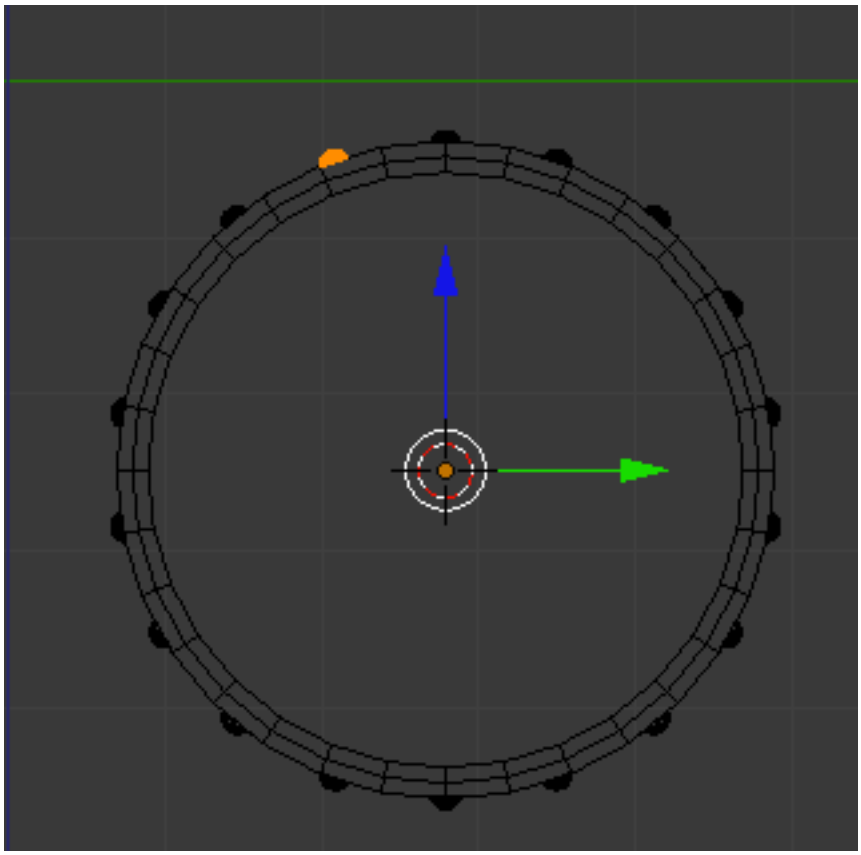
Select the boiler rim object and press SHIFT-S and snap your cursor to the selected (if it is not still there). Select the rim rivet object and press SHIFT-CTRL-ALT-C and set the ORIGIN TO THE 3D CURSOR.

With the rim rivet object selected, press SHIFT-D then the RKEY then the XKEY then 20 and then press ENTER.

This will make a duplicate rivet and place it 20 degrees about the rim.

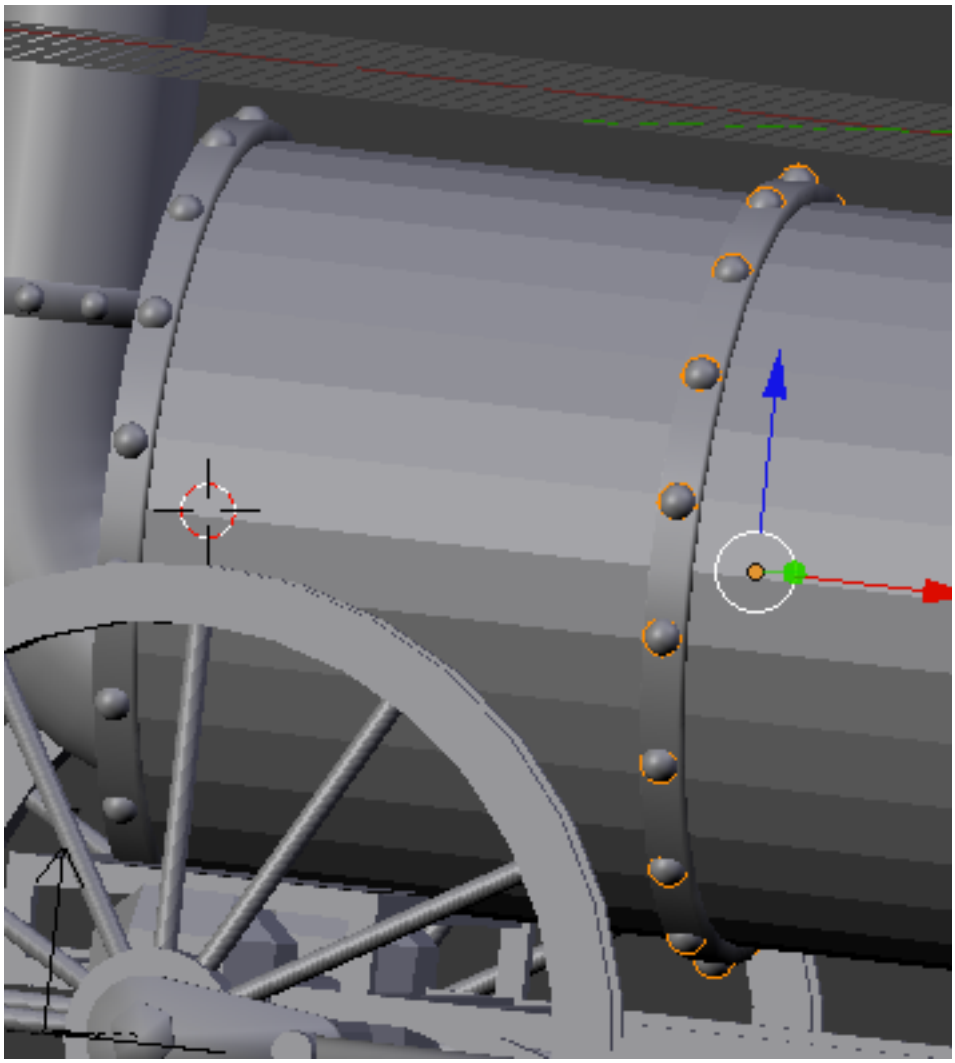


Repeat this sequence 16 more times creating rivet objects around the boiler rim object.

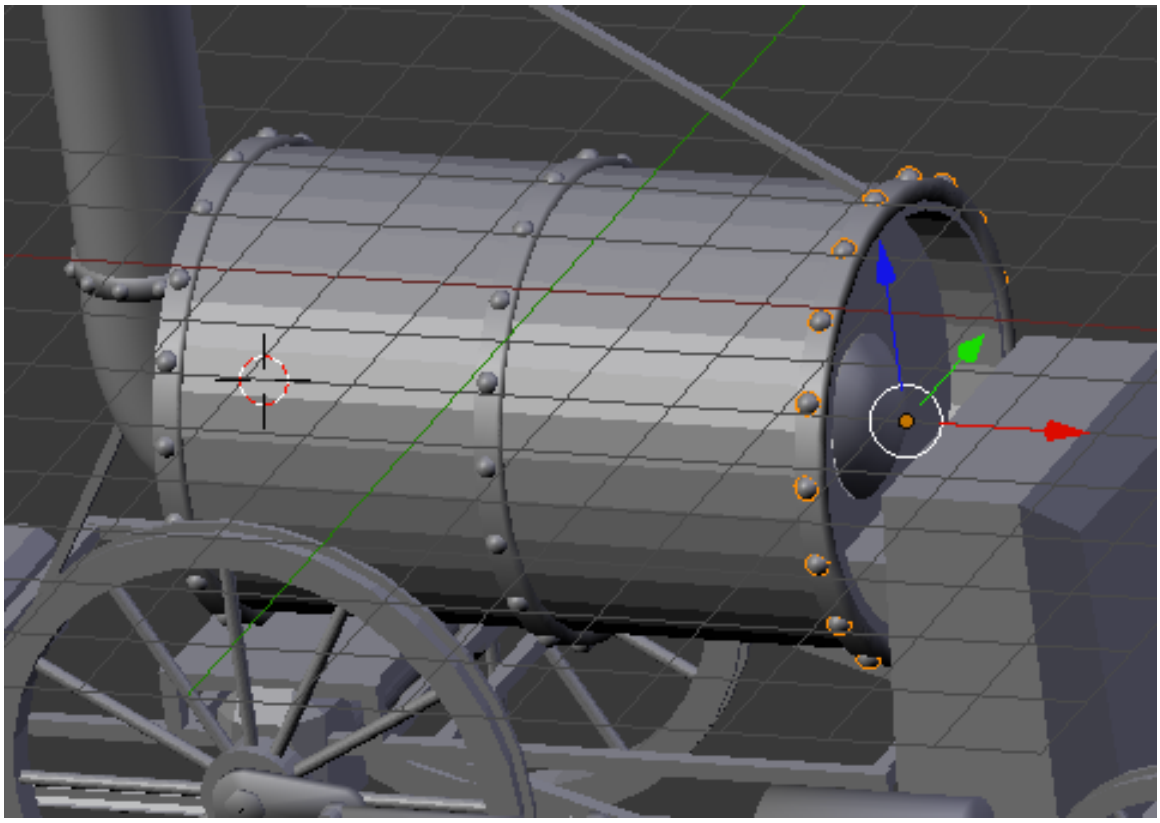


Select all of the rivet objects and press CTRL-J and join them into one object called “Rim Rivets”

Select the boiler rim and rim rivets objects, press the MKEY and place them on layer 1. Go to layer one. Select the rim rivets object, press SHIFT-D followed by the XKEY and place a duplicate set of rivets on the middle boiler rim as shown below.



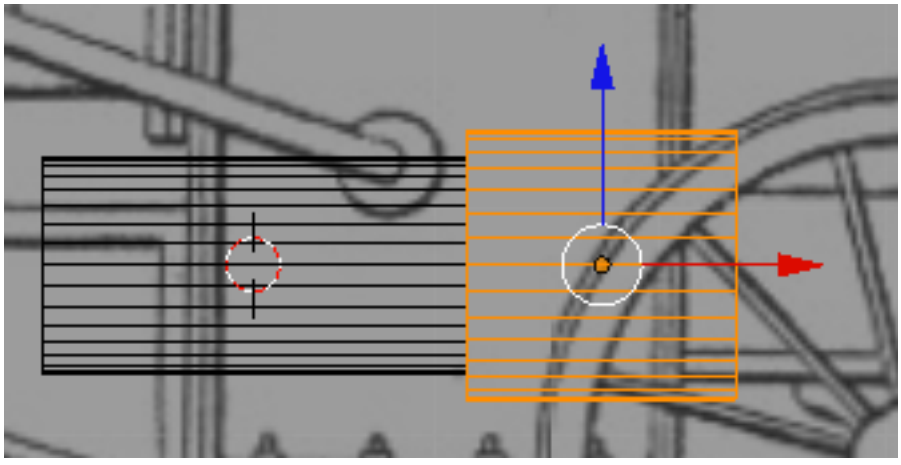
Make another duplicate and place it on the rear boiler rim as shown below.



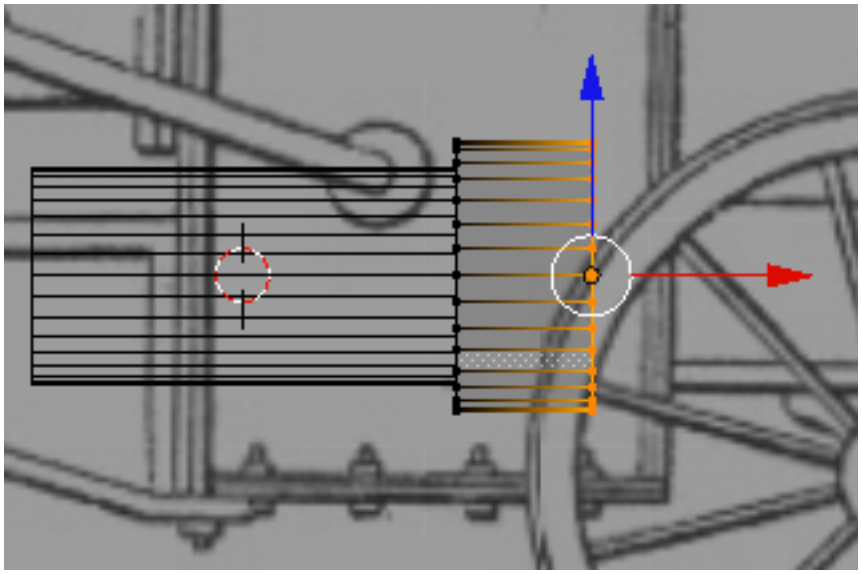
Save your Blender file.

Next we will add some detail to the piston objects. Select the piston object and place it on layer 2 to isolate it. Go to layer 2. Go to front view and wireframe display mode. Use SHIFT-S to snap your cursor to the selected object.

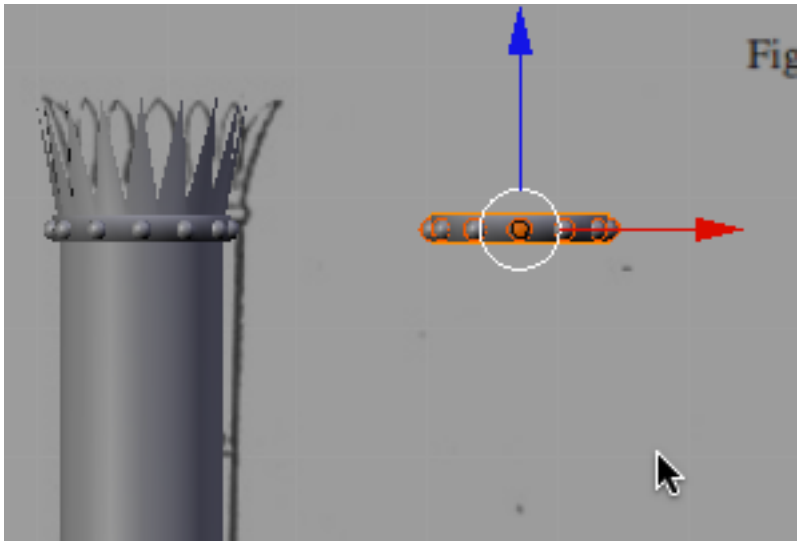
Press SHIFT-A and add a capped tube object. Set the Y rotation to 90 degrees. Scale the tube object down and place it to the right of the piston as shown below.



TAB into edit mode and move the right set of vertices to the left as shown below.

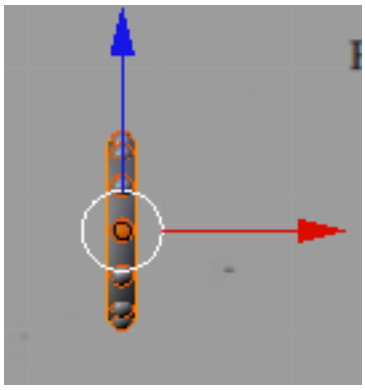


Deselect the vertices and TAB out of edit mode. Go to layer 1. Select both the stack collar and collar rivet objects (located at the top of the smoke stack). Press SHIFT-D and make a duplicate copy of these two objects and move them to the side of the stack as shown below.

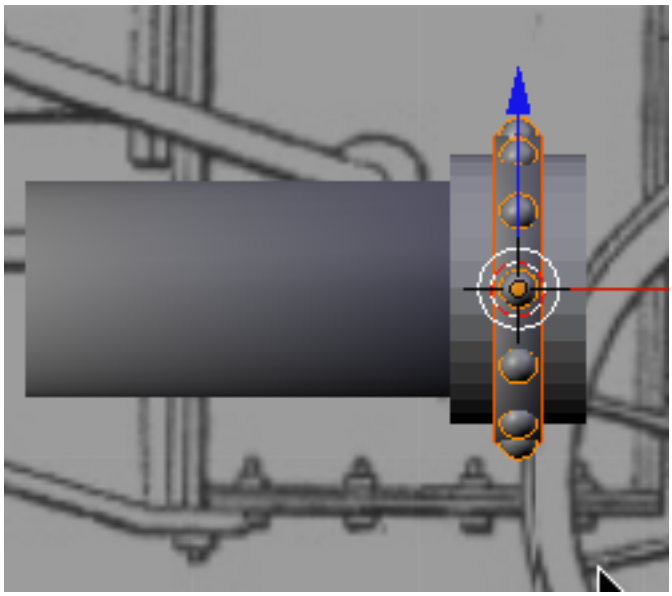


With these 2 duplicate objects selected, press the MKEY and place them on layer 2. Go to layer 2.

With these 2 duplicate objects selected on layer 2, press the RKEY followed by the YKEY followed by 90 then ENTER. This will rotate the objects 90 degrees around the Y-axis.

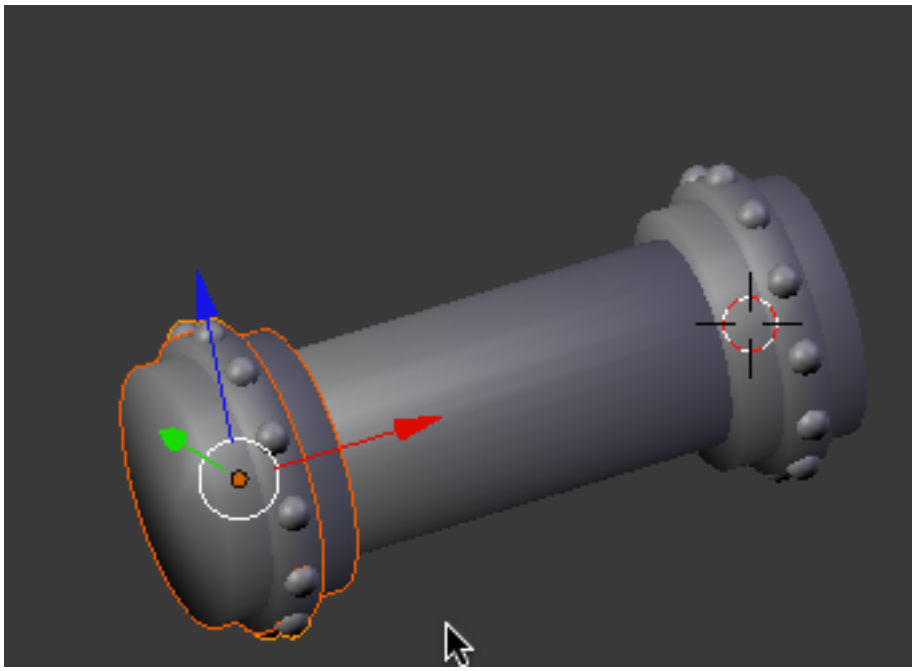


Select the tube object to the right of the piston object that we modeled earlier. Press SHIFT-CTRL-ALT-C and select ORIGIN TO GEOMETRY. This places the tube's origin point in the center of the tube. Press SHIFT-S and snap your cursor to the selected. This places the 3D cursor at the origin point of the tube object. Then select the duplicate collar and rivet objects brought over from layer 1. Press SHIFT-S again and select SELECTION TO CURSOR. This moves the collar and rivet duplicate object to the origin point of the newly created tube object.

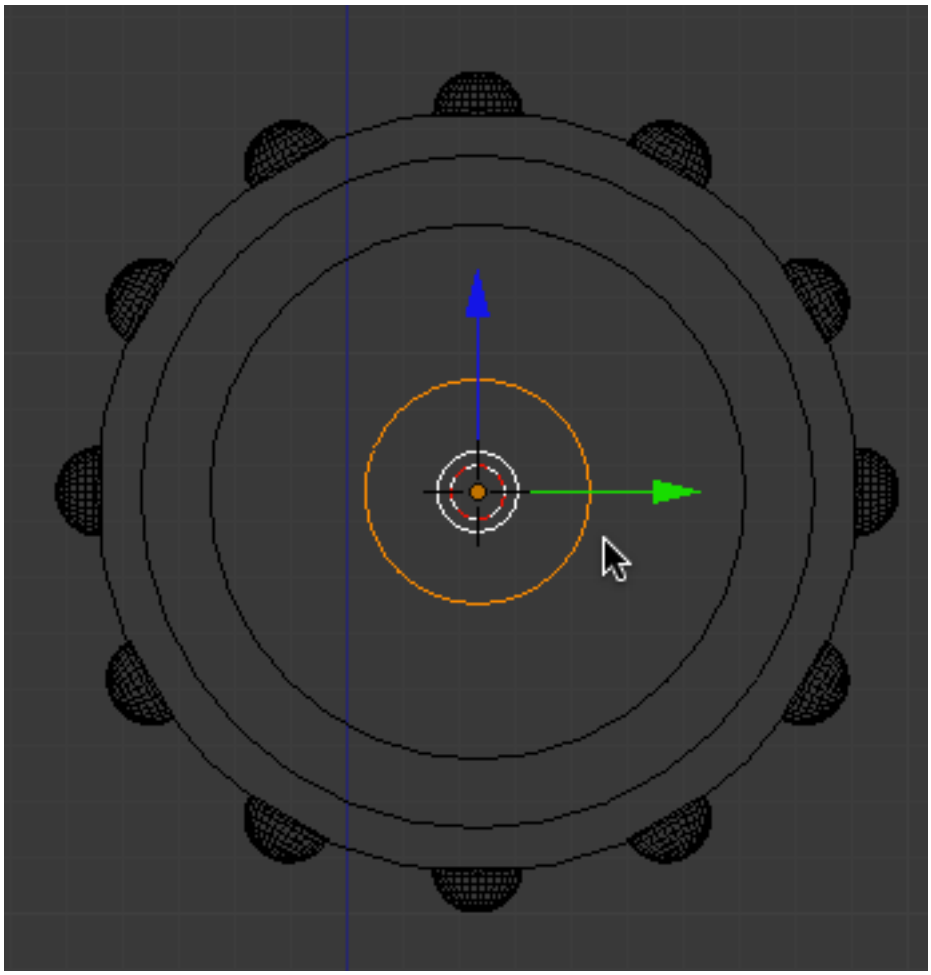


Select the tube object and name it "Piston Detail". Press the Smooth button in the 3D editor viewport tools panel to smooth the object.

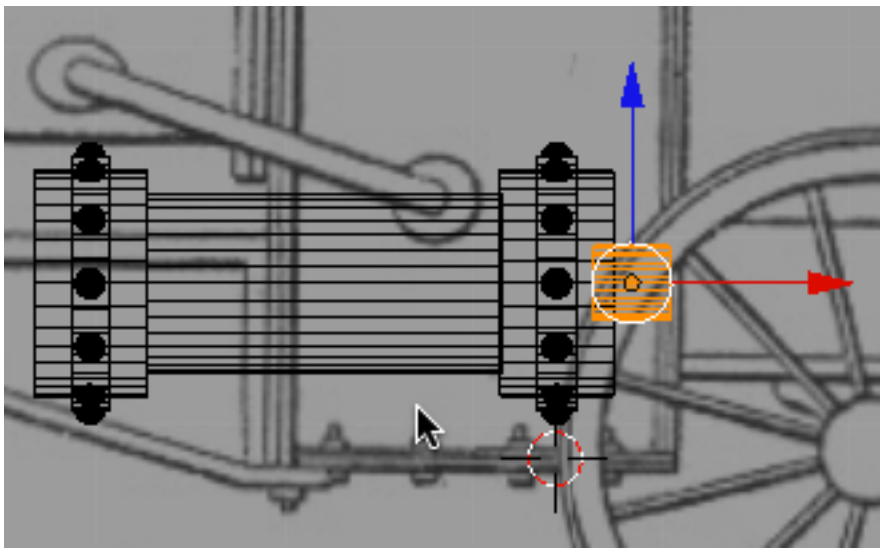
Make a duplicate of the piston detail, collar and rivets objects and place them on the other side of the piston as shown below.



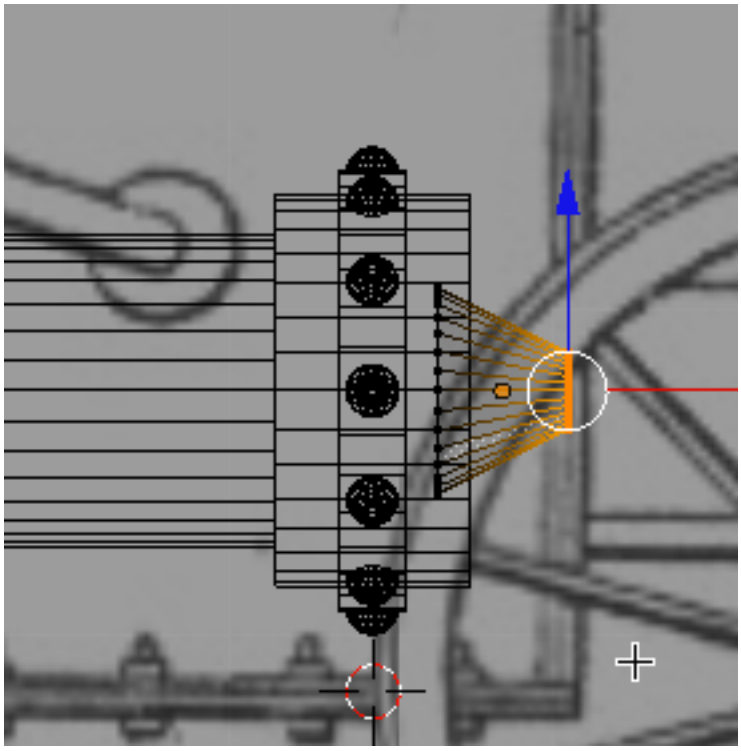
Go to side view. Go to wireframe display mode. Press SHIFT-A and add a capped tube object. Scale it down as shown below.



Go to front view and move the object to the right as shown below.

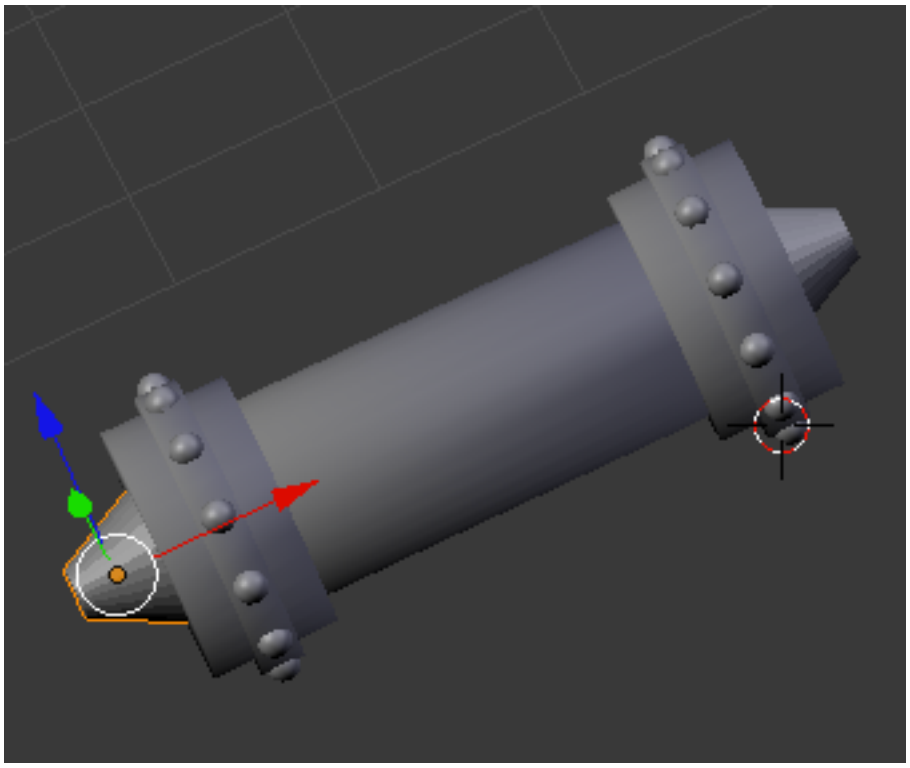


TAB into edit mode and select the left set of vertices and scale them out a bit and then select the right set of vertices and scale them down a bit as shown below.



Deselect the vertices. TAB out of edit mode. Name this object “Piston Cap”.

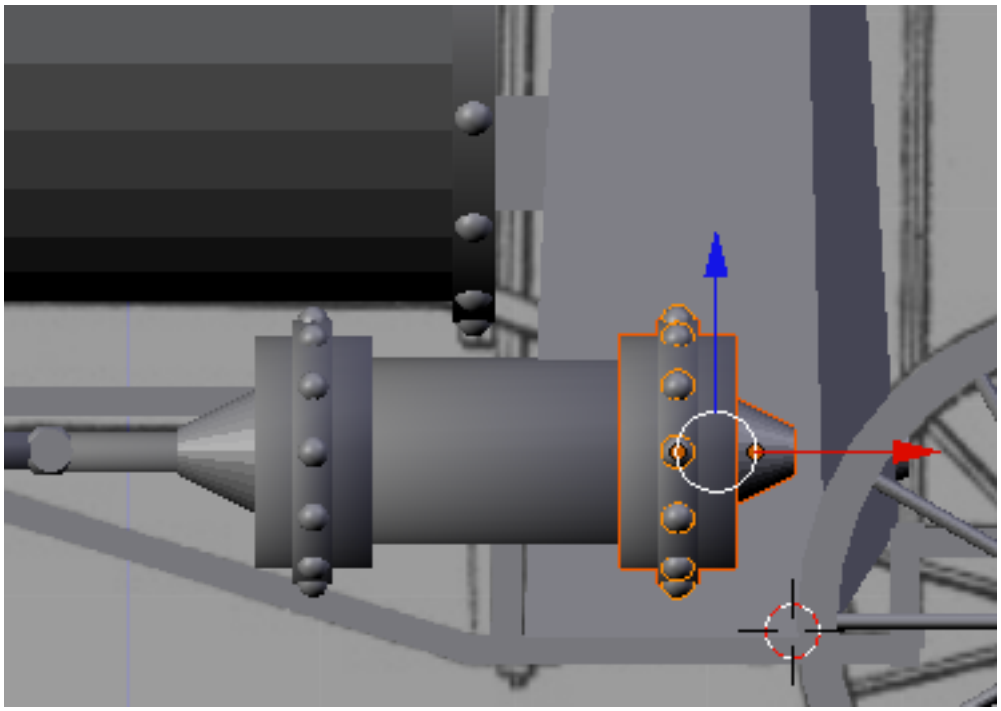
Make a duplicate copy of the piston cap object, rotate it 180 degrees around the Y-axis and place it on the other side of the piston as shown below.

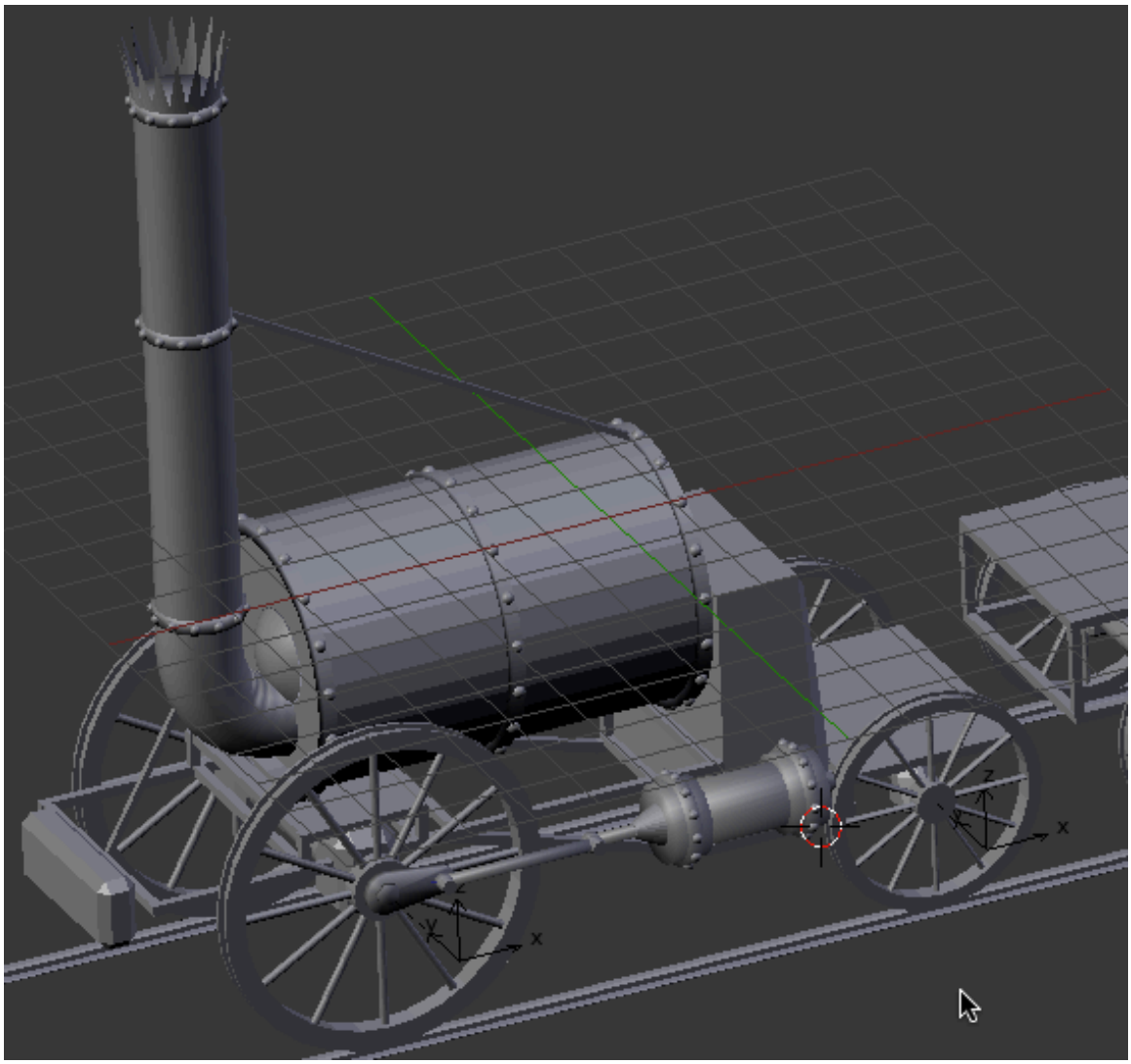


Place all of these objects on layer 1.  Go to layer 1.

Select the 2 piston cap objects, the 2 piston detail objects, the two collar objects and the 2 rivet objects and press SHIFT-D followed by the YKEY and move the duplicates to the other piston object.

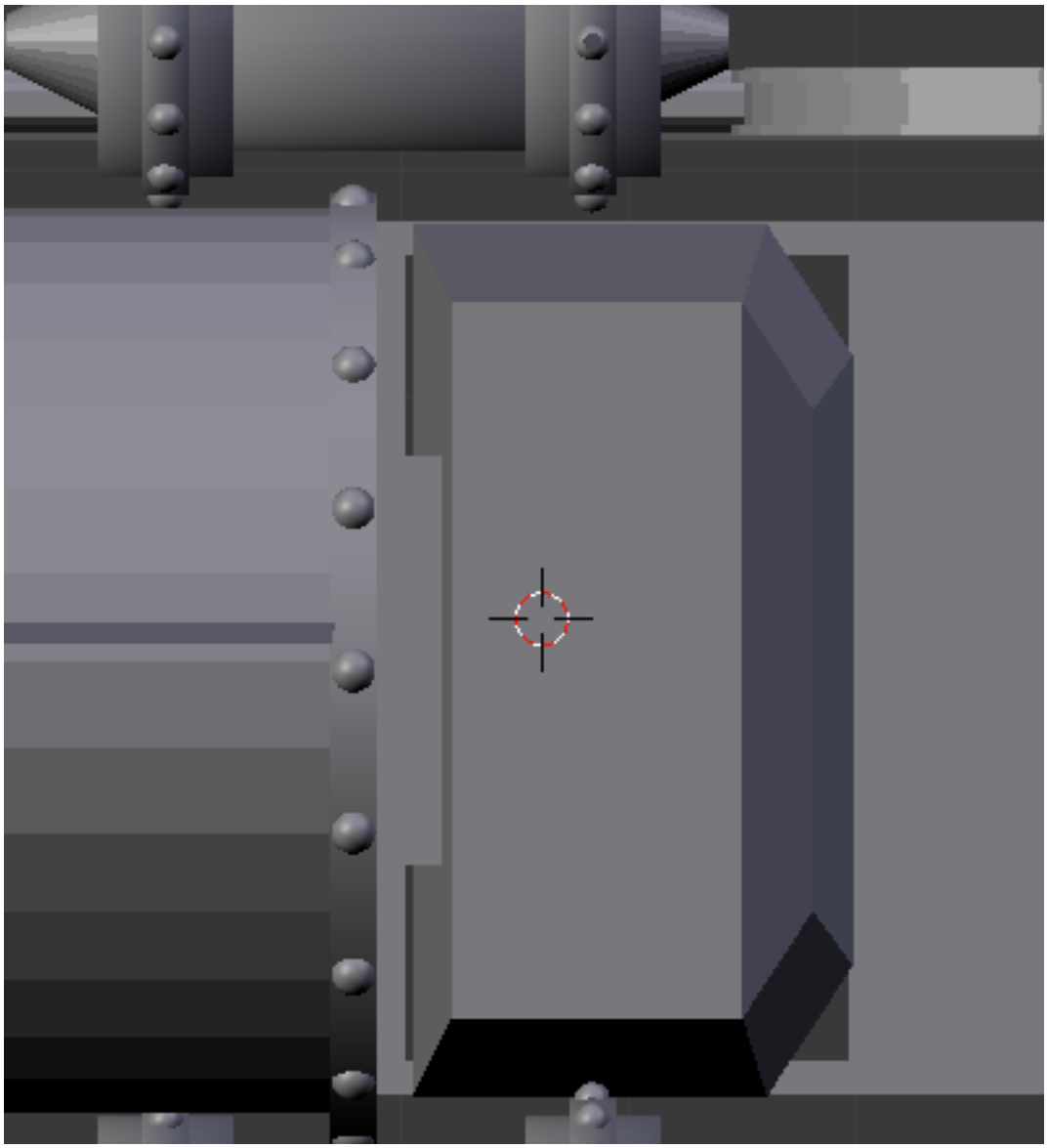
Notice that the rear piston cap, detail, collar and rivet objects extend into the rear wheel. Select these objects and move them to the left  (on both sides of the train) so that they clear the rear wheel as shown below.





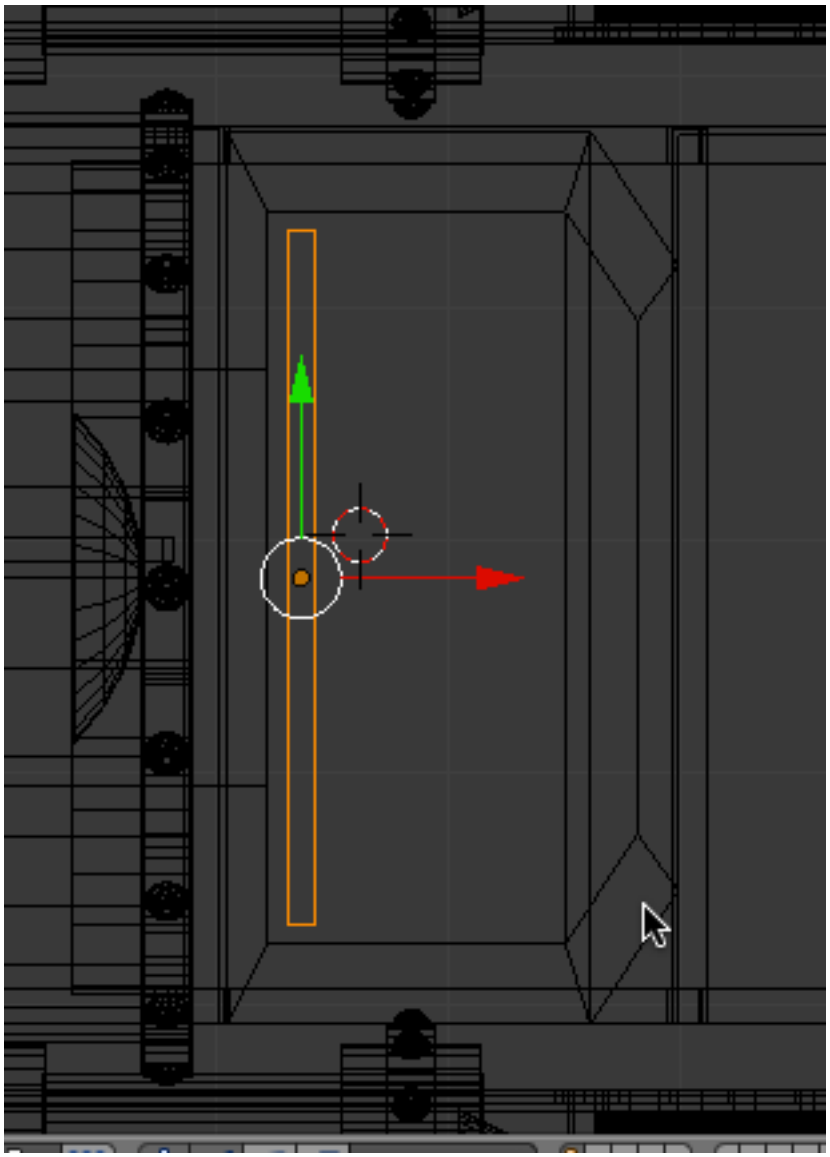
Save your Blender file.

We will now add some rivet detail to the furnace. Go to top view and place your cursor as shown below.

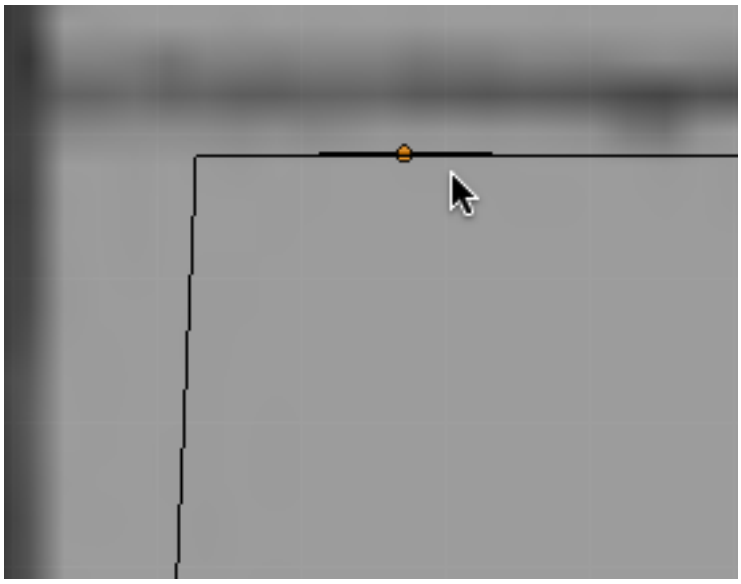


Go to wireframe display mode and press SHIFT-A and add a plane object. Edit the plane as shown below. Set the origin to the geometry (SHIFT-CTRL-ALT-C).

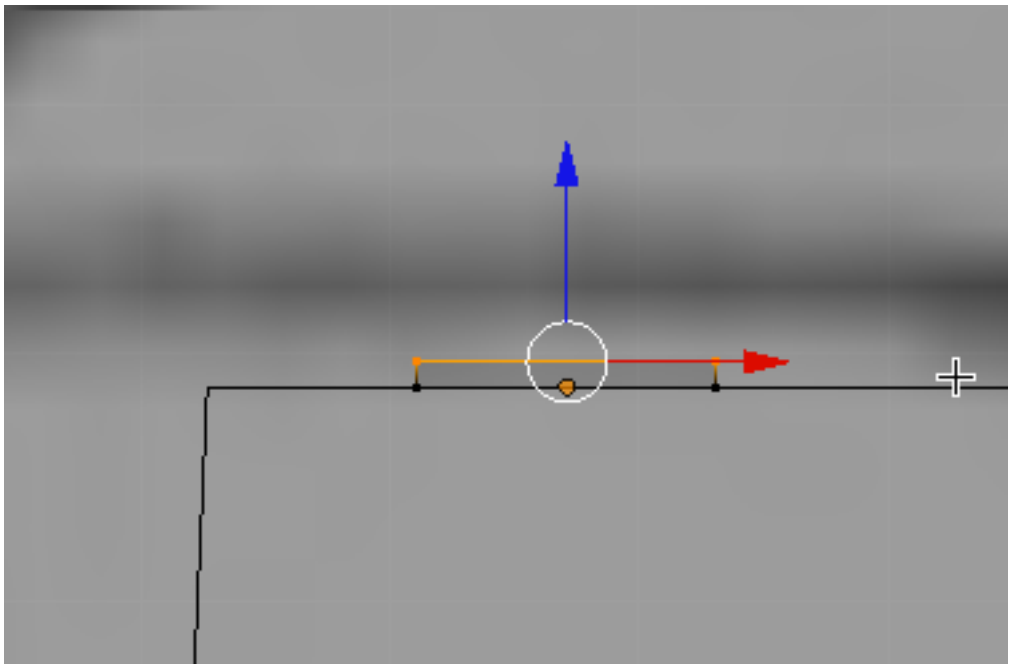
NOTE: If you are having difficulty moving things precisely, click on the translate arrow for the direction you want to move it, then hold your SHIFT key down and move your mouse. The movement will be constrained.



Go to front view and move the object up along the Z-axis to sit on top of the furnace object.

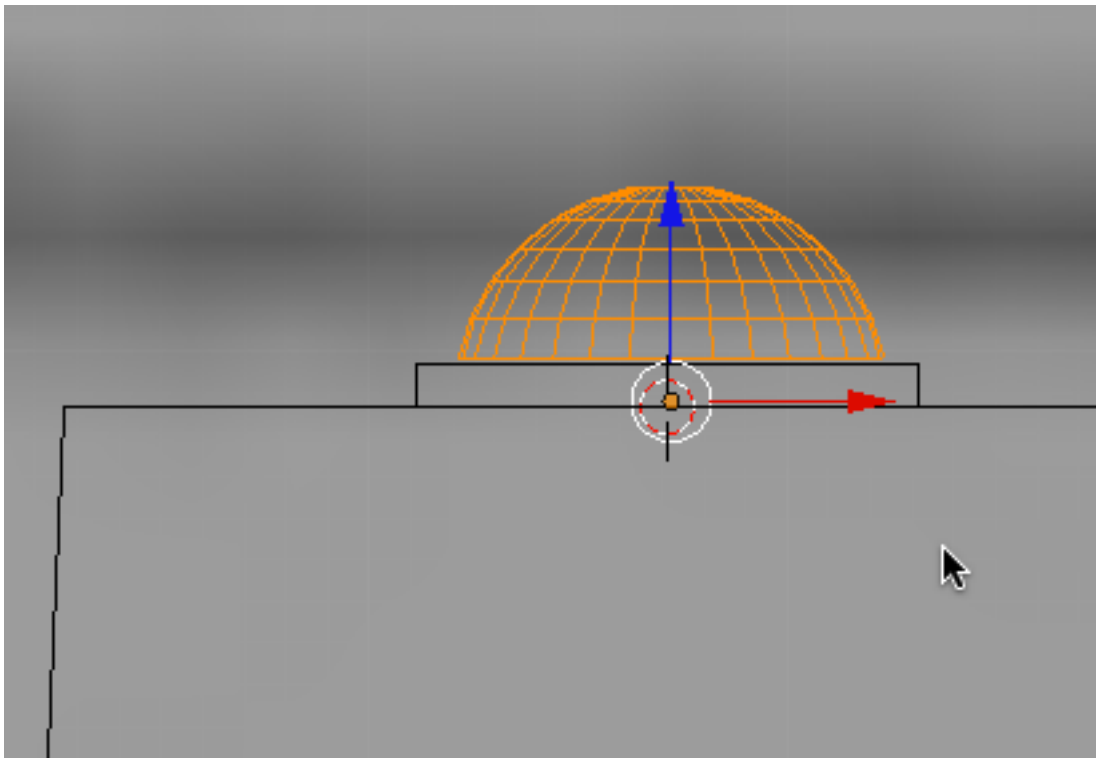


TAB into edit mode, select all the vertices and extrude them up along the Z-axis just a small bit as shown below.

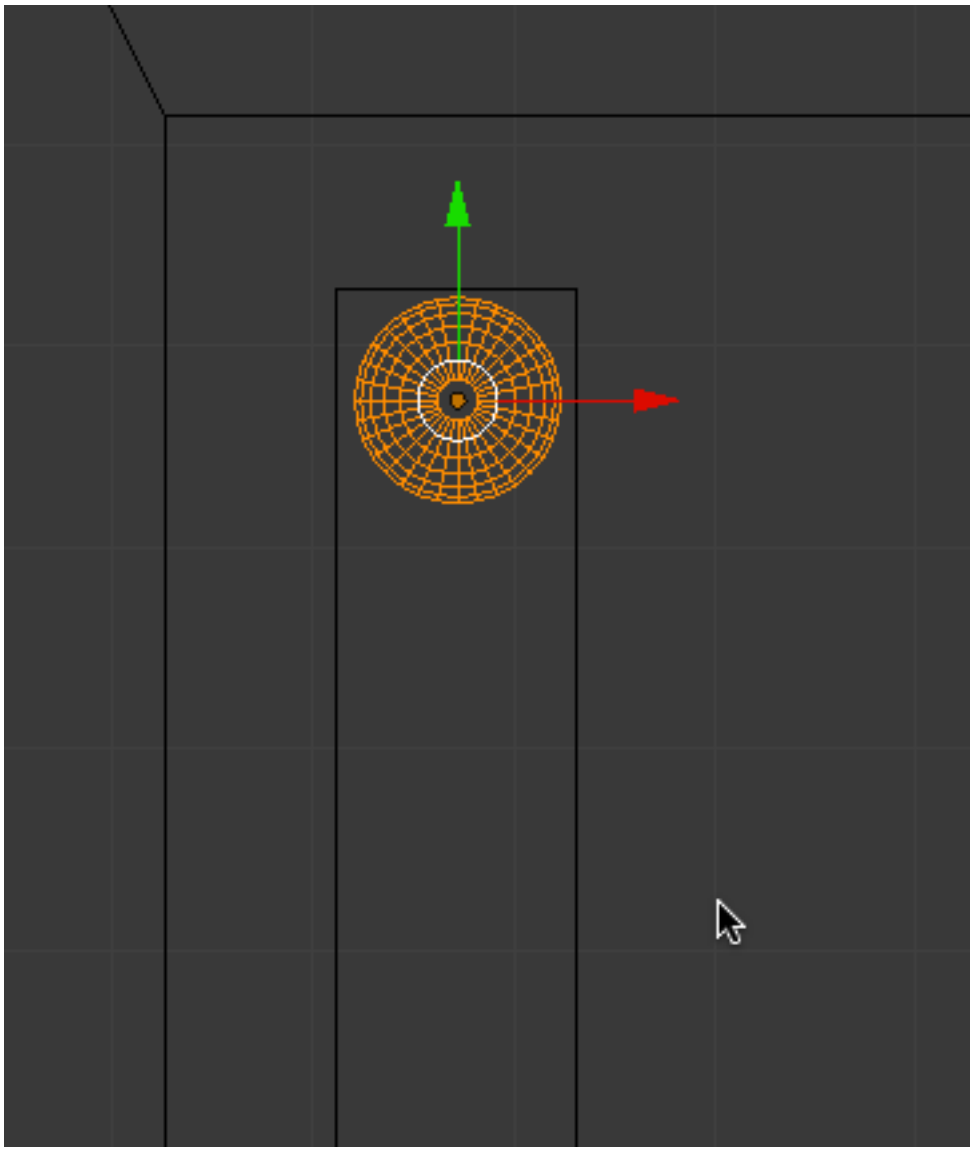


TAB out of edit mode and name this object “Rivet Plate”.

Snap your cursor to the rivet plate object (SHIFT-S). Add a UV Sphere. Scale it down to the size of a rivet. Edit the UV sphere by deleting the lower half vertices then move the half sphere up along the Z-axis as shown below.

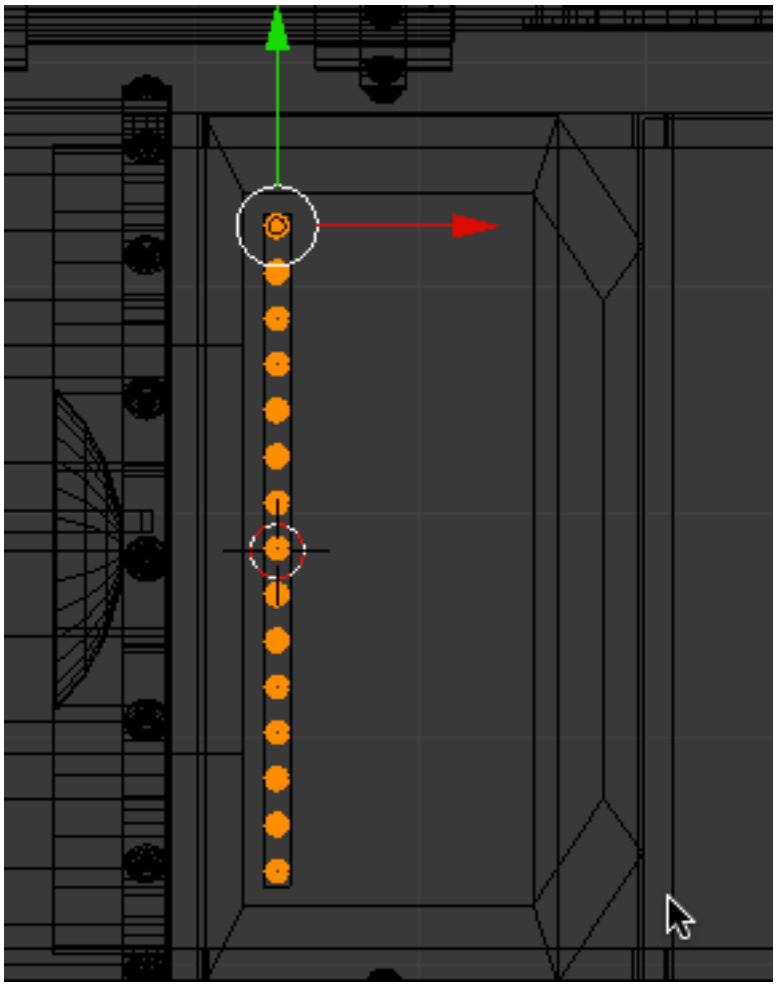


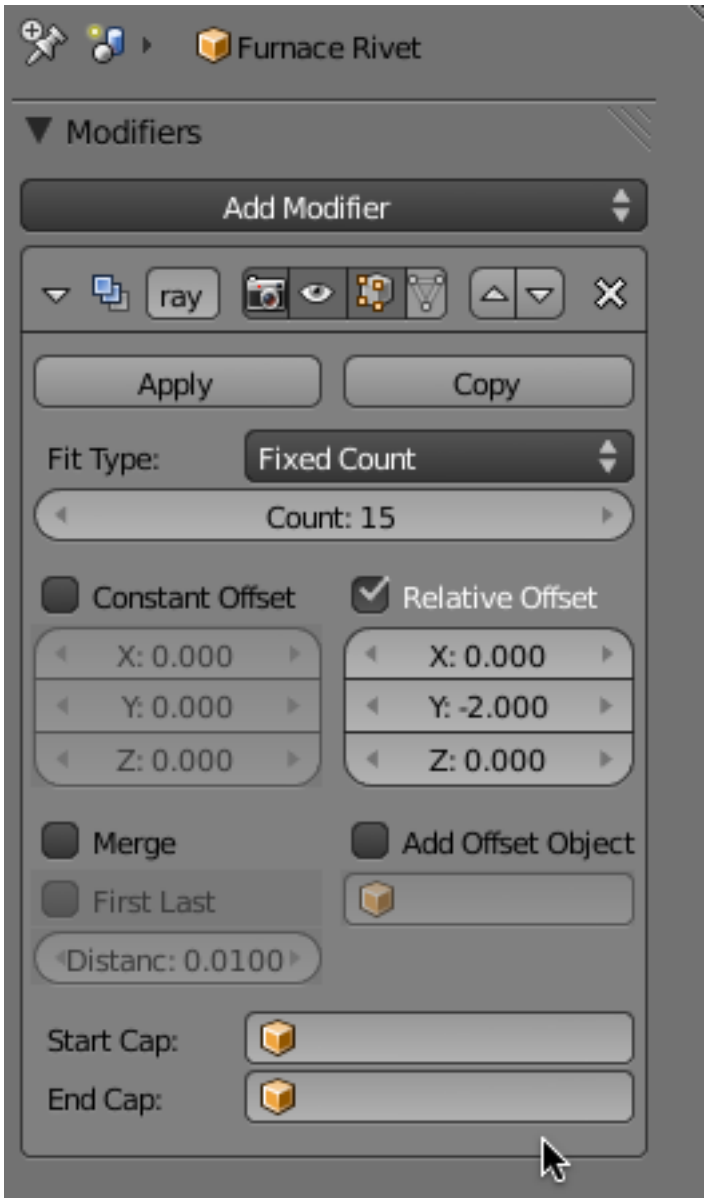
Name this object “Furnace Rivet”.  Go to top view and place the furnace rivet as shown below.



Select the Furnace Rivet and add an ARRAY modifier (this is another way to make duplicate objects.)

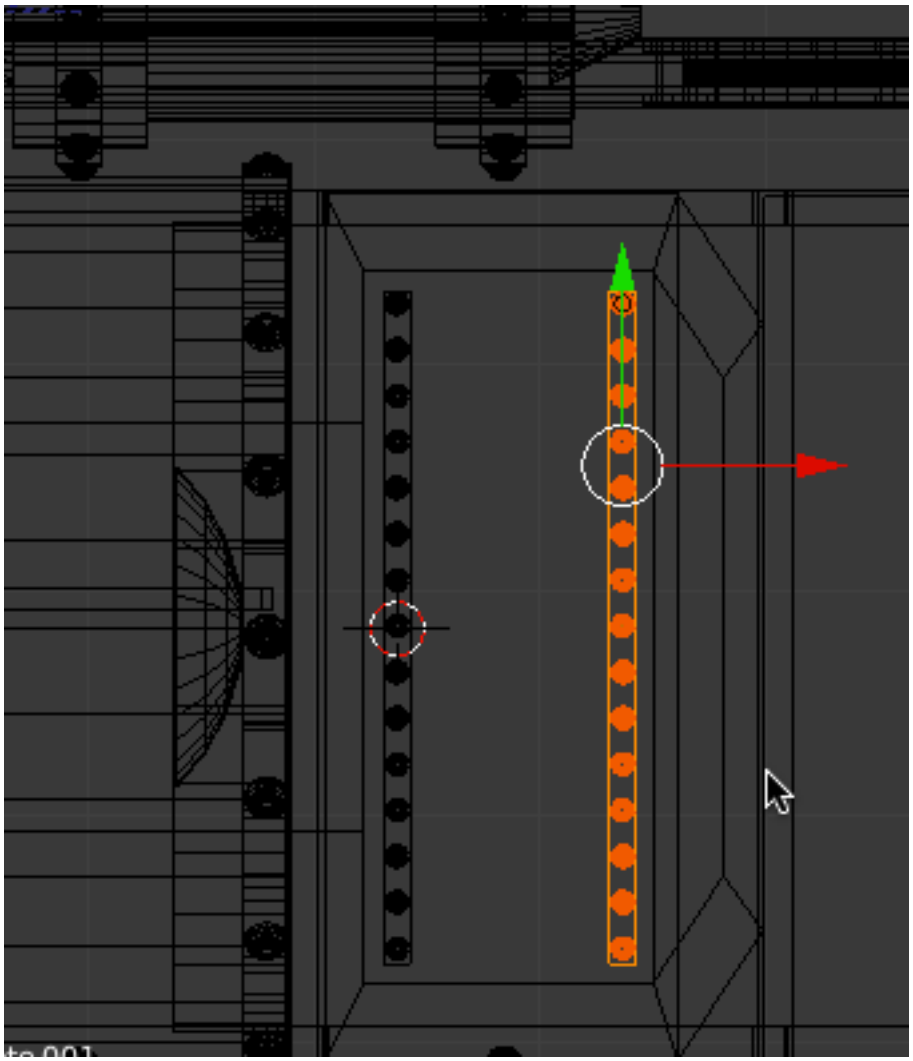
Leave the Fit Type as fixed count. Leave the Relative Offset box checked.
Set the X Relative Offset to 0  Set the Y Relative Offset to -2
Set the count at 15.





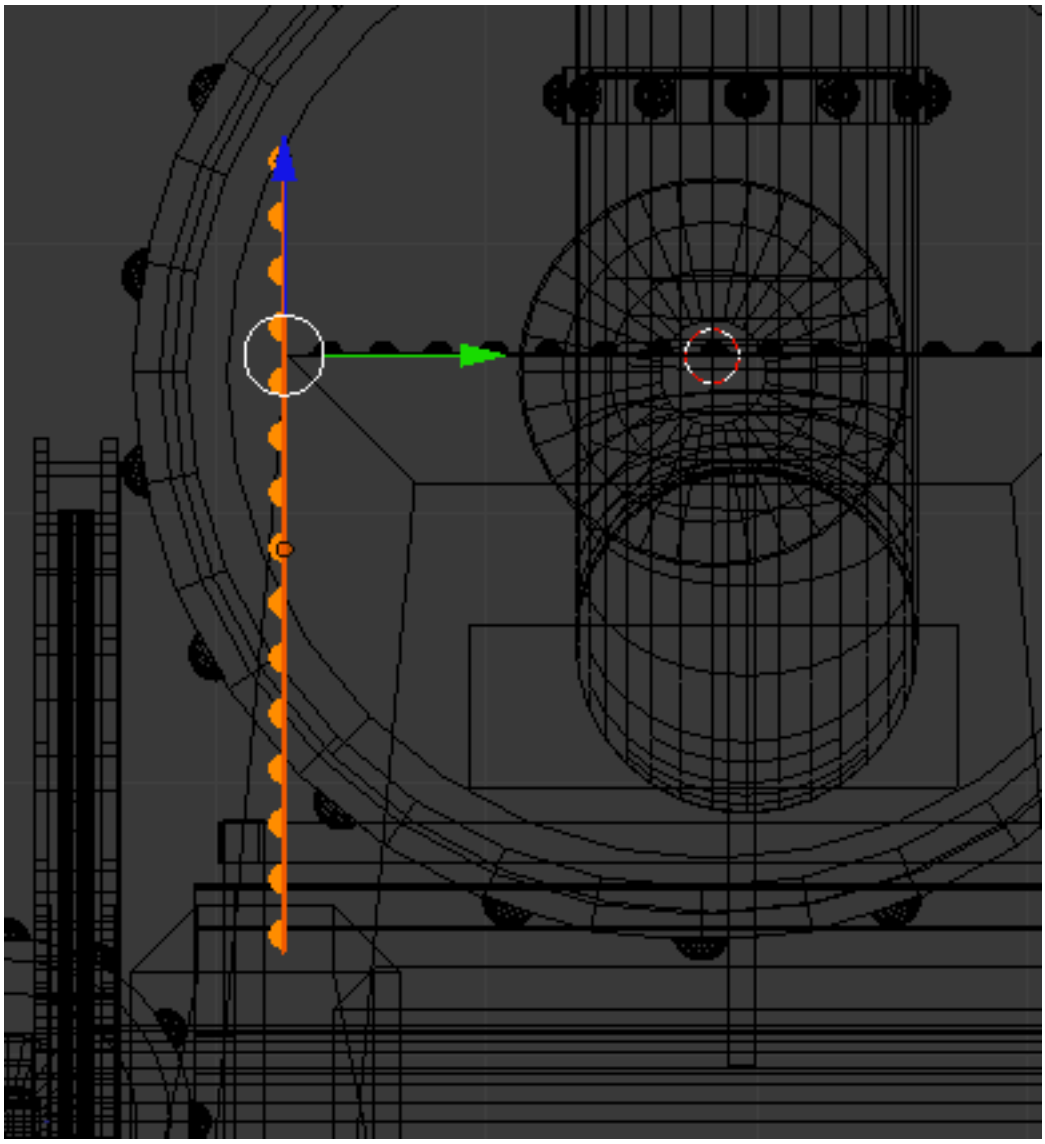

Note: The count number and the offset number depend on the size of your original furnace rivet object. You may have to rescale the rivet object or adjust the count and/or the Y offset distance.

Select both the furnace rivet object and the rivet plate object and make a duplicate and move it to the right as shown below.

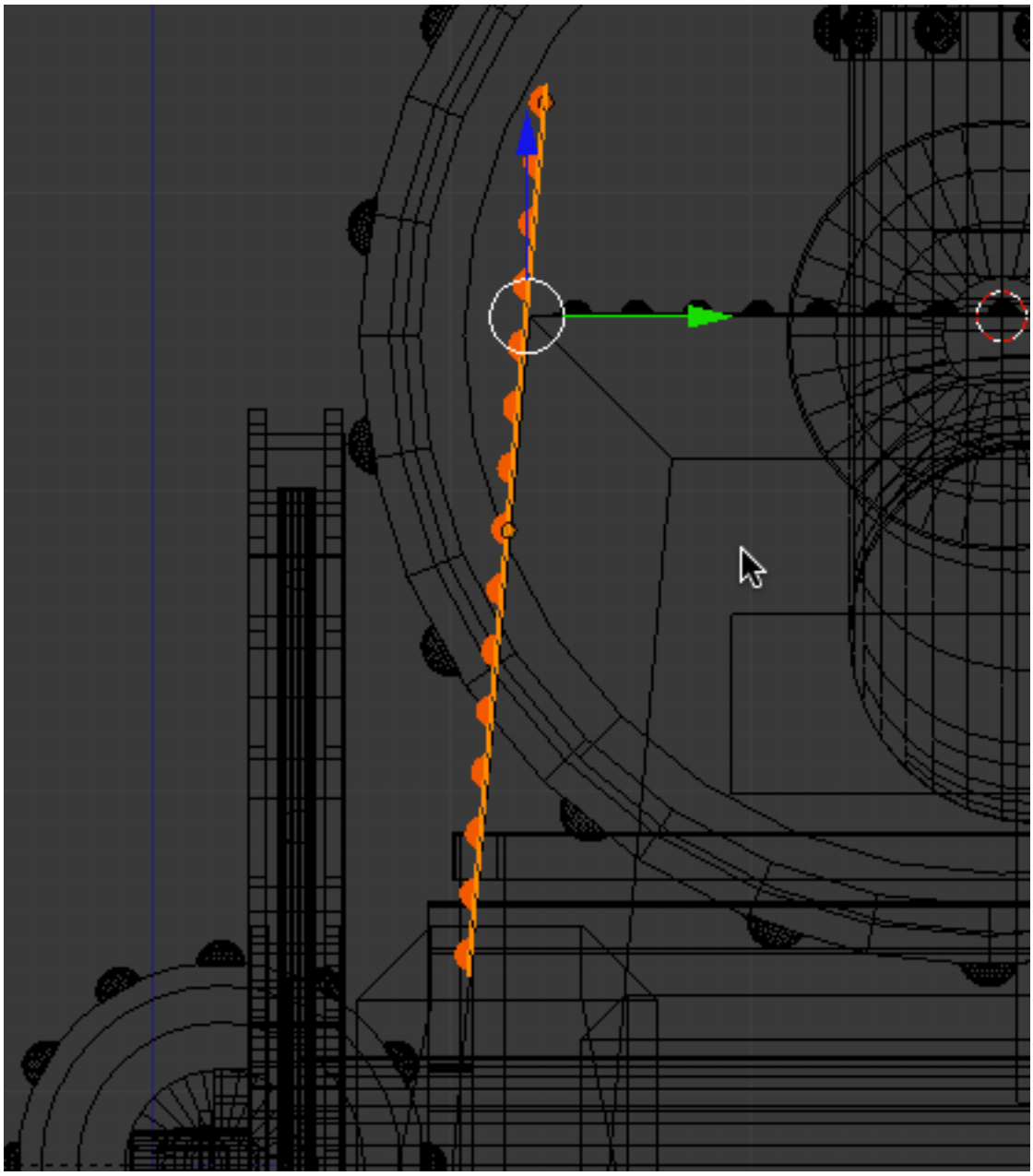


Make another duplicate of both objects and move it to the right. With the duplicates selected press the RKEY followed by the XKEY followed by 90 then ENTER

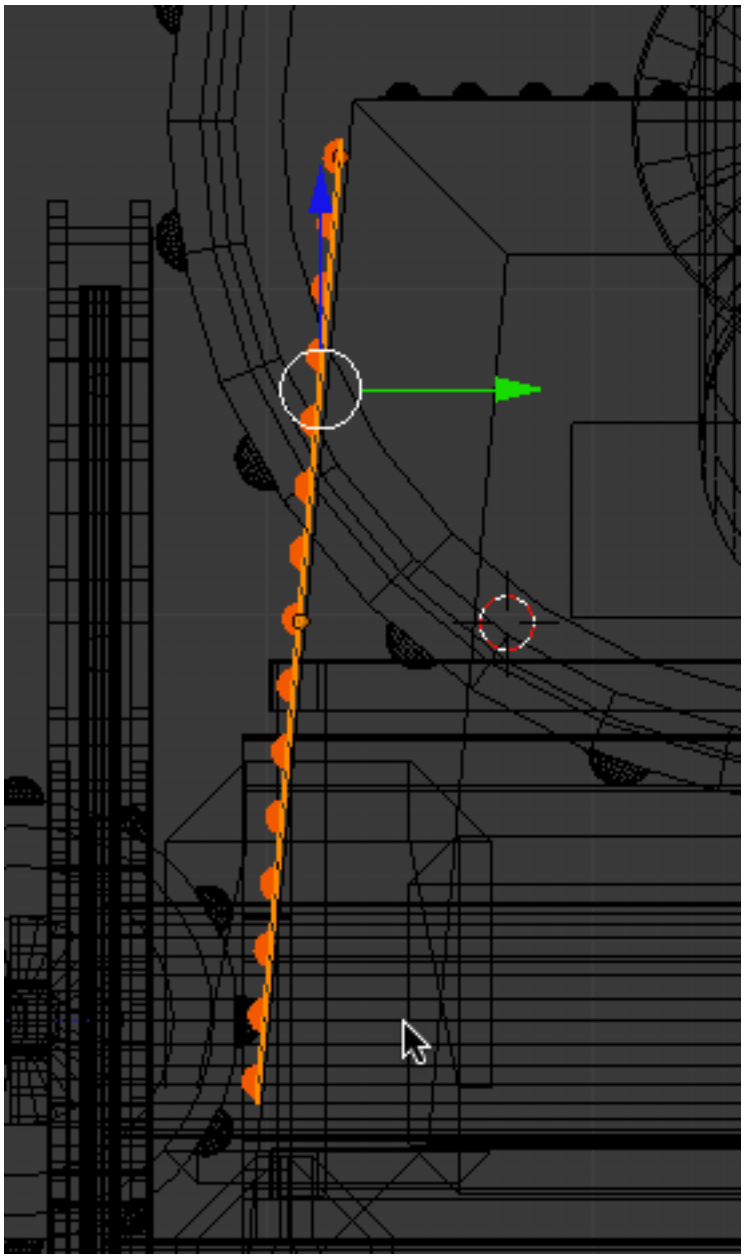
This will rotate the objects around the X-axis by 90 degrees. Go to side view and move the objects to the edge of the furnace as shown below.



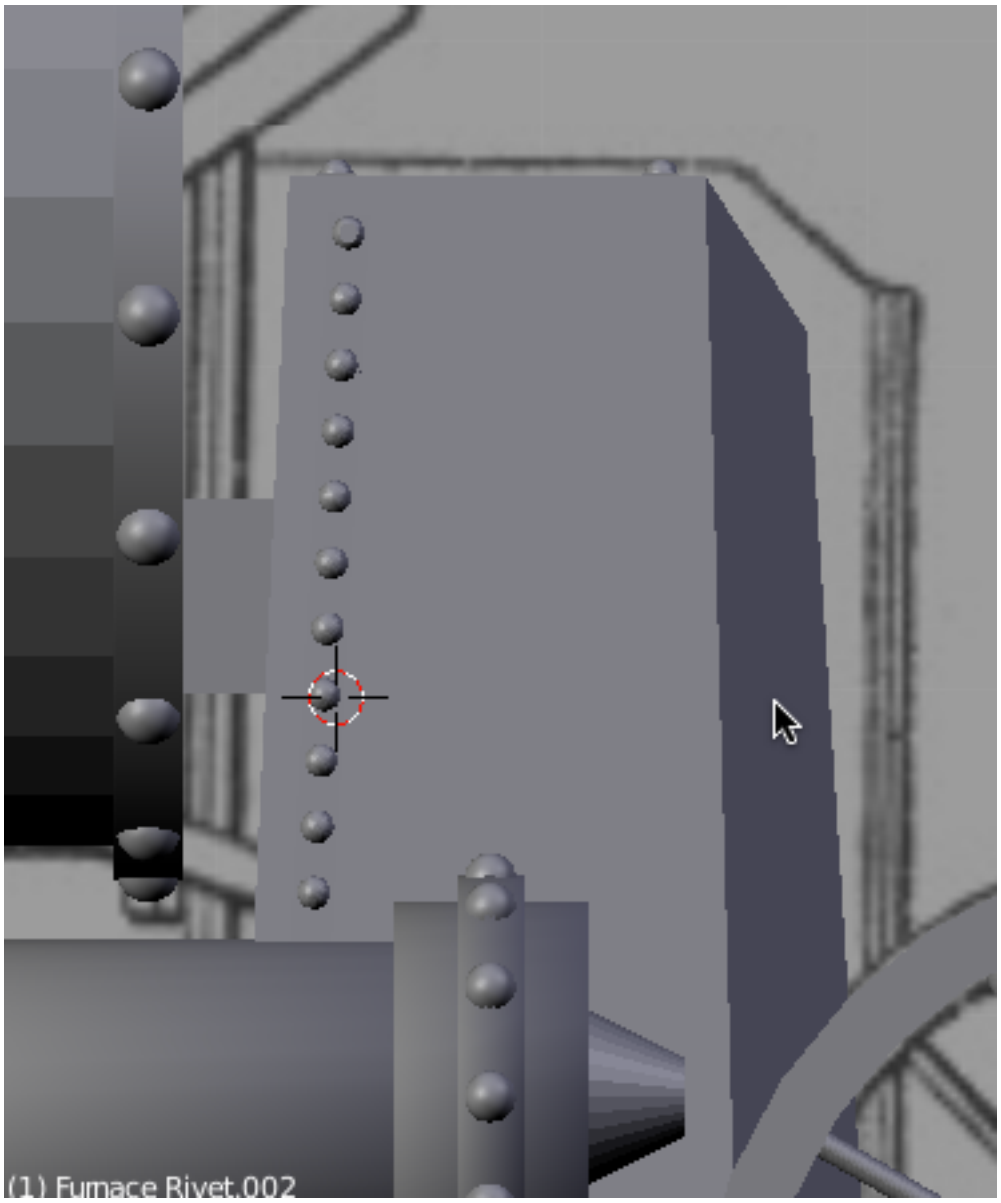
Press the RKEY followed by the XKEY and rotate the objects so they align with the angle of the side of the furnace as shown below.



Press the GKEY (grab) and position them down along the side of the furnace as shown below.

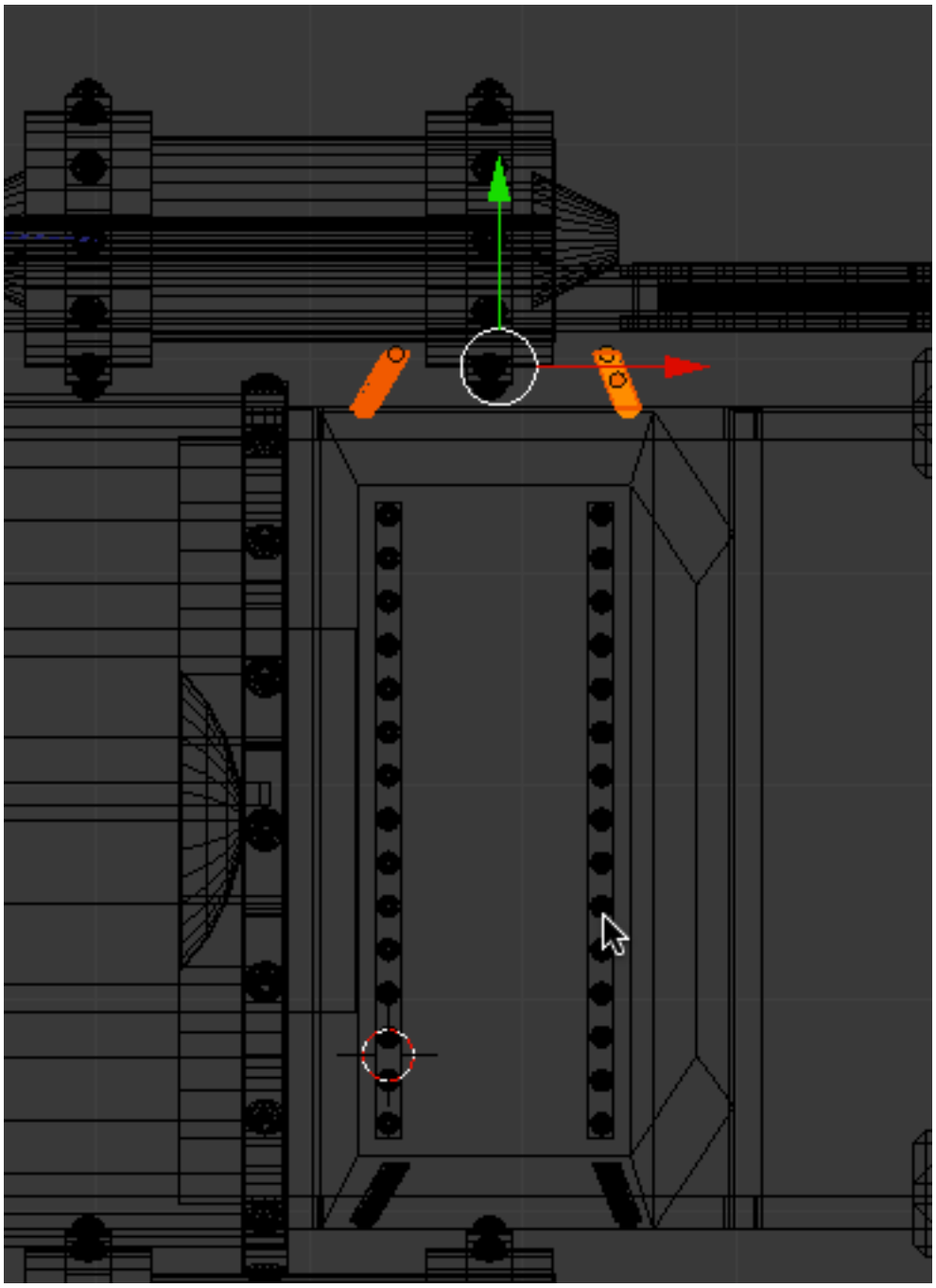


Go to front view. Move the objects to the left and position them on the side of the furnace. Rotate the objects to get the proper angle as shown below.



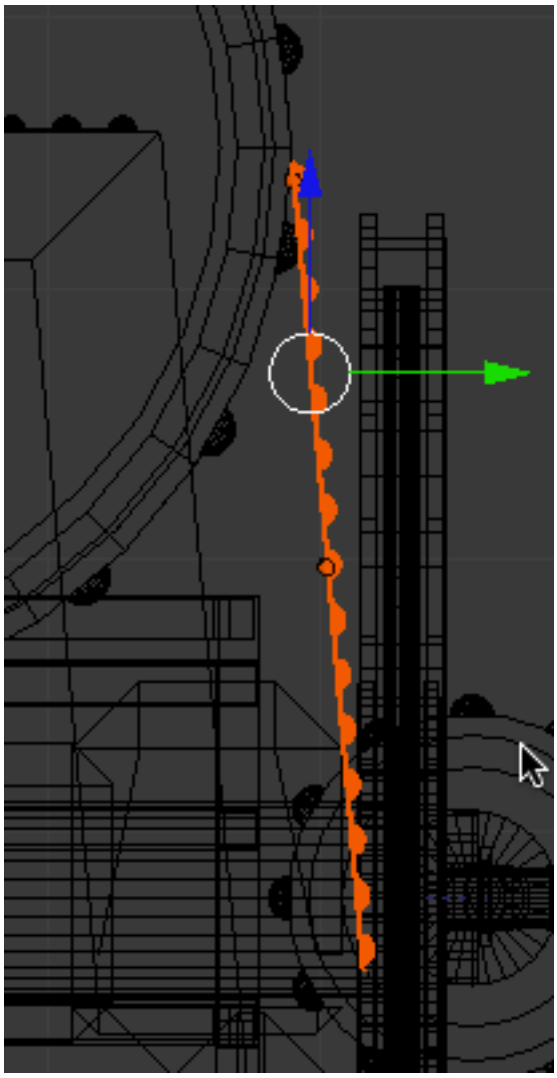

Make a duplicate copy of these objects and move them to the right and rotate them to position them as shown below.

Select both of these side rivet plates and both of these side furnace rivet objects and then press SHIF-D followed by the YKEY and move them up past the other side of the furnace as shown below.

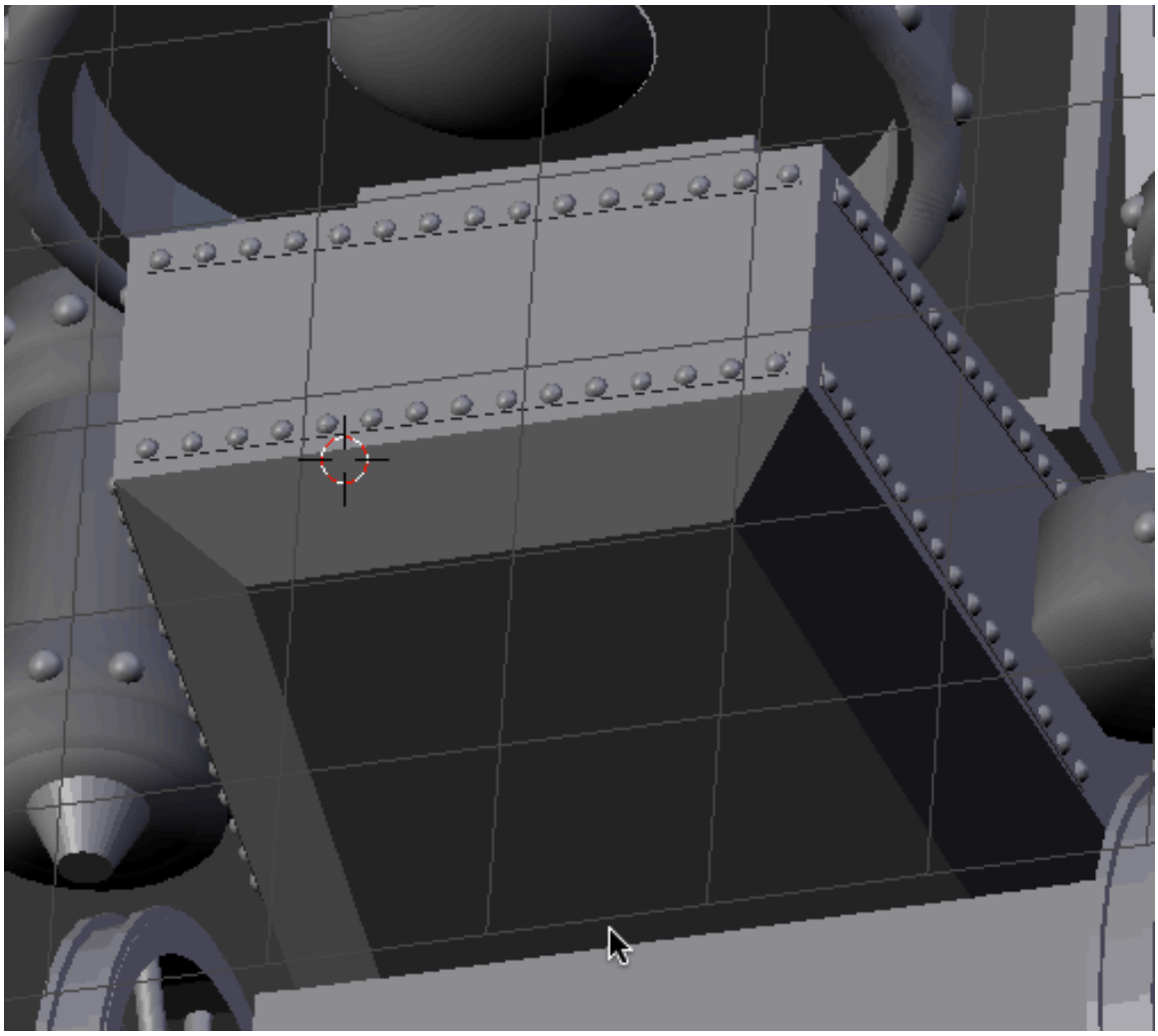


With these 4 duplicate objects selected, press the RKEY followed by the ZKEY followed by 180 then ENTER.

This will rotate the objects 180 degrees around the z-axis.



In side view, move these objects to the left up against the furnace object side as shown below.



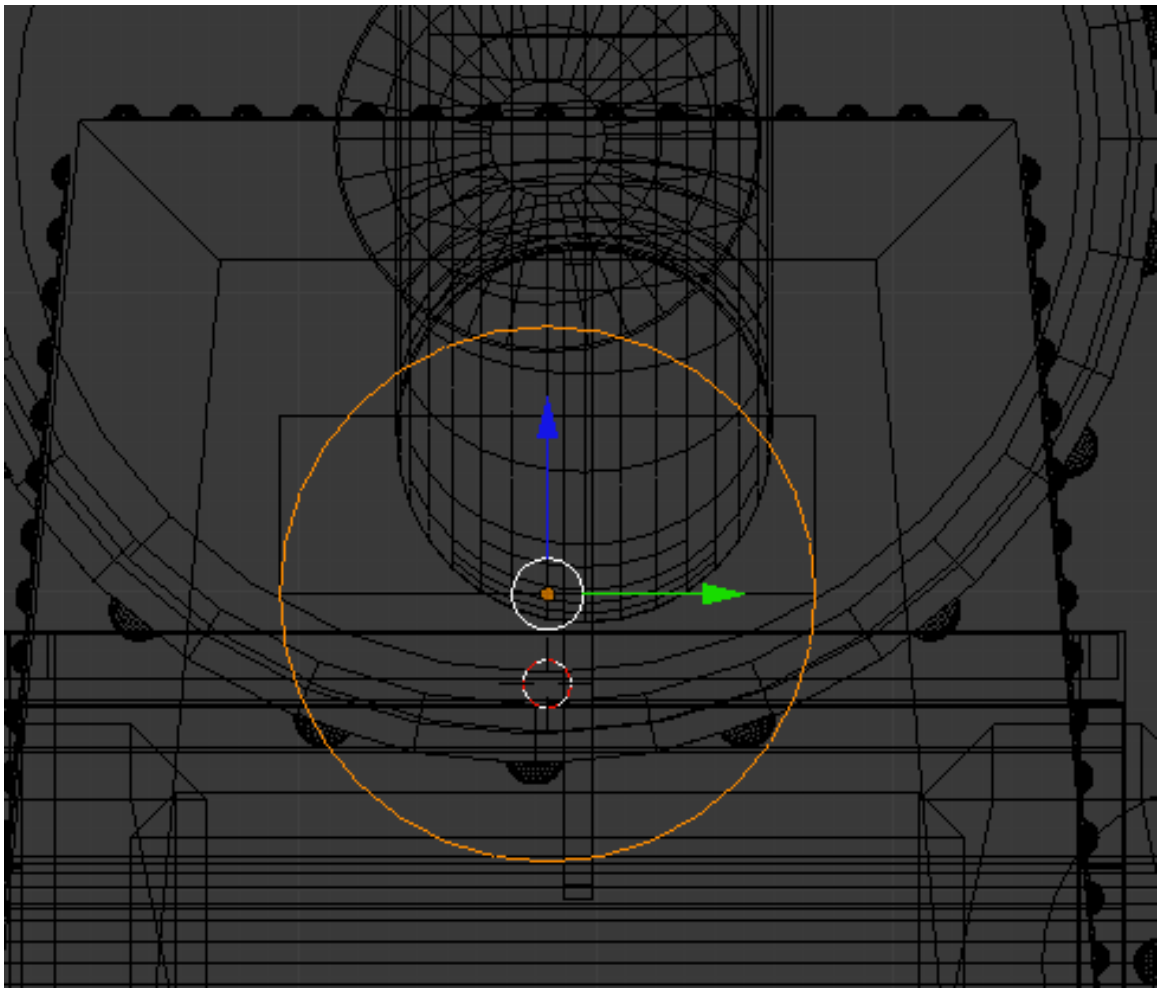
Save your Blender file.

We will now model the furnace door.

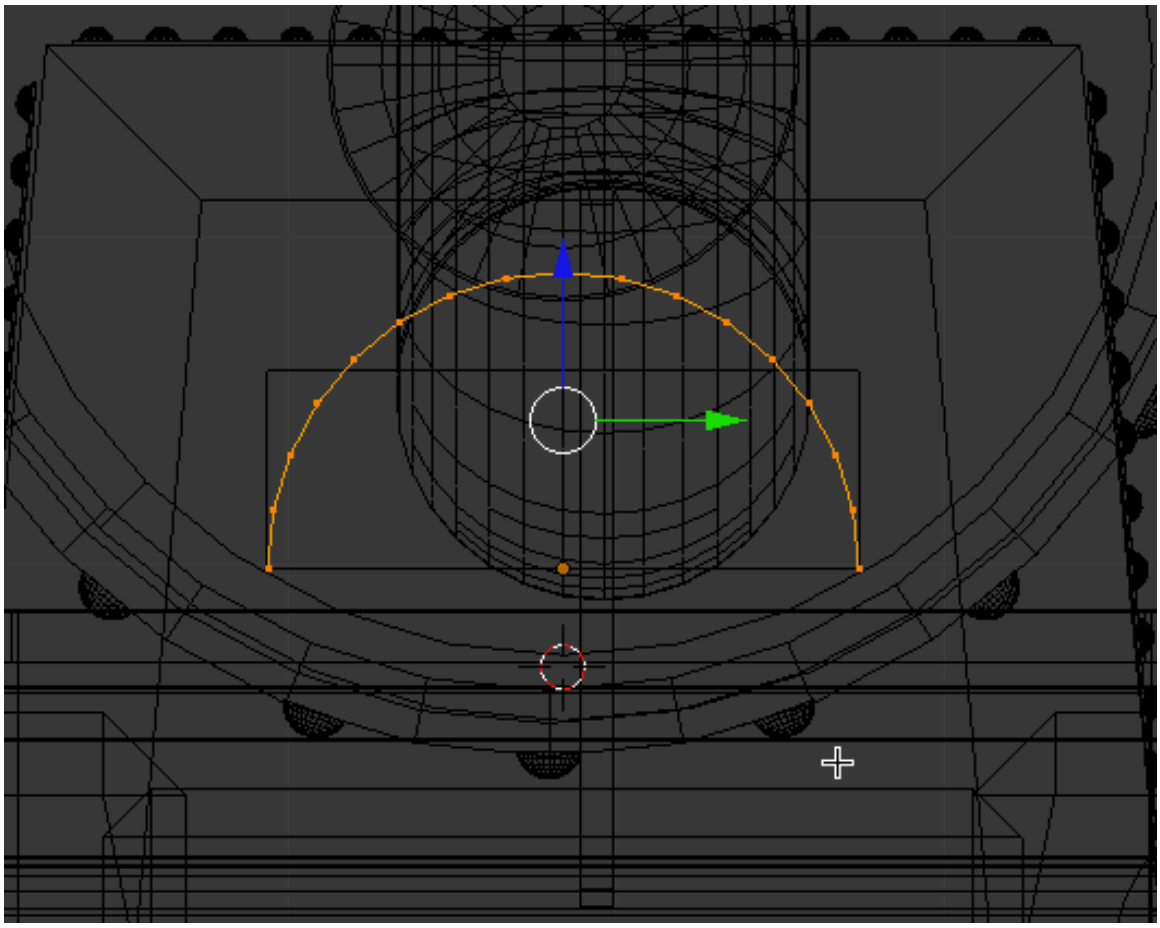
Go to side view. Go to wireframe mode. Select the furnace object. Snap your cursor to the object's origin.

Press SHIFT-A and add a circle object (make sure the circle is not filled). Set the Y rotation to 90 degrees.

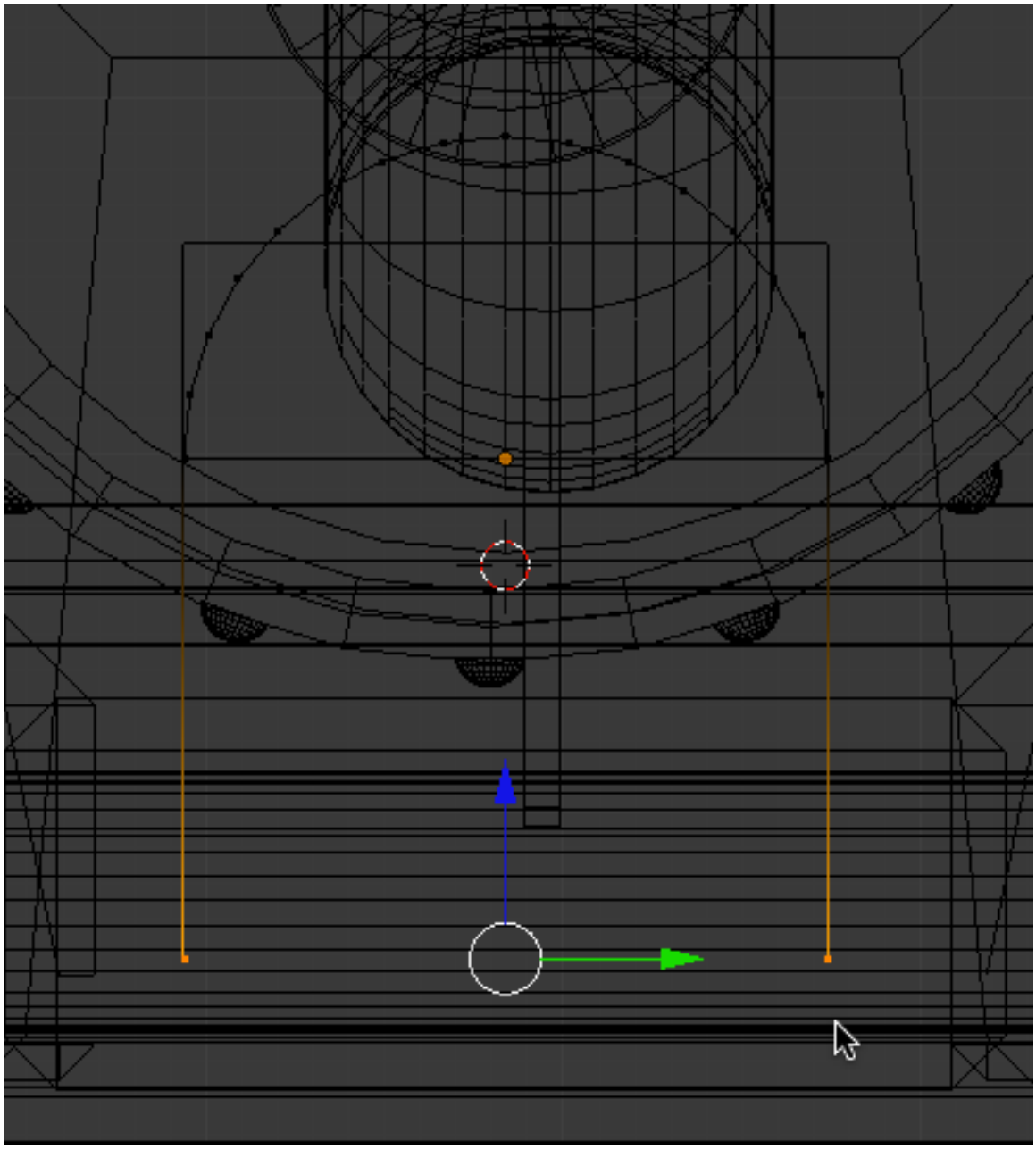
Scale the circle down just a bit and move it up along the Z-axis just a bit as shown below.



TAB into edit mode. Select the bottom vertices and delete them leaving an arc of vertices as shown below (note the middle vertices are not deleted).

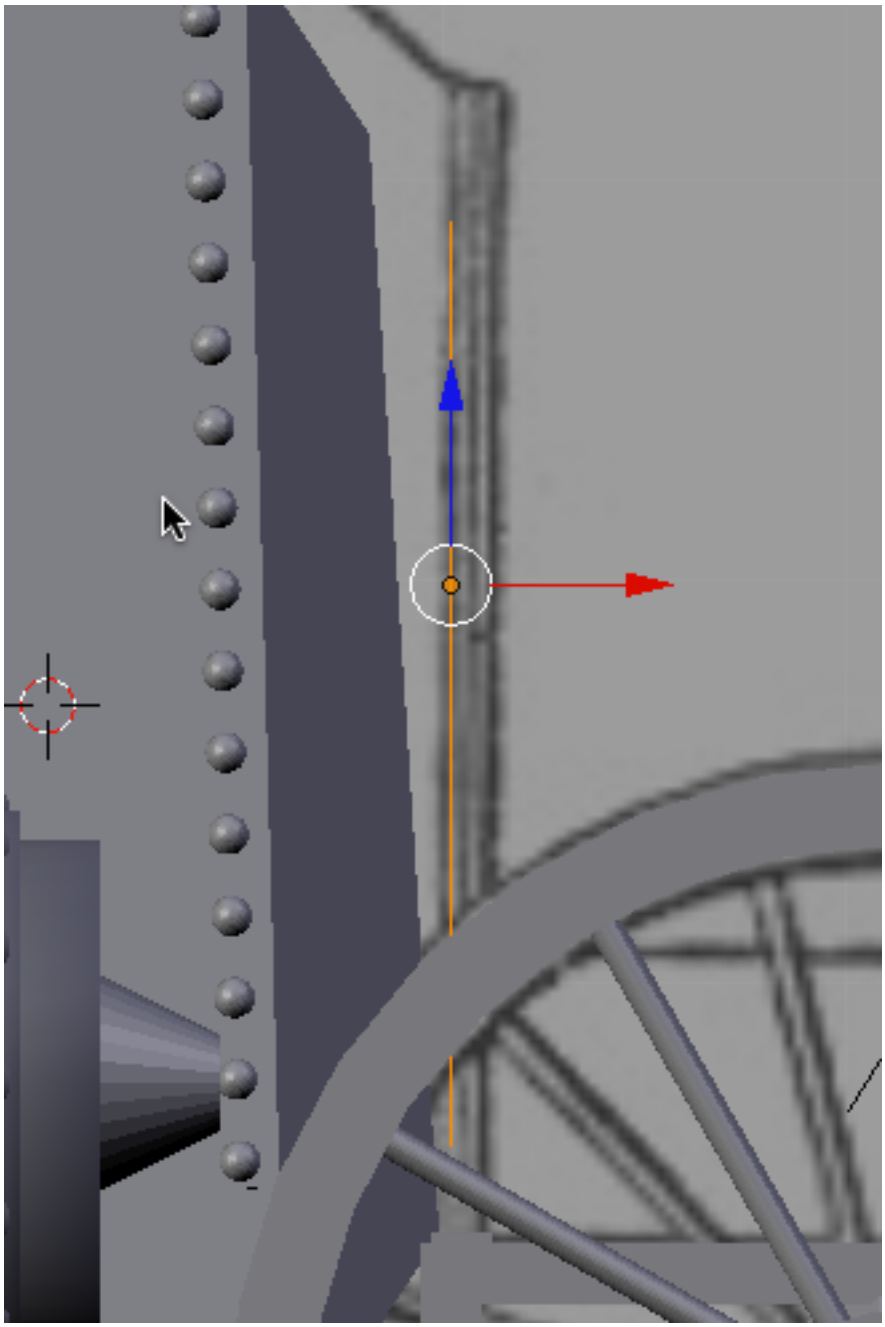


Select the 2 bottom vertices and press the EKEY (Extrude) followed by the ZKEY and extrude the vertices down as shown below.

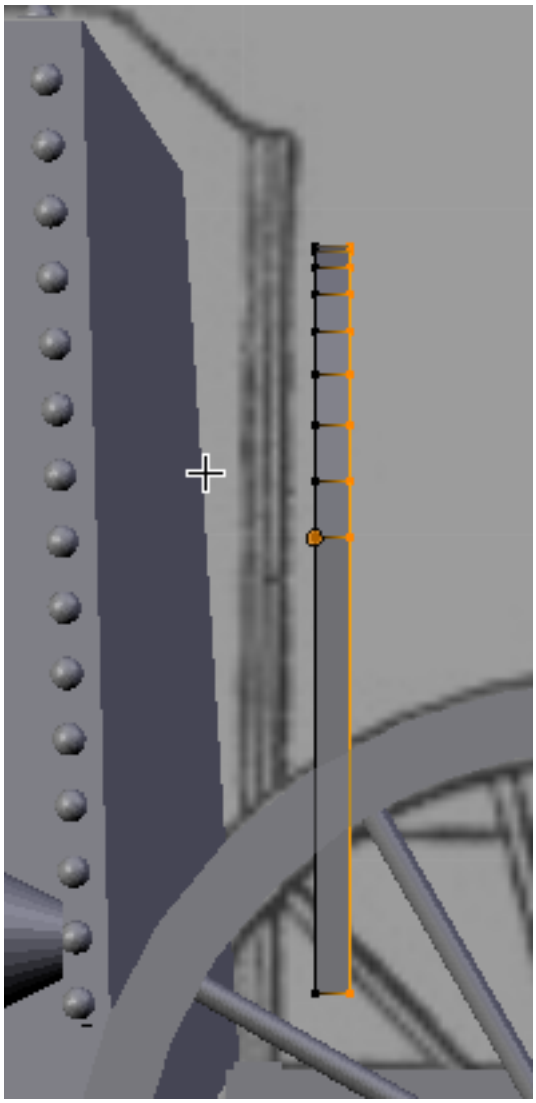


With the 2 vertices still selected, press the FKEY, which will create an edge connecting the 2 vertices.

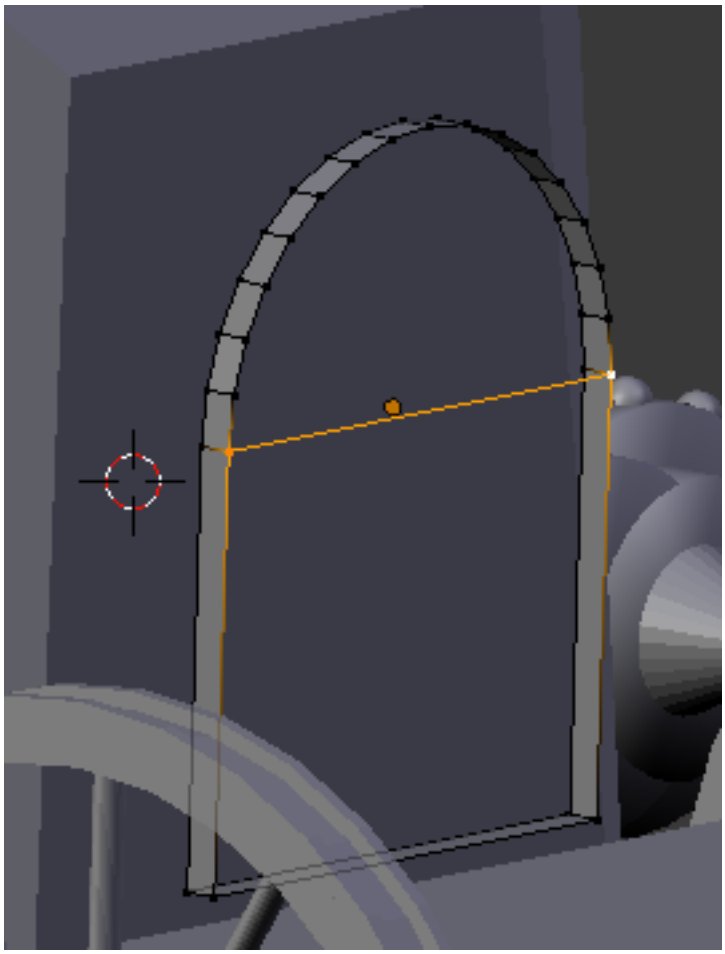
Go to front view and move the object to the right along the X-axis until it is outside of the furnace box as shown below.



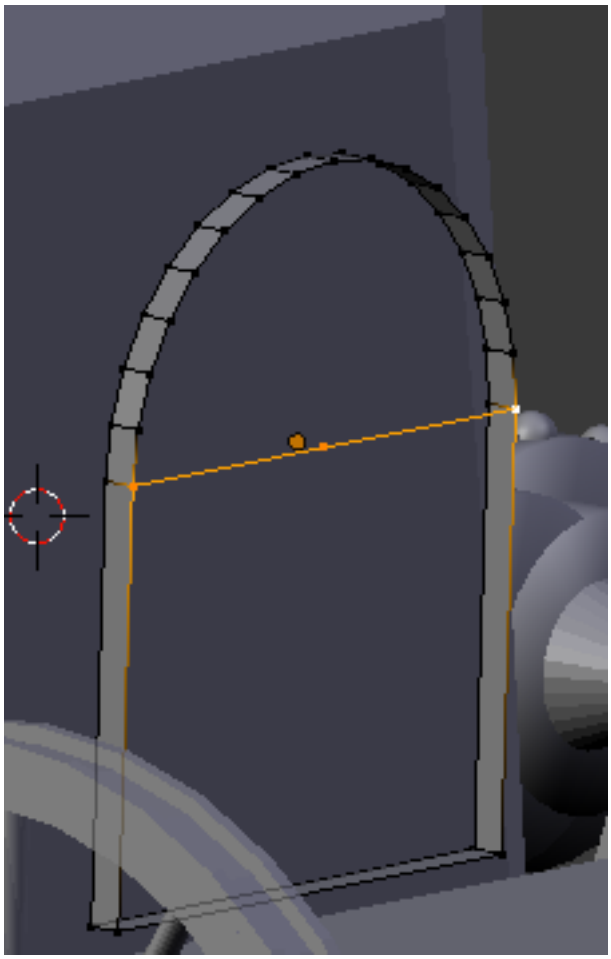
TAB into edit mode. Select all the vertices. Extrude them out a bit along the X-axis as shown below.



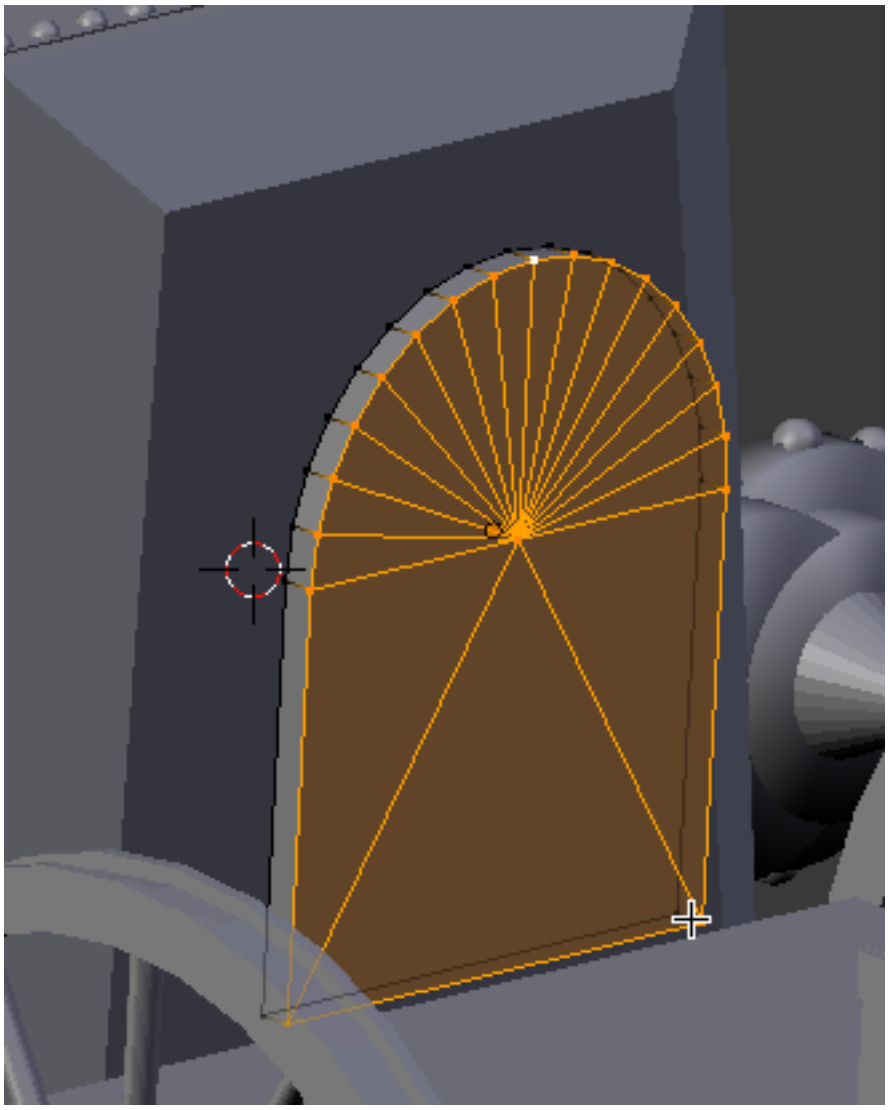
Rotate your view so you can see the door more dimensionally. We need to fill the front with faces. To make the faces cleaner, select the two vertices at the bottom of the arch as shown below and press the FKEY. This will create an edge there.



Next press the Subdivide button in the 3D editor viewport tools panel. This will create a center vertex on this new edge.

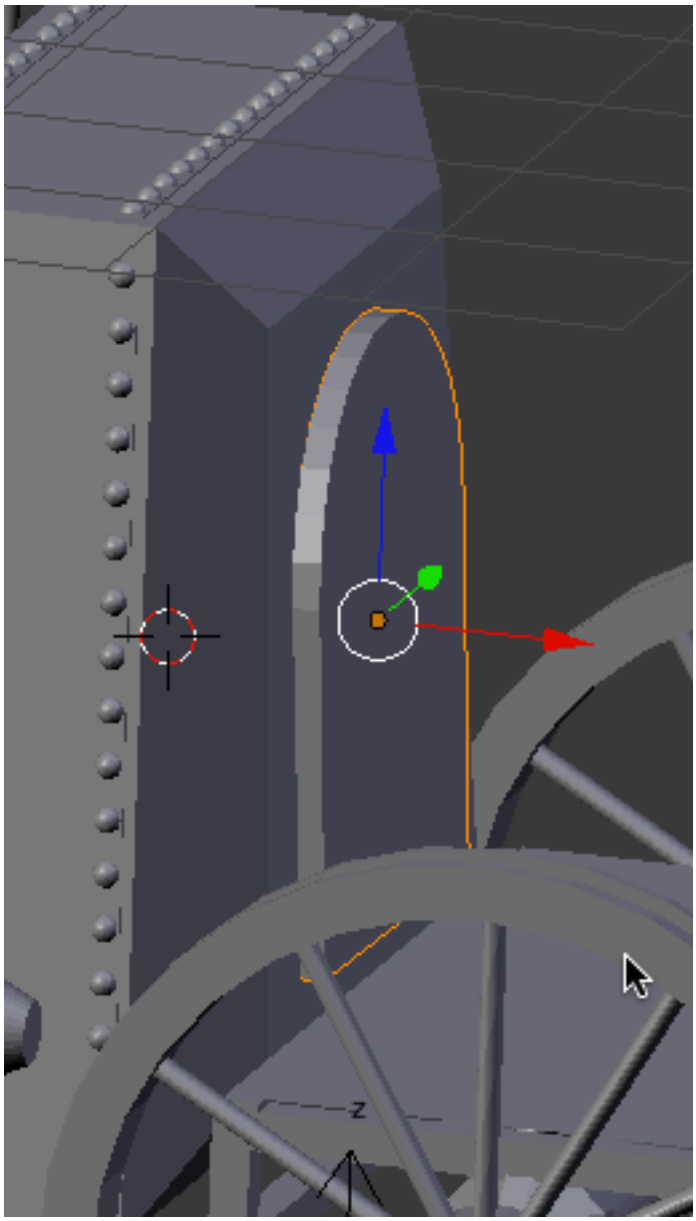


Now select all of the front vertices and press SHIFT-F. This will fill the front with faces.

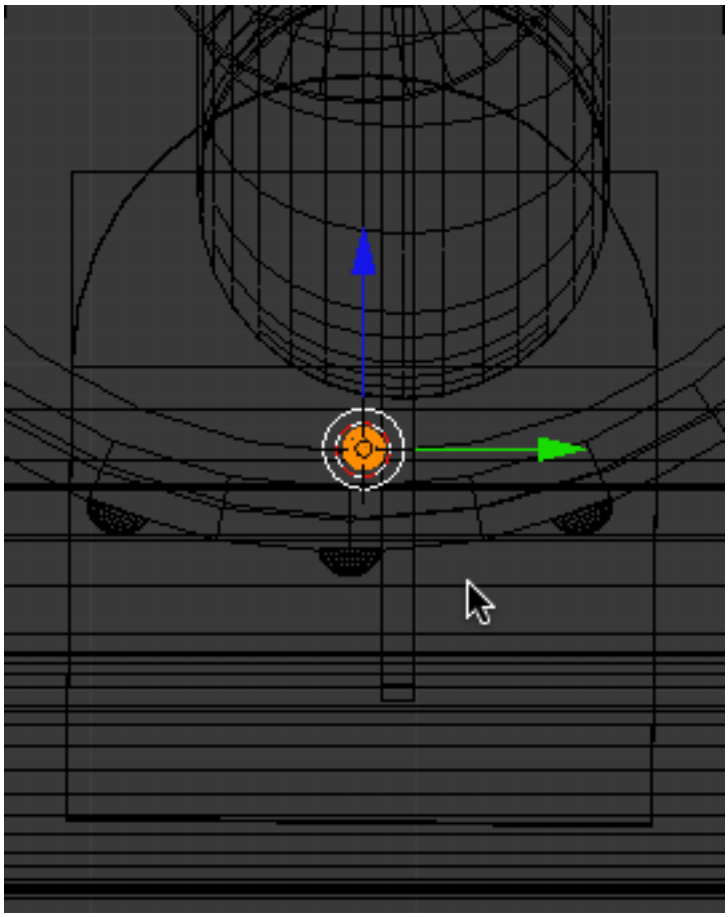


TAB out of edit mode. Name this object “Furnace Door”. Press SHIFT-CTRL-ALT-C and set the origin to the geometry.

Go to front view and rotate the object slightly to align with the front of the furnace and move to the edge of the front of the furnace as shown below.

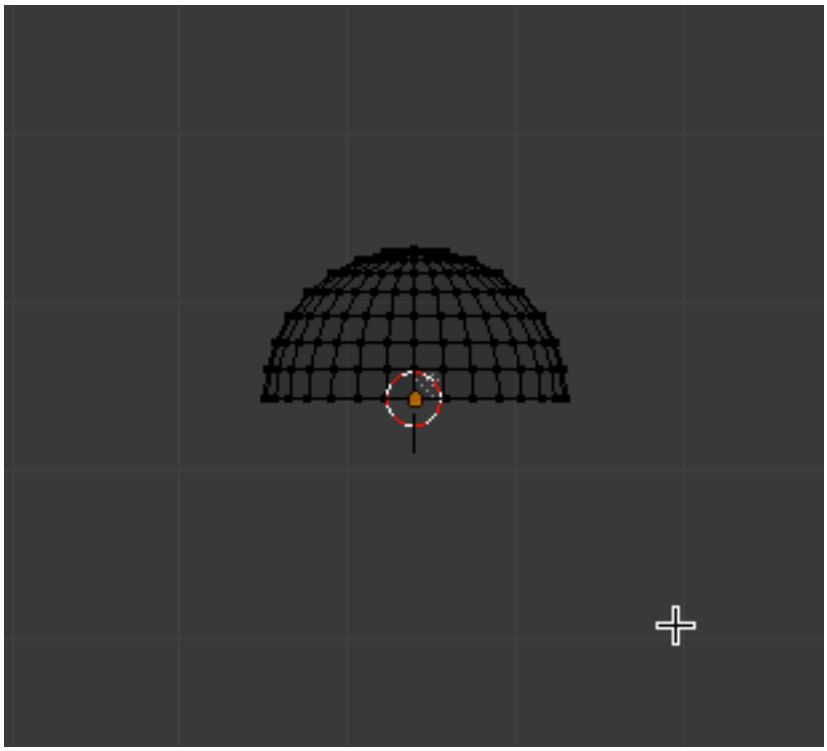



We will put a few rivets on the door using another technique. Go to side view. Select the Furnace door object. Snap your cursor to the object's origin. Press SHIFT-A and add a UV Sphere object. Scale it down to river size.



Press the MKEY and place this object on layer 2 so we can work on it easier. Go to layer 2.

TAB into edit mode, select the bottom half of the vertices and delete them.

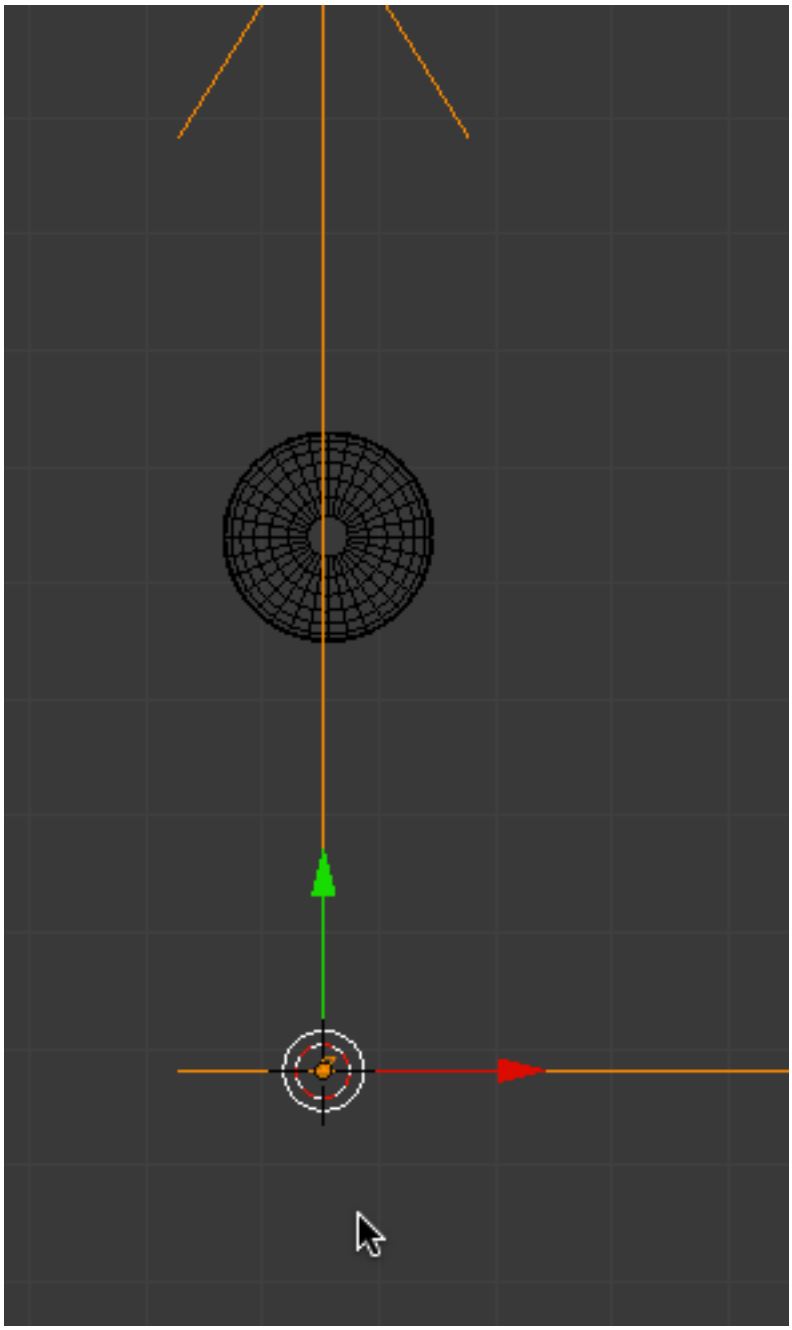


TAB out of edit mode and name this object “Furnace Door Rivets”.

We will add an array modifier but first need to do some set up. Go to top view. With the object selected press SHIFT-CTRL-ALT-C and set the origin to the geometry.

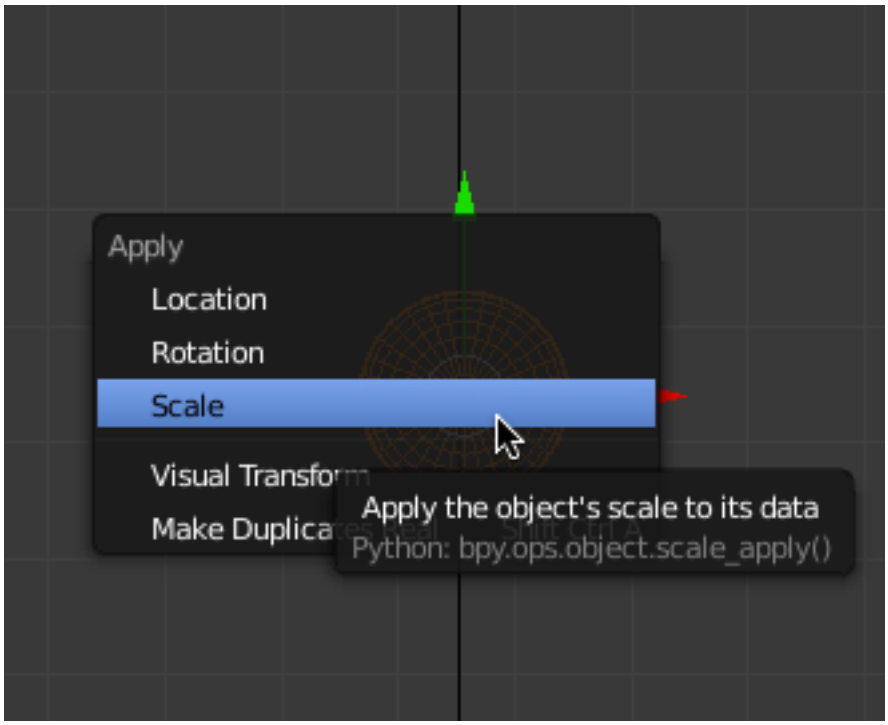
The press SHIFT-S and snap your cursor to the selected.

Now place your 3d cursor below the furnace door rivets object and press SHIFT-A and add an empty object as shown below.



Name this empty object “Door Rivet Empty”.

We now need to reset (apply) the scale and rotation of the furnace door rivets object. Select the furnace door rivets object and press CTRL-A and choose Scale.

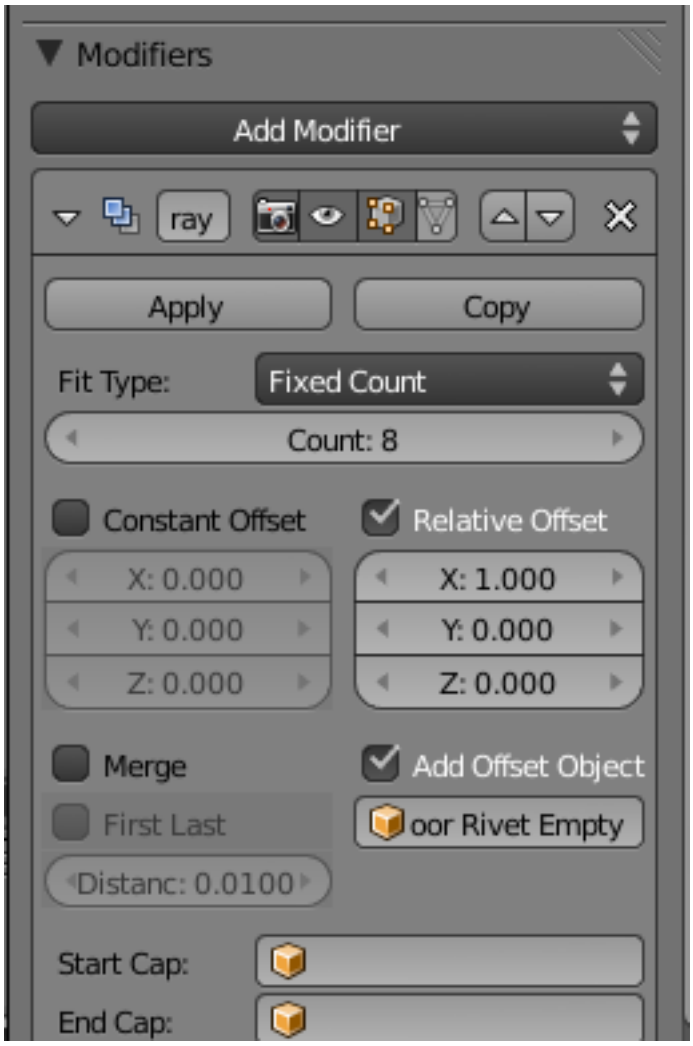



This will reset the scale of the object. Note the scale in the properties panel now reads "1".

Press CTRL-A again and this time select "Rotation". This will reset the rotation of the object. Note in the properties panel the rotation reads 0 for X, Y, and Z.

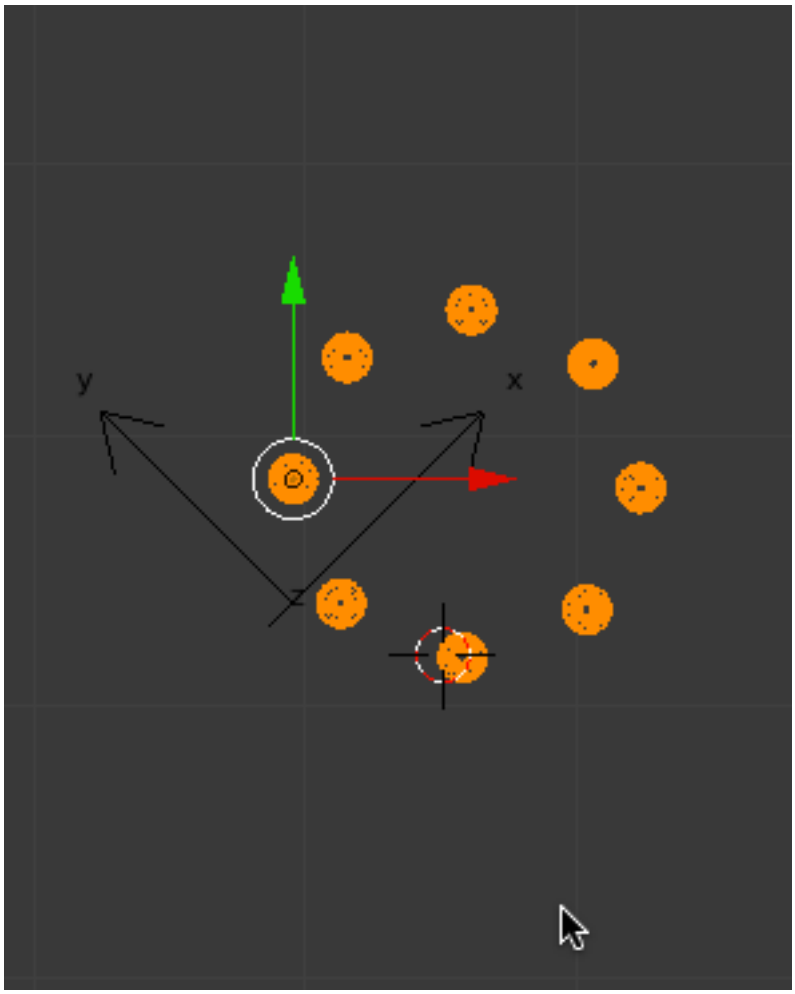
Now add an ARRAY modifier to the object.

Set the count to 8. Checkmark the Add Offset Object check box. Click in the box and select Door Rivet Empty as the offset object.




Now select the Door Rivet Empty object  press the RKEY followed by the ZKEY followed by 45 then ENTER.

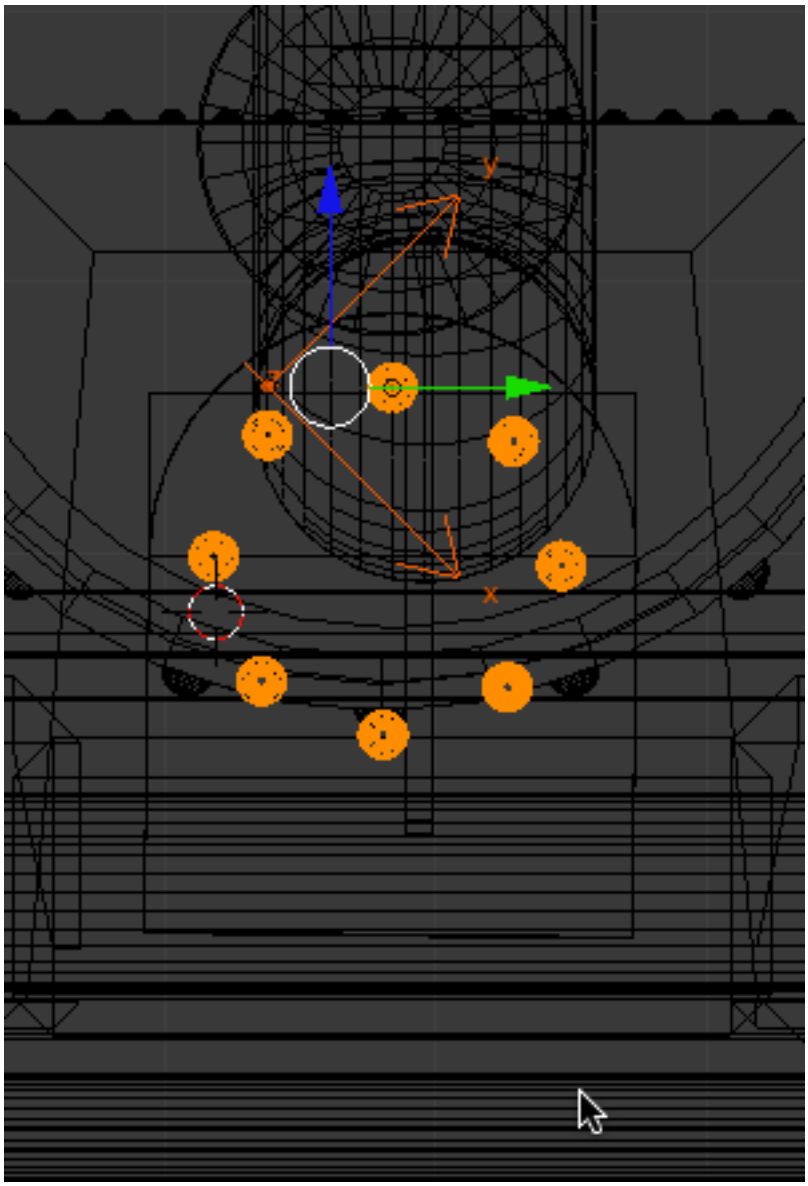
This creates a ring of rivets as shown below.



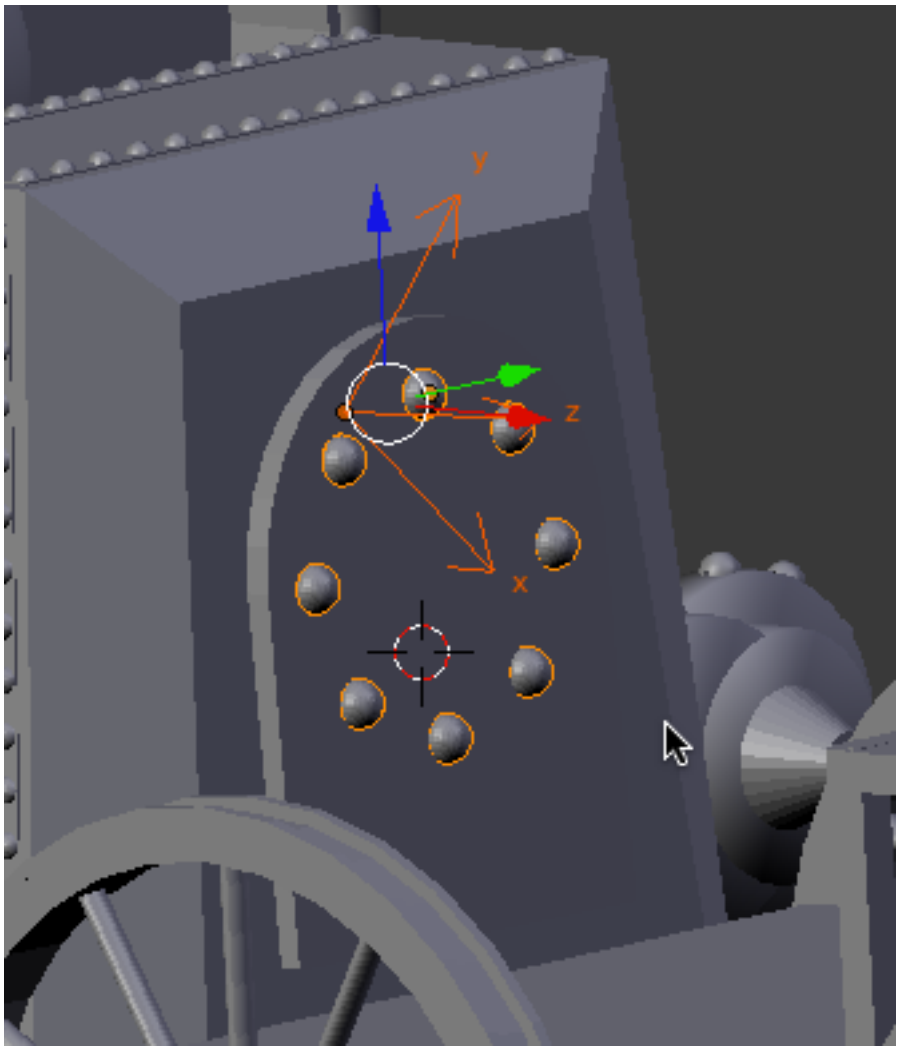

Select both the Rivets and empty objects and place them on layer 1. Go to layer 1. Go to front view.

With both objects selected press the RKEY followed by the YKEY followed by 90 then ENTER. This will rotate the objects around the Y-axis 90 degrees.

Go to side view and move the objects up a bit s shown below.

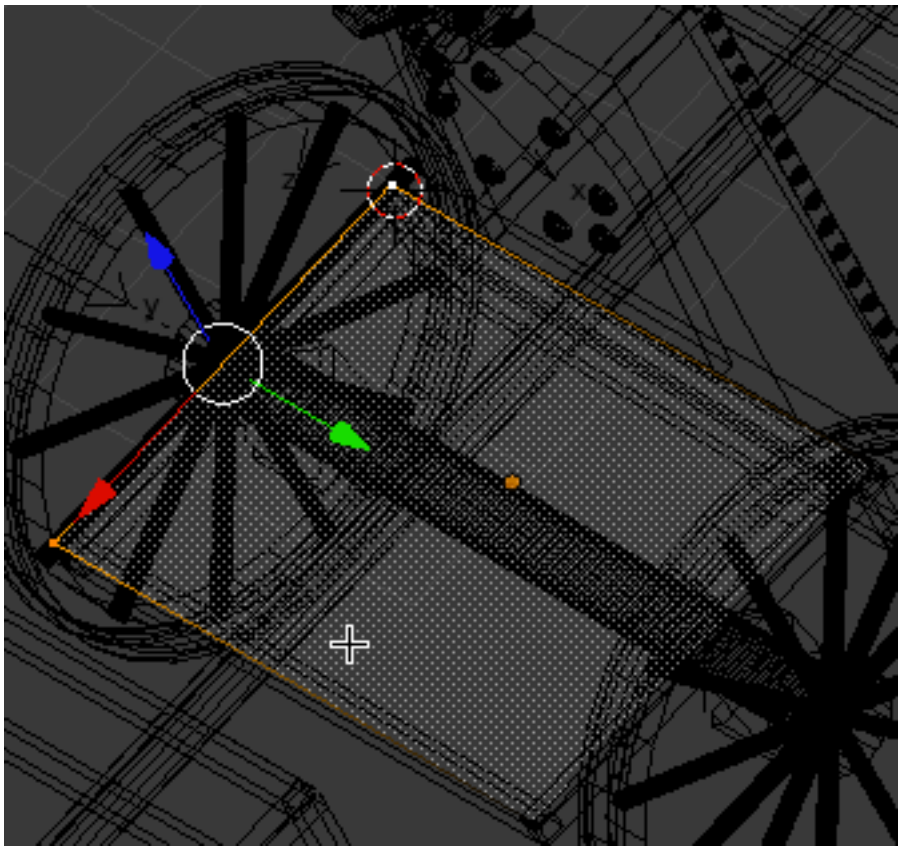



Go to side view and solid display mode and move and rotate them slightly to align with the door angle and place them as shown below.

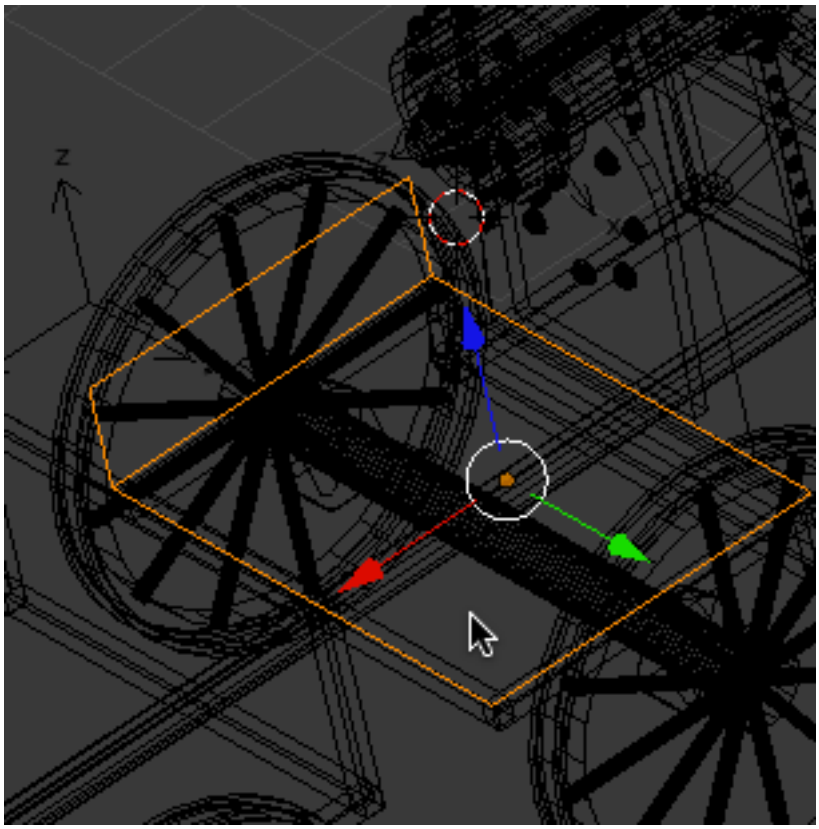



Save your Blender file.

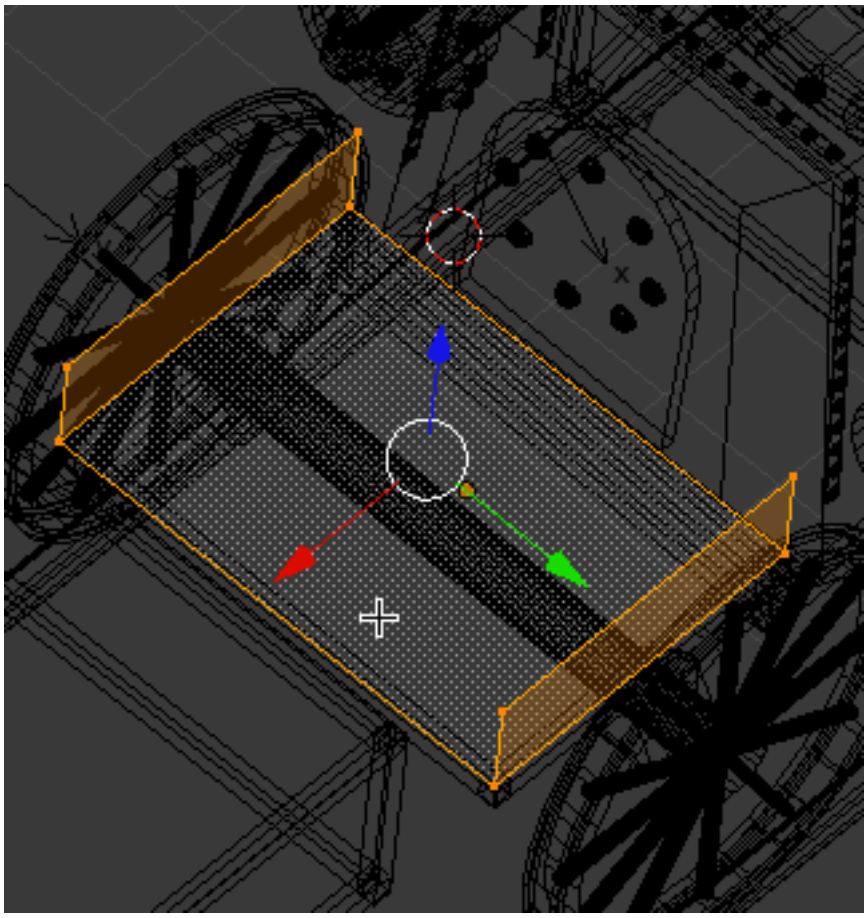
Select the flat plate adjacent to the furnace object. TAB into edit mode. Select the 3 vertices as shown below.



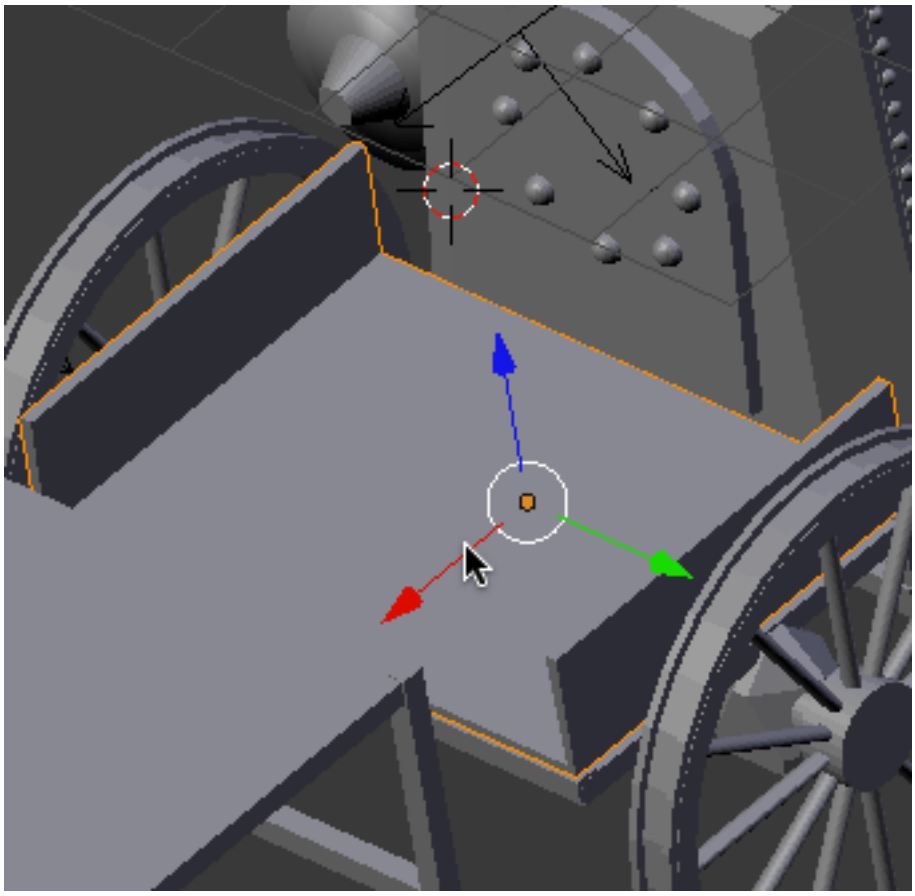
Extrude these vertices up a bit along the Z-axis as show below.



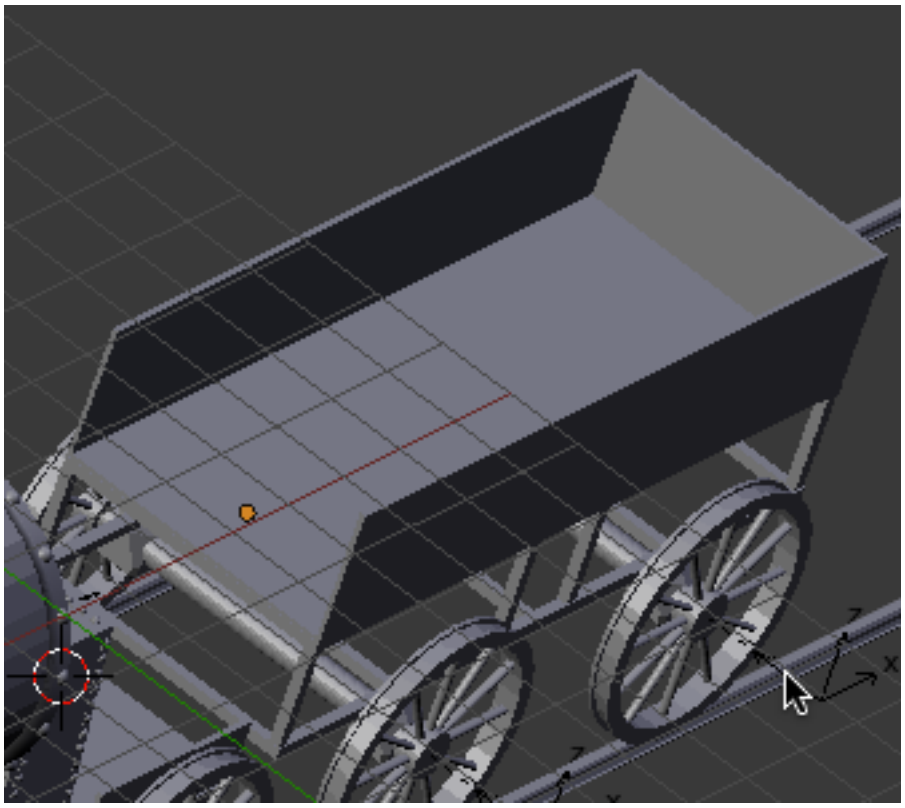

Do the same extrusion on the other side of the plate.



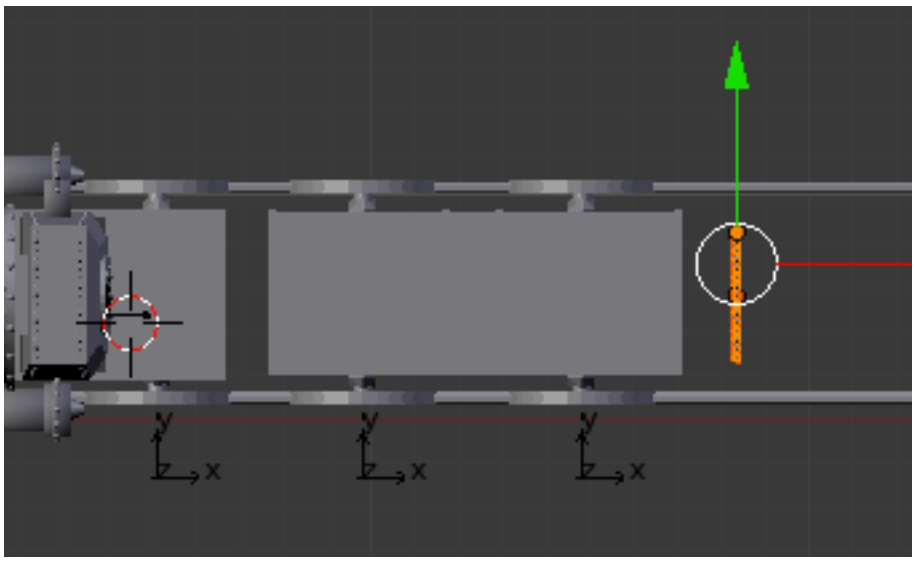
Tab out of edit mode.  Add a SOLIDIFY modifier to the object. Set the thickness to .08
This modifier adds thickness to the faces of an object.



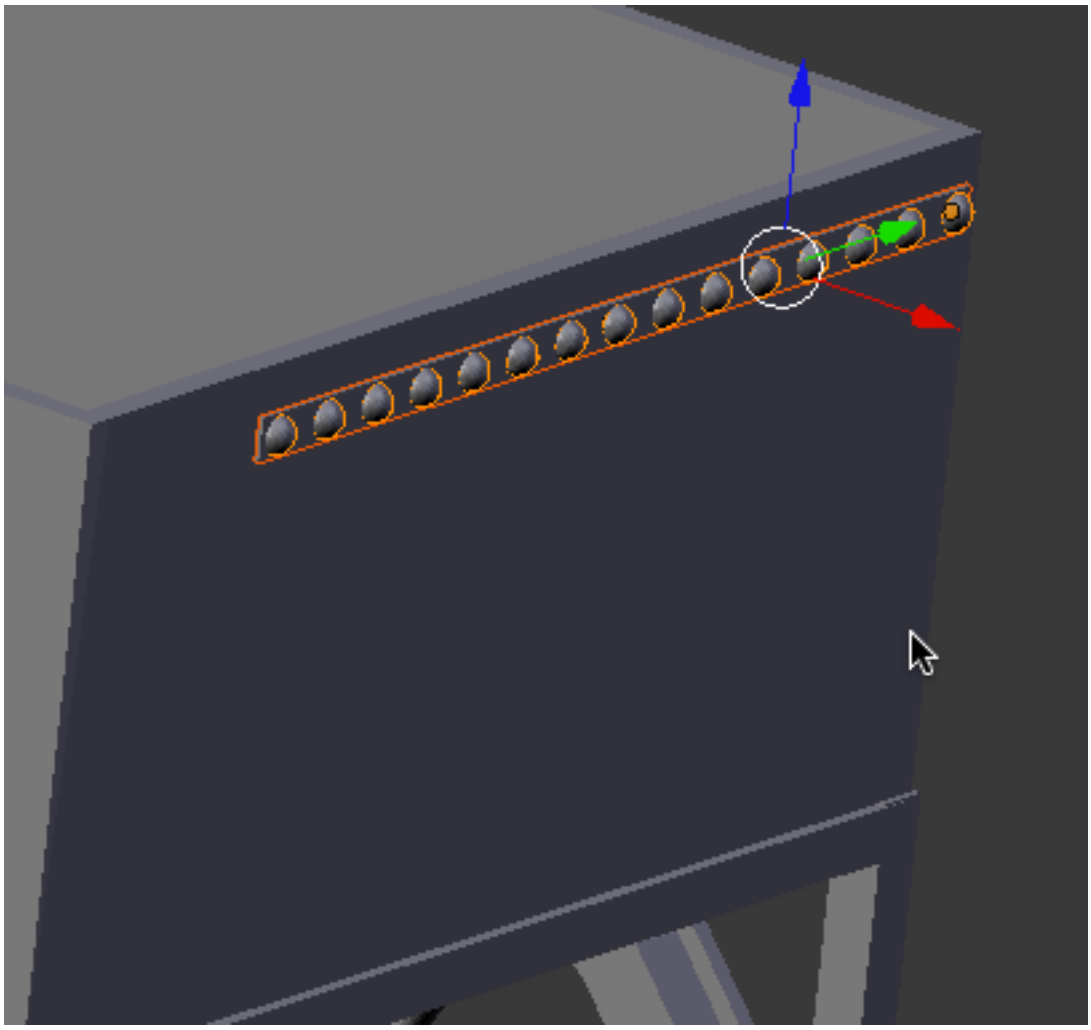
Do the same thing with the plate that lies on the top of the car frame as shown below.



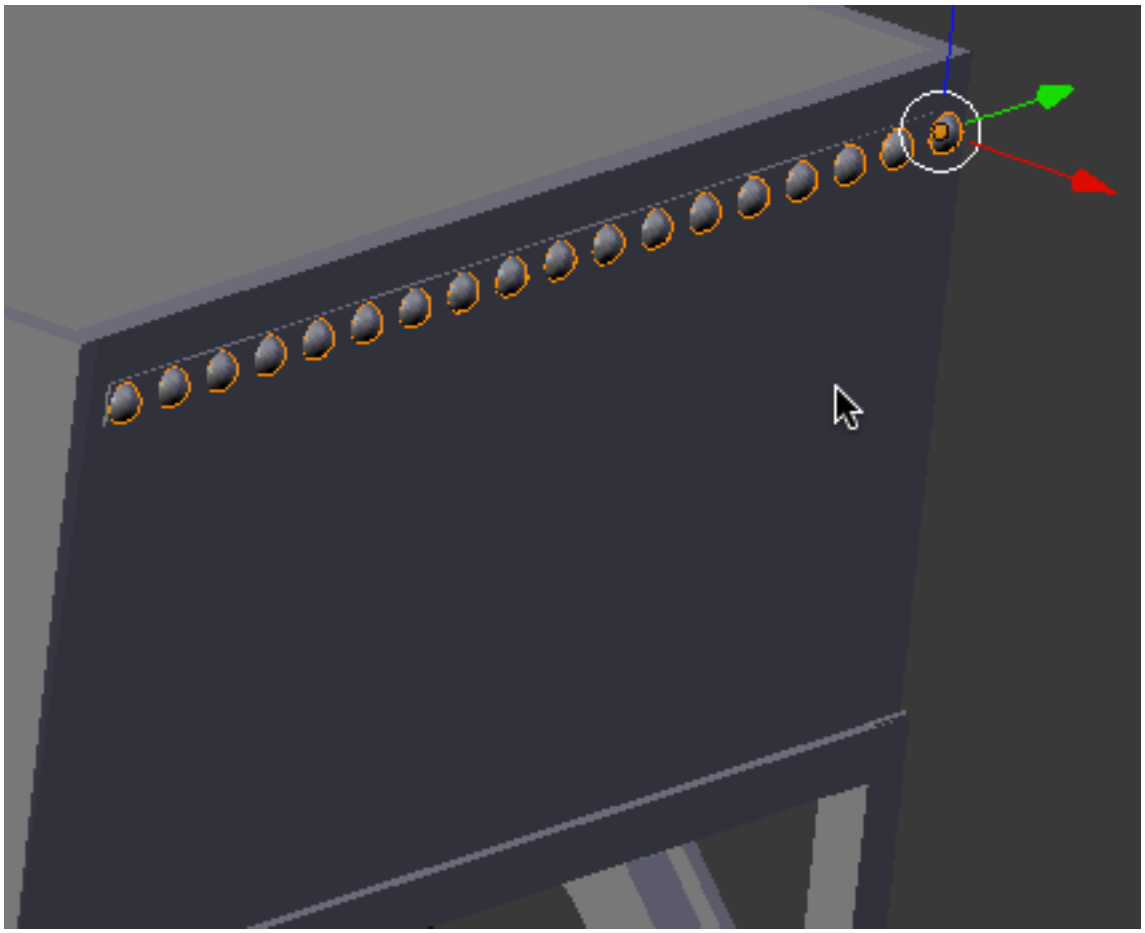
We will put some rivet trim on the car as well. Go to top view. Select the Furnace Rivet and Rivet plate objects from the top of the furnace. Press SHIFT-D and move the duplicate objects along the X-axis to the rear of the car as shown below.



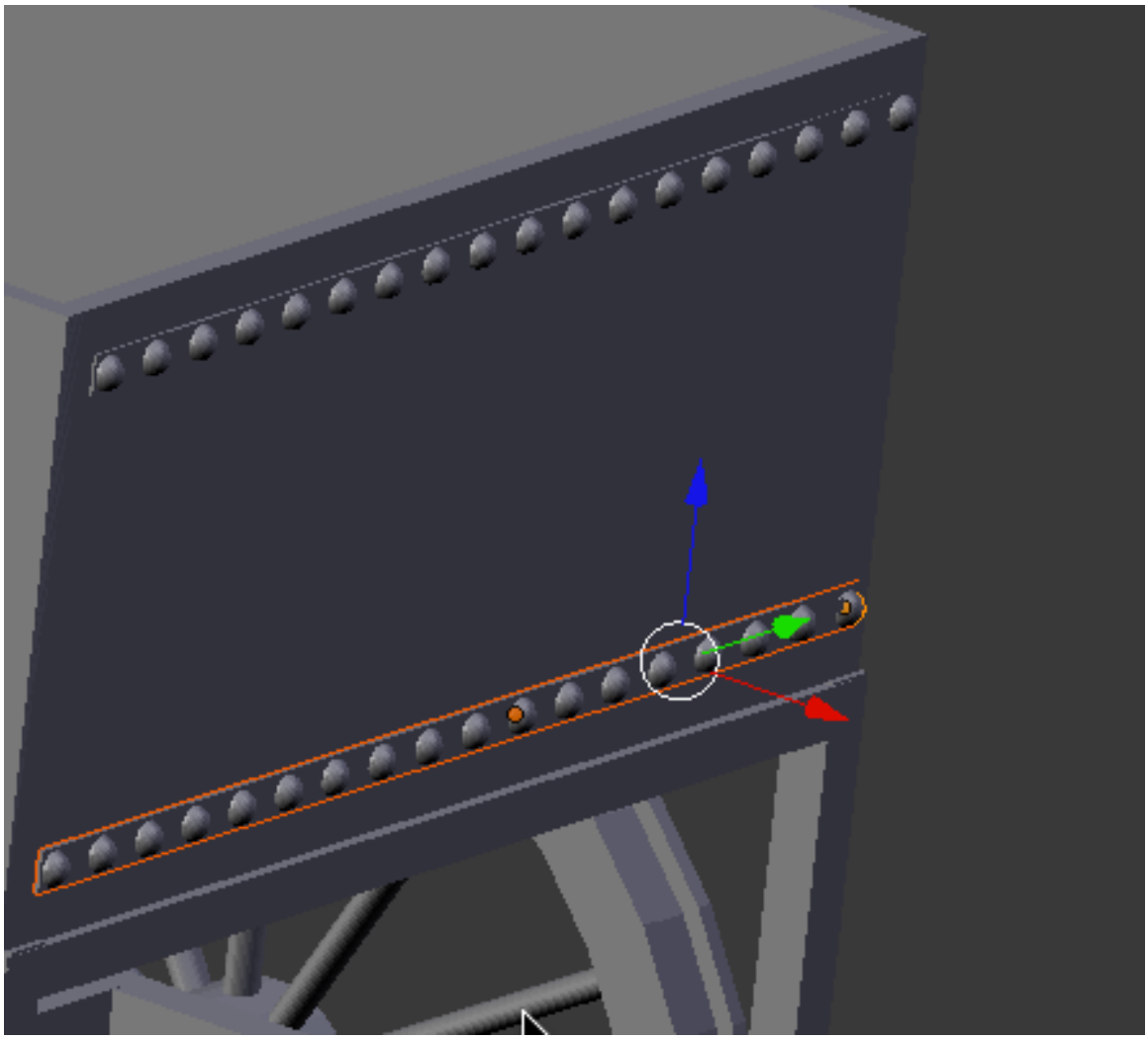
Press the RKEY followed by the YKEY followed by 90 then ENTER. Position the objects on the rear of the car as shown below.



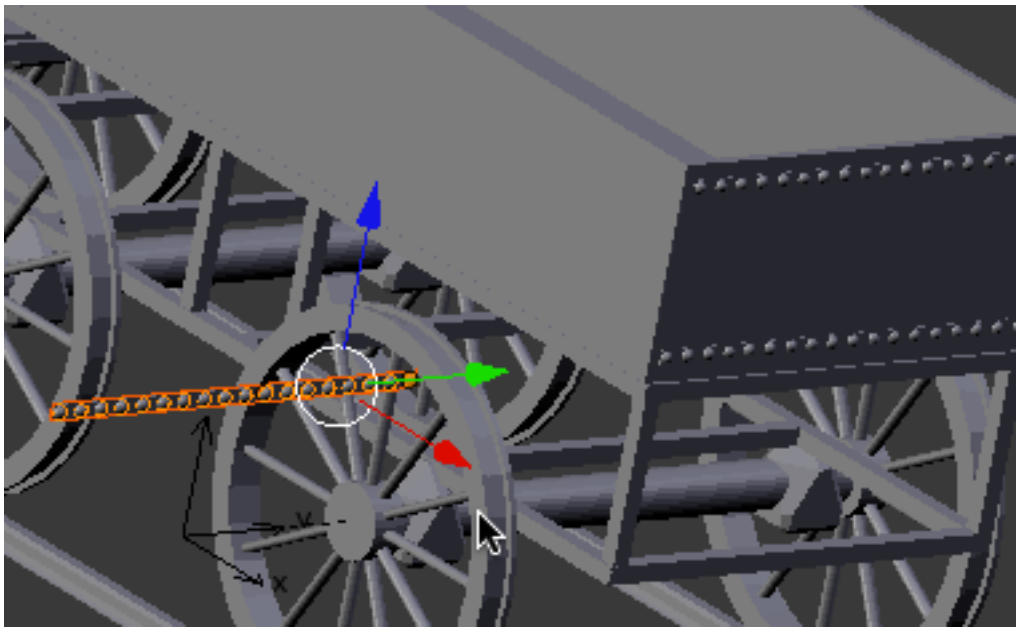
Since these are their own objects we can edit them including the array modifier. Select the plate object. TAB into edit mode and extend the vertices to the edge of the car. Select the rivets object and in the modifier panel increase the count to 18 (or whatever you need to fill up the plate).



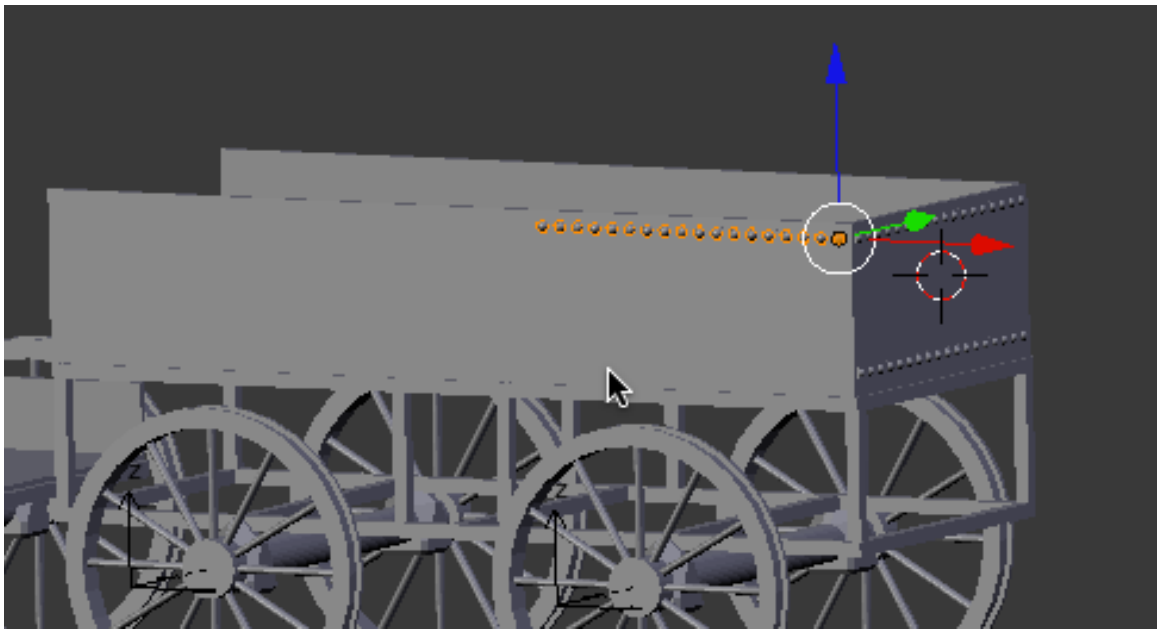
Make a duplicate of these objects and move them to the bottom of the rear car plate as shown below.



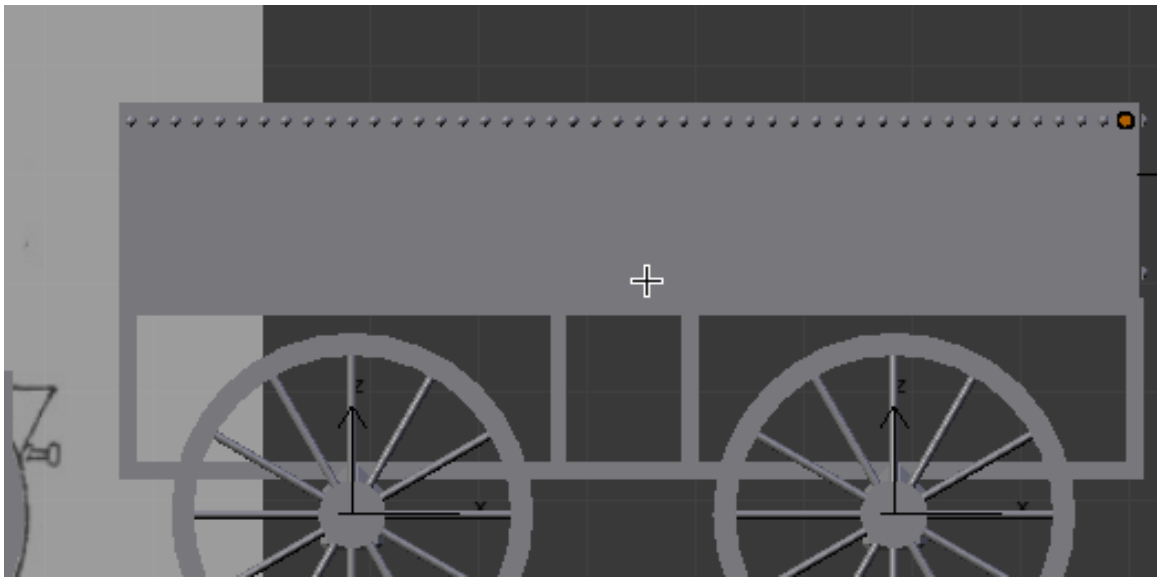
With the duplicate objects still selected, press SHIFT-D and make another copy of the objects and move it out along the Y-axis as shown below.



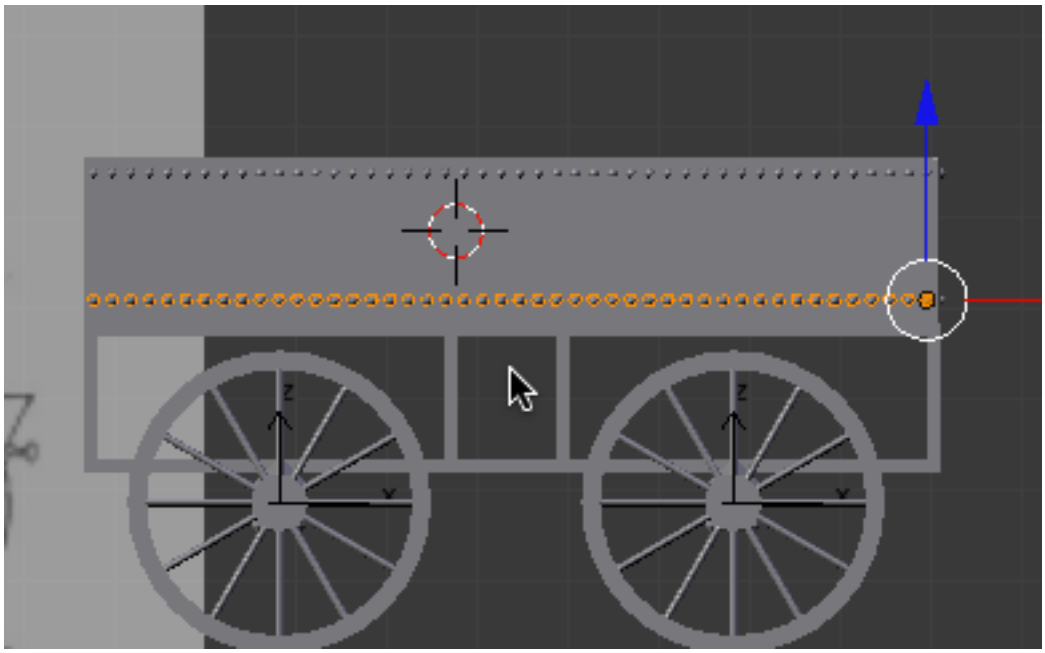
Rotate the objects -90 degrees around the Z-axis and place it on the front car side panel as shown below.



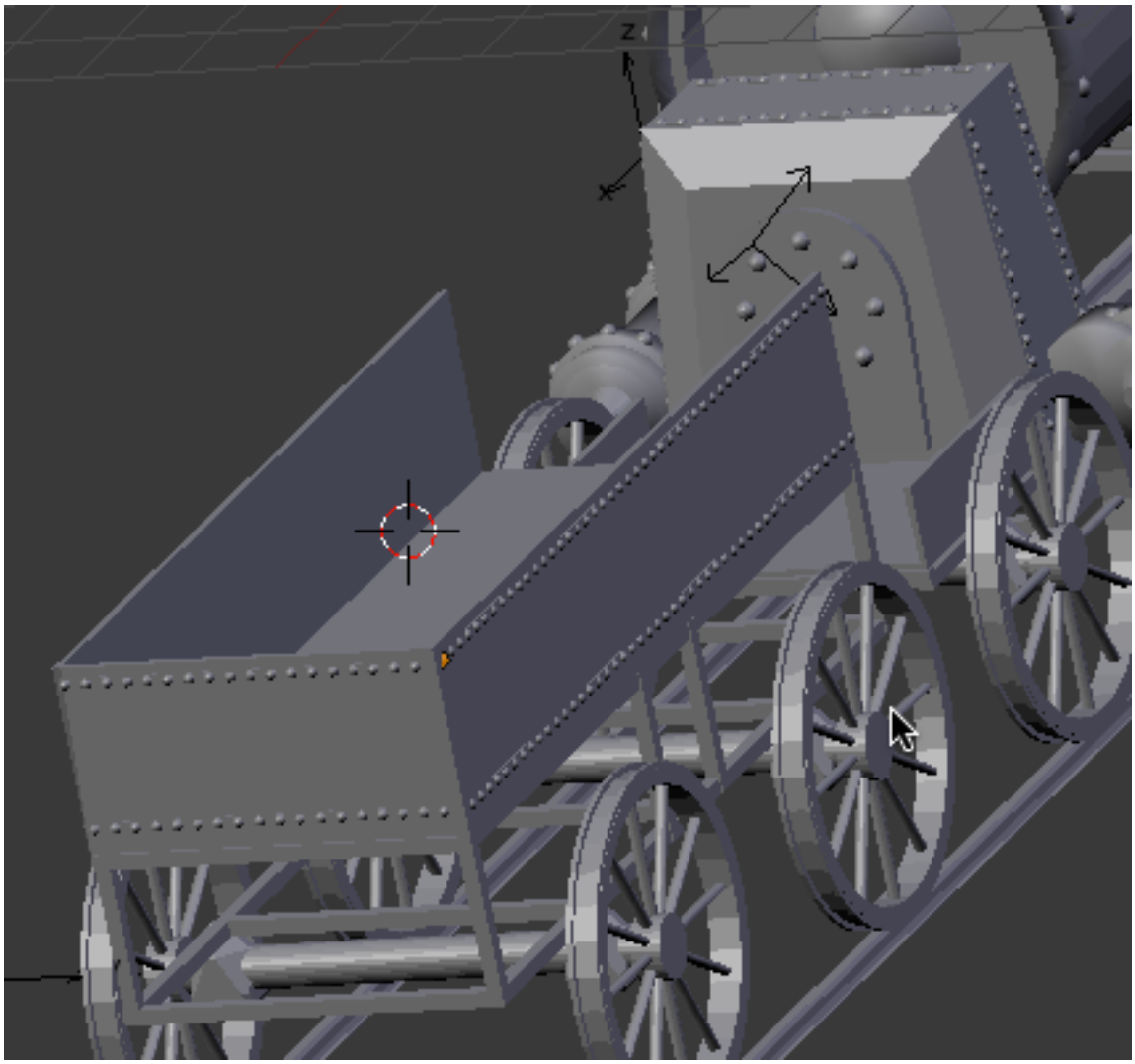
Edit the plate object to extend it the length of the side of the car and then increase the count of the rivet array modifier to fill up the space with rivets (mine took 46).



Make a duplicate for the bottom of the car side.

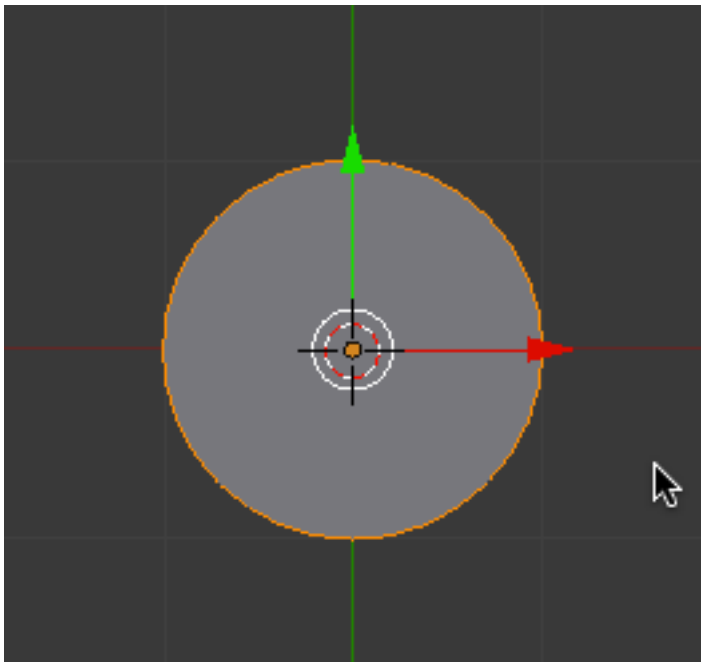


Select both duplicate plates and duplicate rivets and make a duplicate copy for the other side of the car. You will have to rotate them around the X-axis 180 degrees.

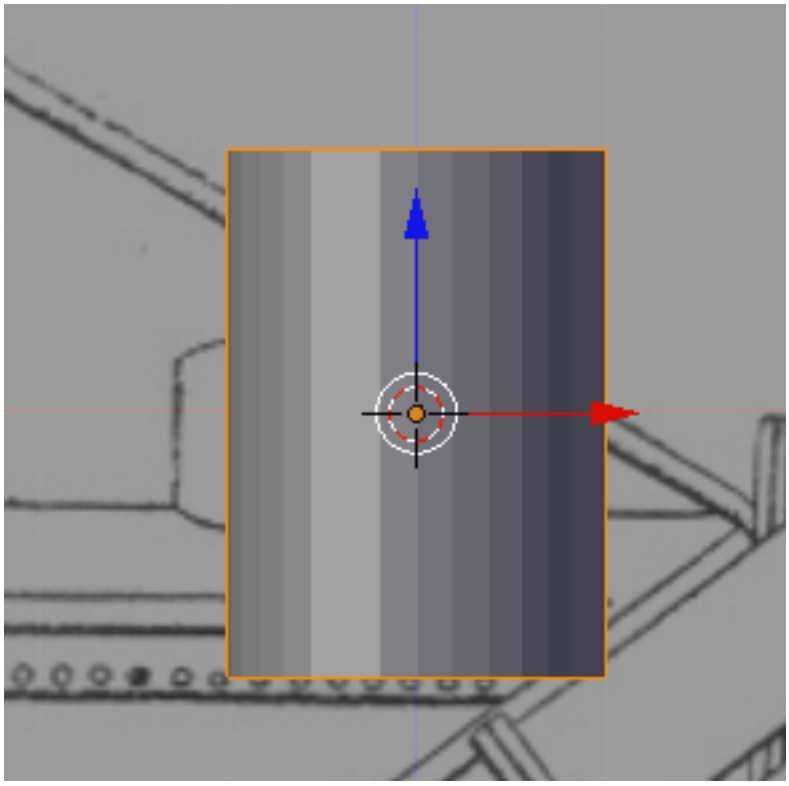


Save your Blender file.

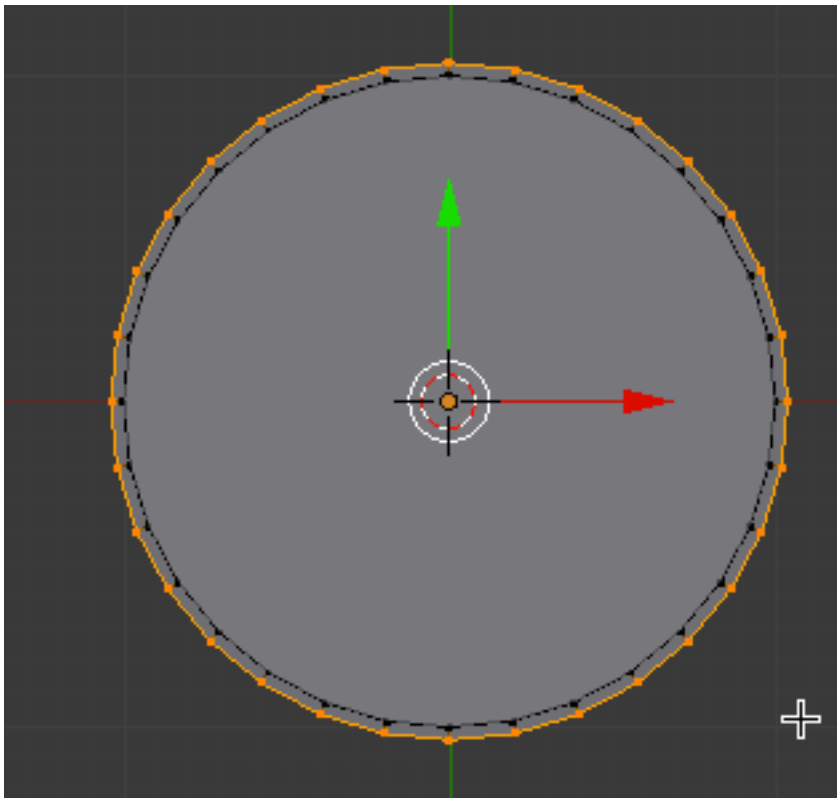
We will model a water barrel and place it in the back of the car. Go to layer 2, which should be empty. Place your 3D cursor at X, Y, Z = 0. Go to top view. Press SHIFT-A and add a capped tube object.



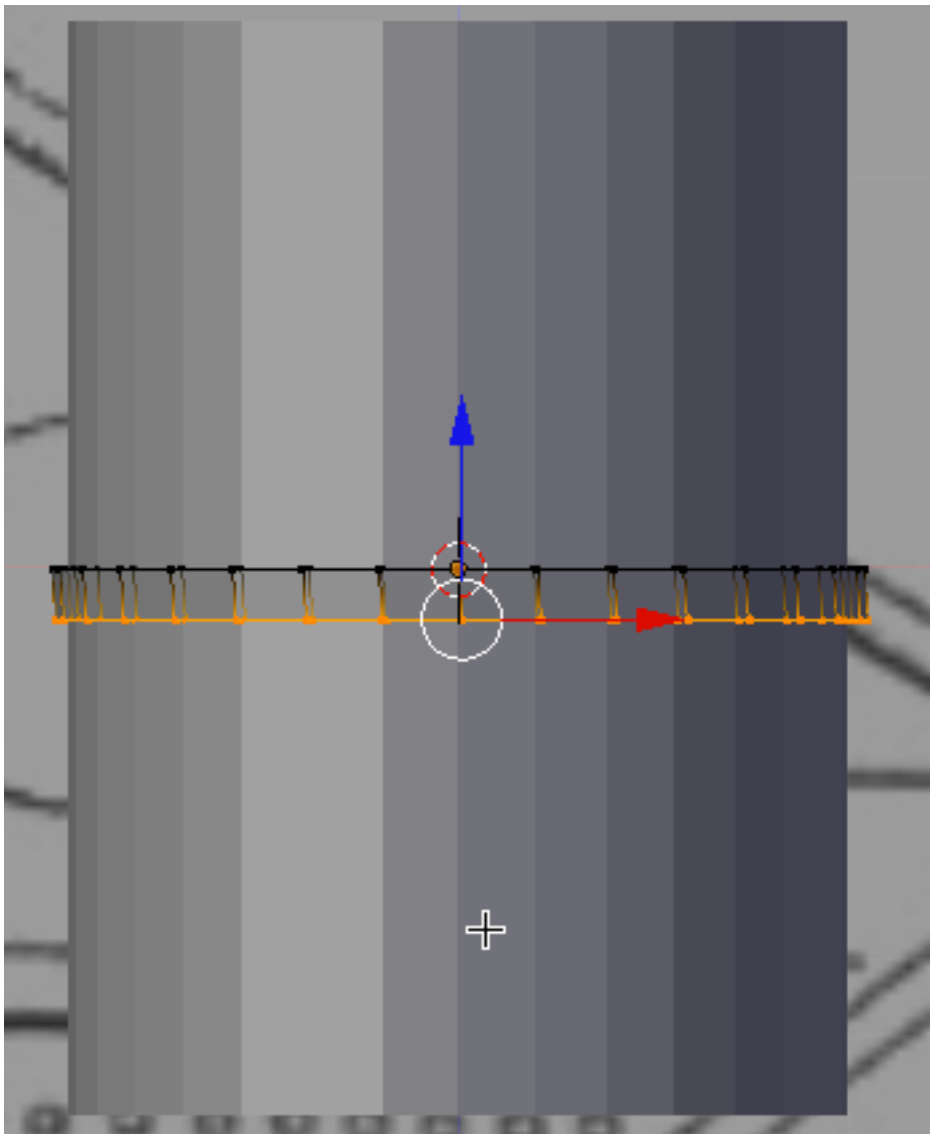
Go to front view and scale it a bit up along the Z-axis as shown below.



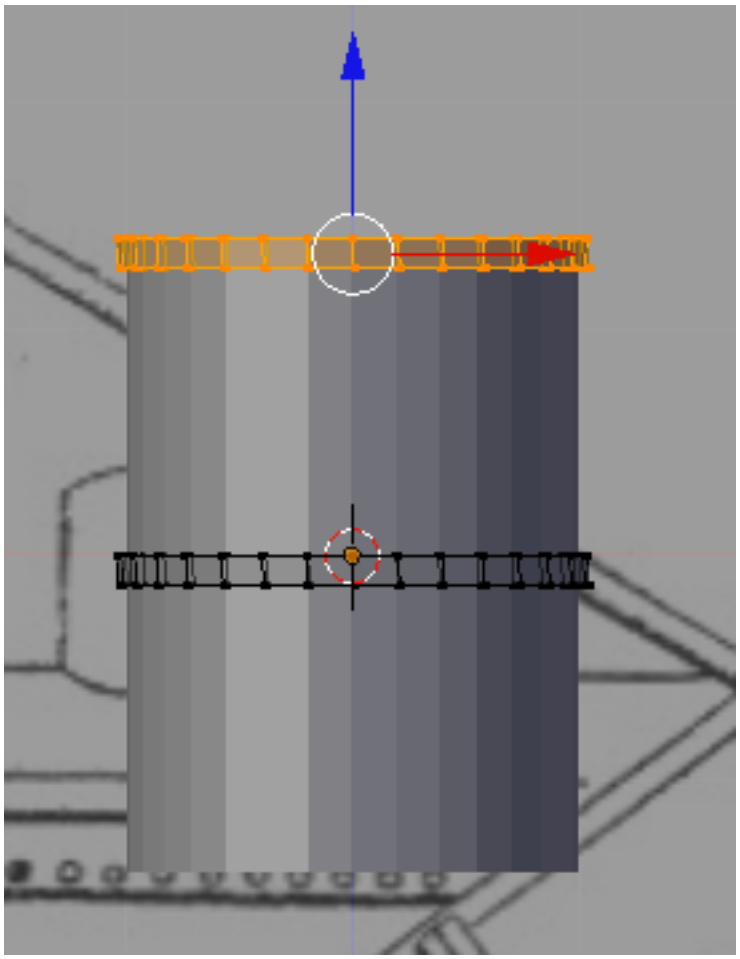
Go back to top view. Press SHIFT-A and add an unfilled circle object. It should be the same diameter as the tube object. TAB into edit mode and extrude /scale out just a small bit as shown below.



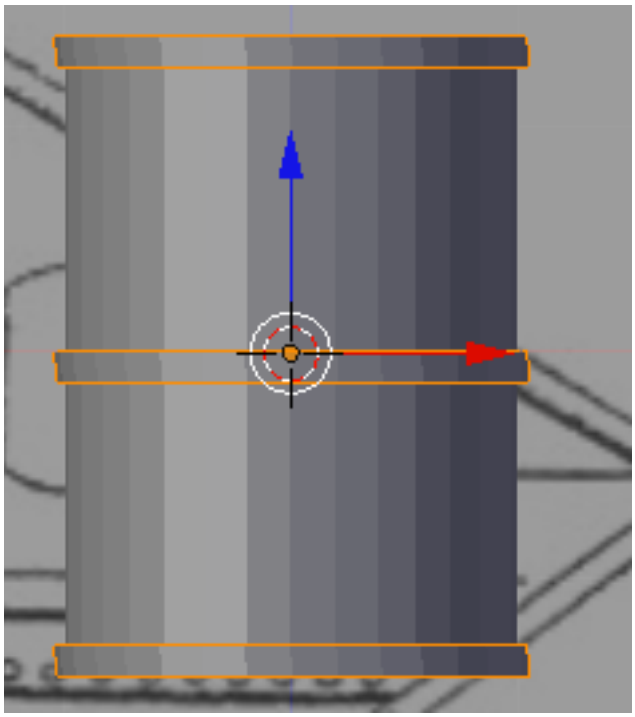
Go to front view. Select all of the vertices and extrude down along the Z-axis a bit to form a barrel ring as shown below.



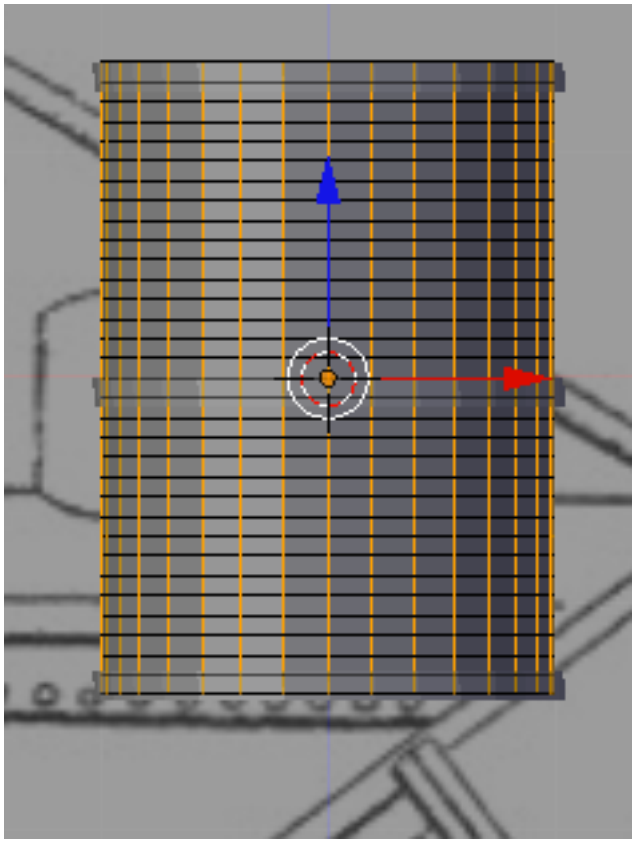
Select all of the vertices then press SHIFT-D, then press the ZKEY and make a duplicate of the vertices and move them to the top of the barrel.



Make another copy of the vertices and move them to the bottom of the barrel. TAB  out of edit mode and name this object Barrel Rings.

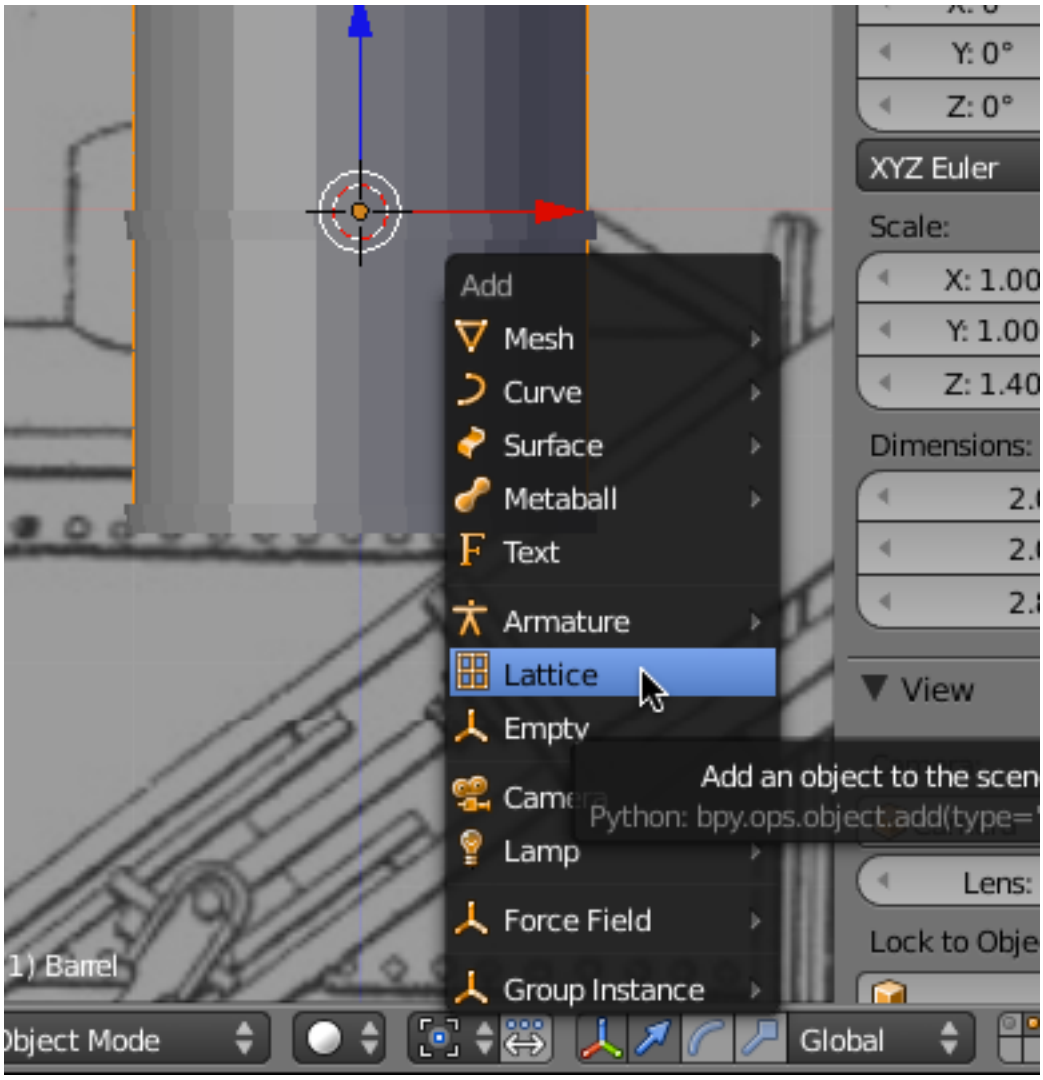


Select the tube object. TAB into edit mode. Press CTRL-TAB and go to edge select mode. Box select the inside edges. Press the Subdivide button in the 3D editor tool panel 5 times. (We need lots of vertices to perform the next deform operation)



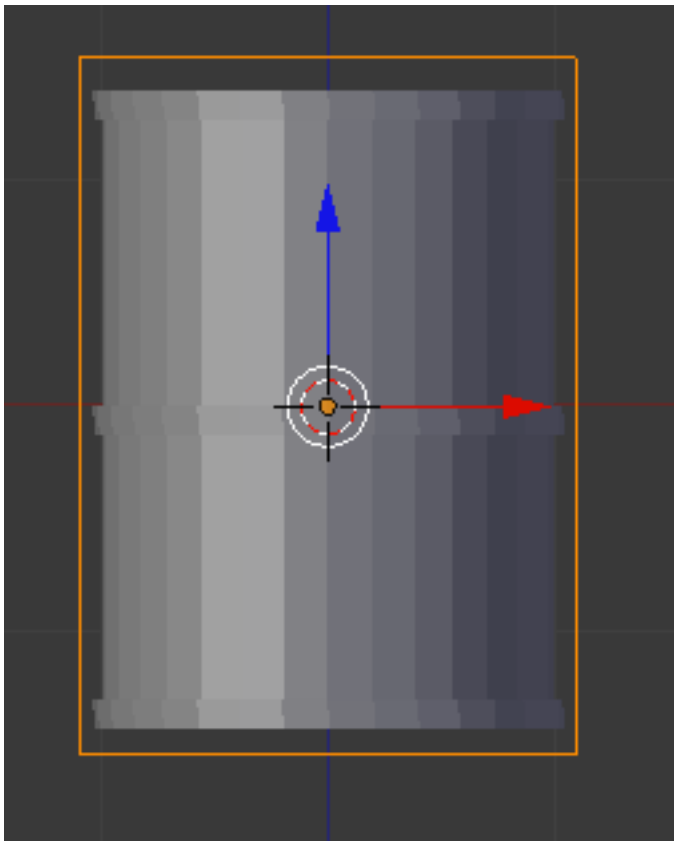
Press CTRL-TAB and go back to vertex select mode. TAB out of edit mode and name this object “Barrel”.

Press SHIFT-A and add a Lattice Object.

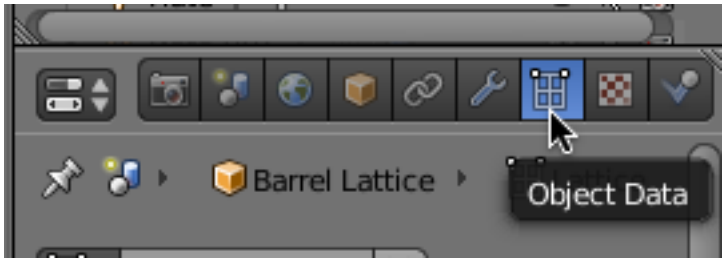



A Lattice is a cage like object that we will use to deform the barrel shape.

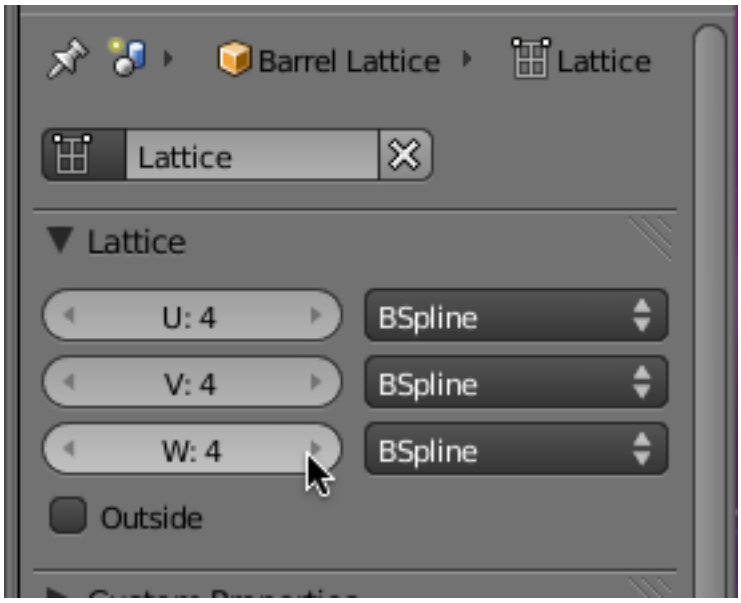
Scale the lattice up so that it is a bit wider than the barrel and rings then scale it along the Z-axis so it is a bit higher than the other objects as shown below (Note: I turned off the background image so you can see then better).



Name this lattice object “Barrel Lattice”. With the Barrel Lattice object selected, press the Object Data button in the Properties panel.

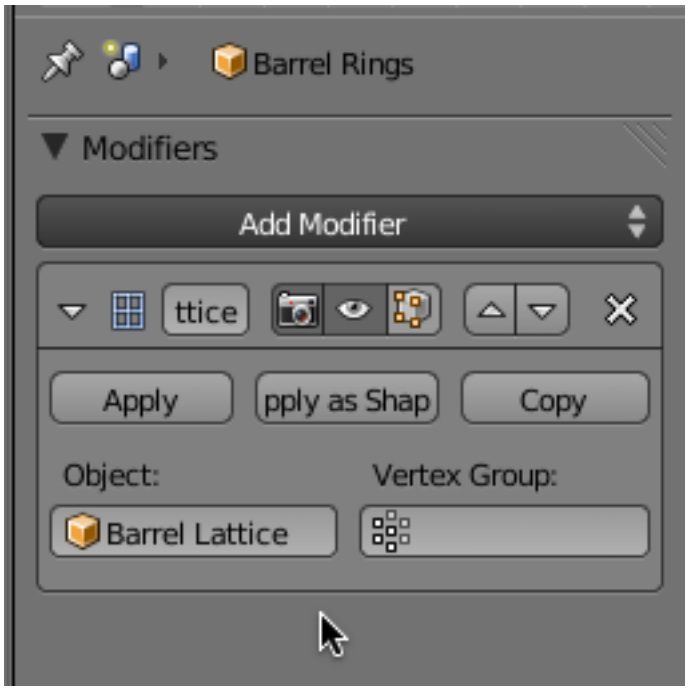



Set the lattice U, V and W controls to 4 (this will add more lattice control points along all 3 axis.

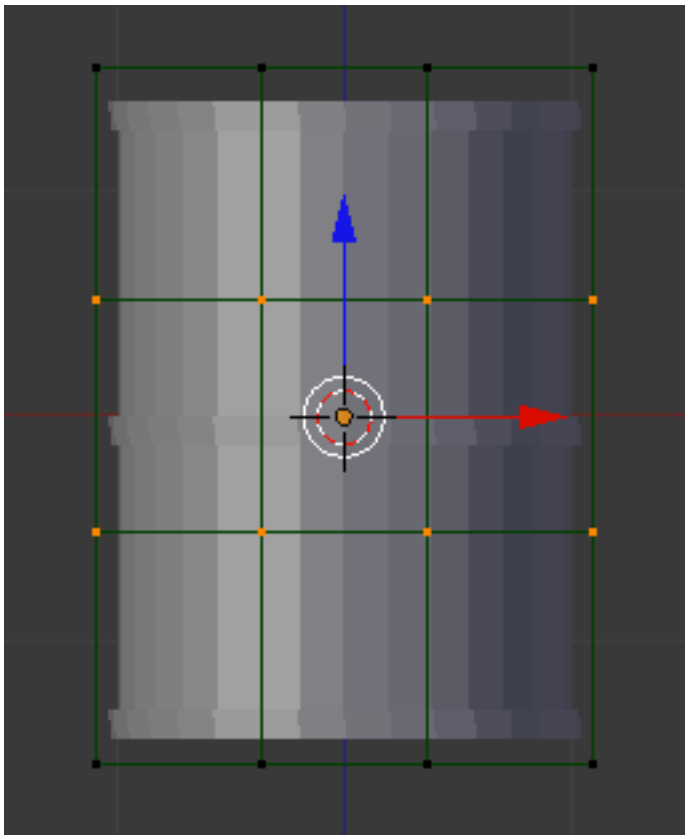



Select the Barrel object and add a Lattice modifier to it. Choose the Barrel Lattice as the Object.

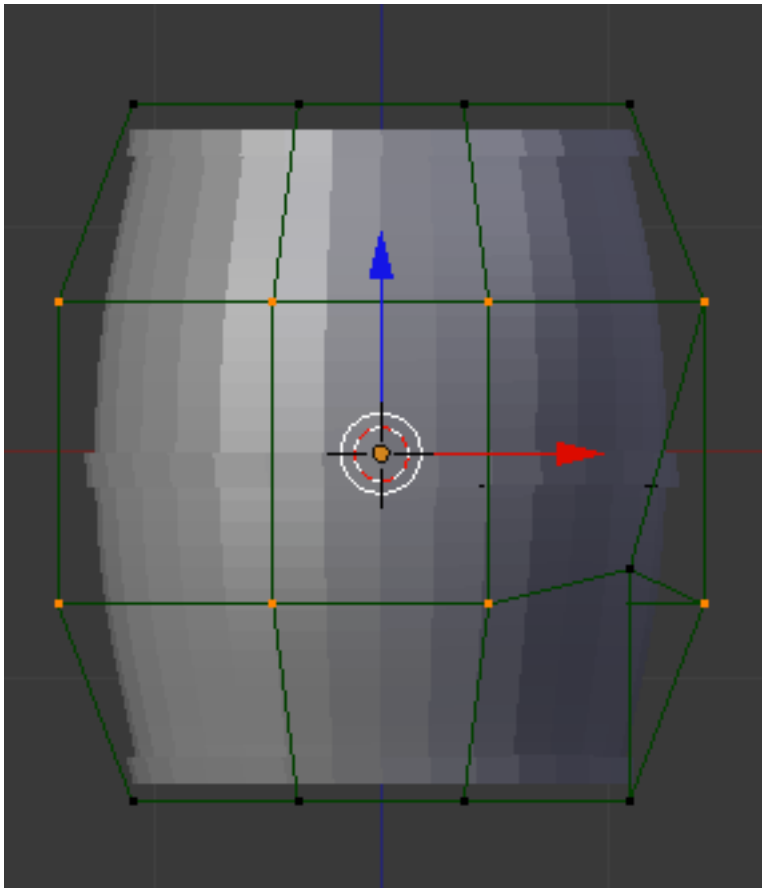
Select the Barrel Rings object and add a Lattice modifier to it. Choose the Barrel Lattice as the Object.

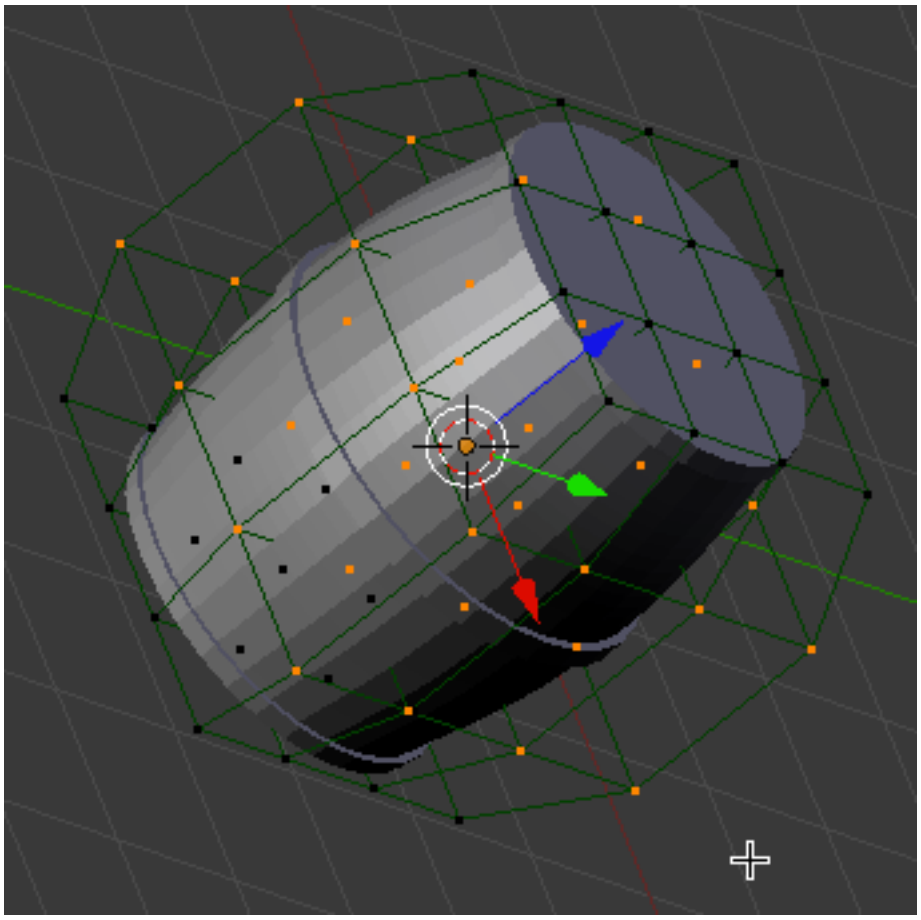



Now, both the Barrel and Barrel Rings objects will be affected by the Barrel Lattice deform modifier. Select the Barrel Lattice object and TAB into edit mode. Box select the center control points as shown below.



Press the SKEY and scale them out a bit. This will deform the barrel and barrel rings objects into a barrel shape.

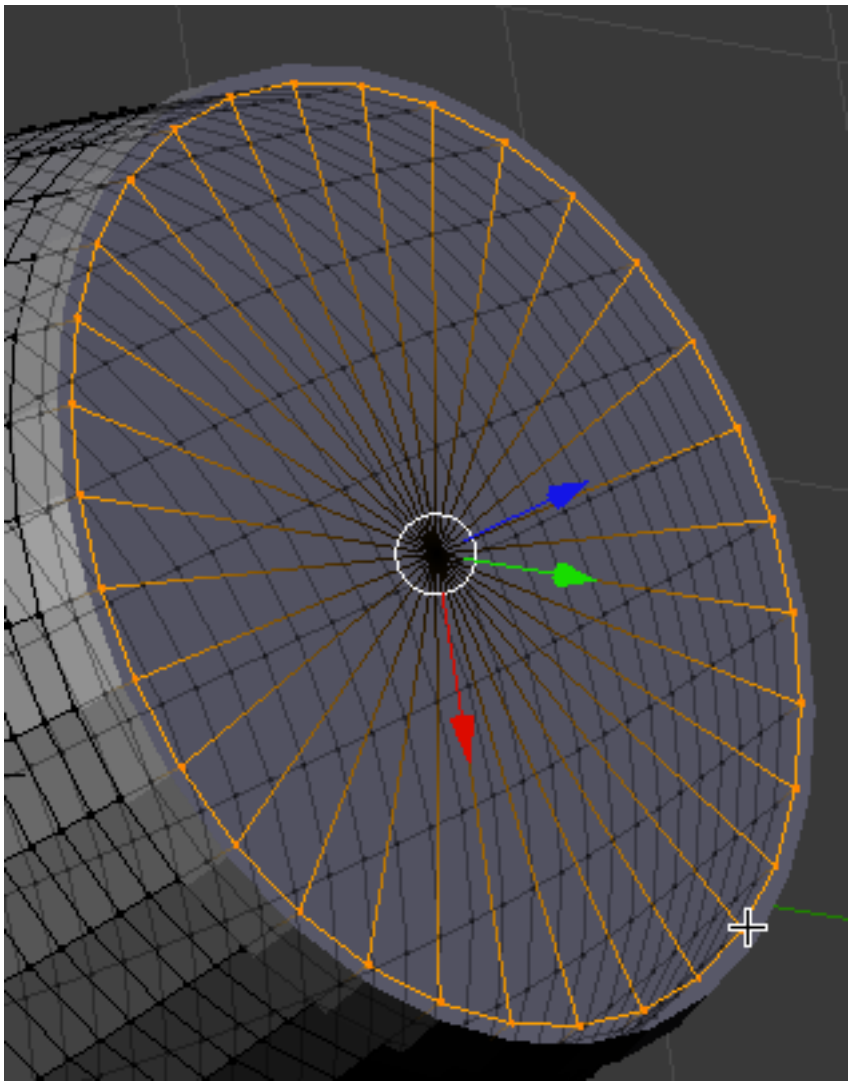




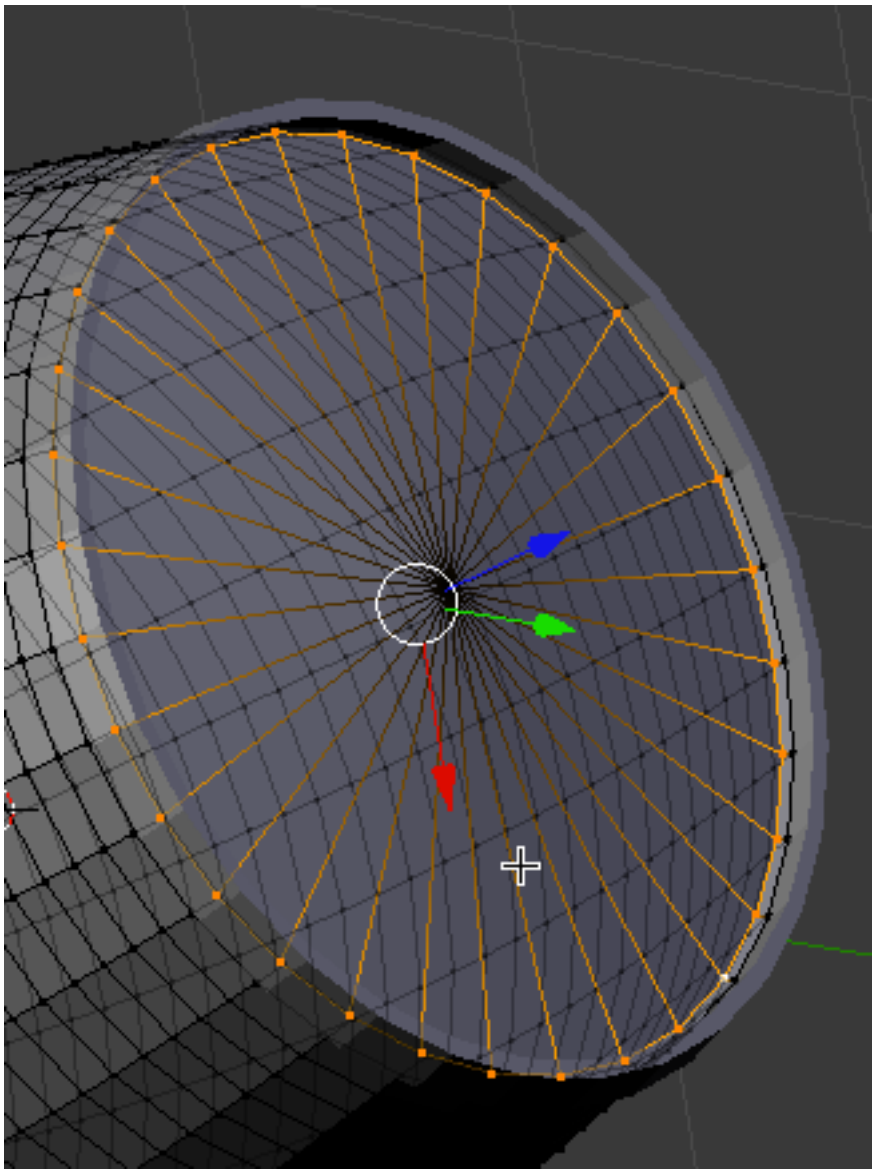
When you are happy with the shape, press the APPLY button ob BOTH the barrel and barrel rings object modifiers.

Once the modifiers have been APPLIED, you can delete the Barrel Lattice object.

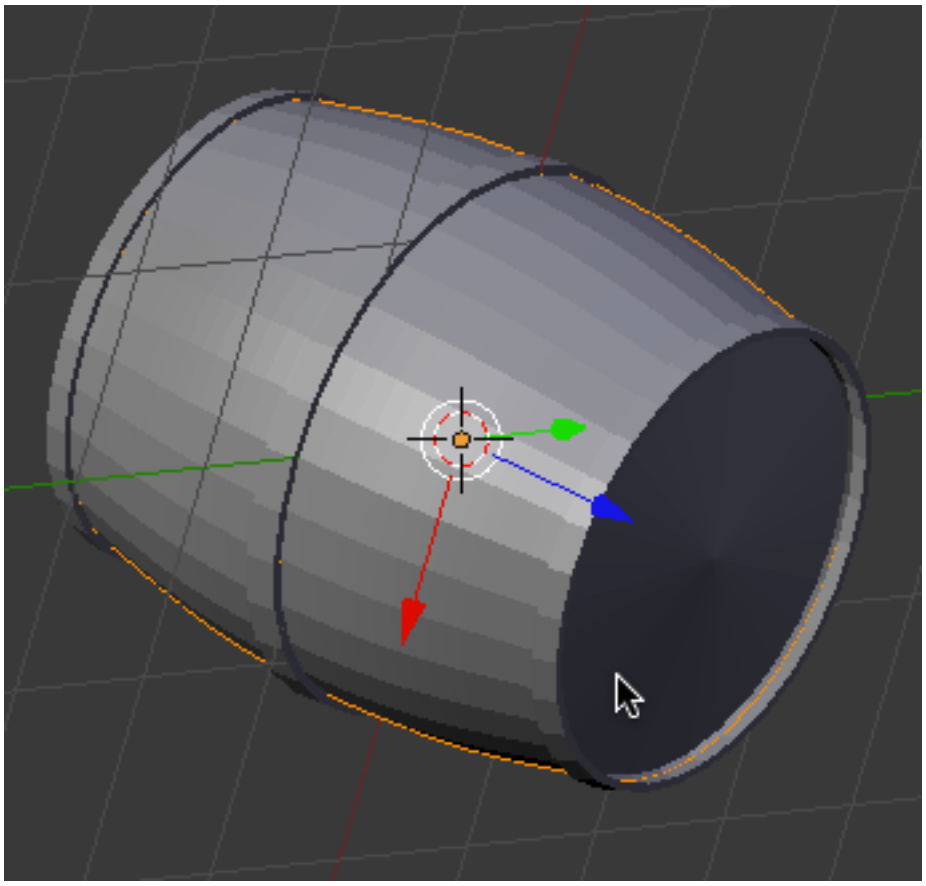
Select the barrel object and TAB into edit mode. Hold your ALT KEY down and select one of the top vertices. This will select the whole top loop of vertices as shown below.



Press the GKEY (grab) followed by the ZKEY and move these vertices back a bit into the barrel to form a lip as shown below.

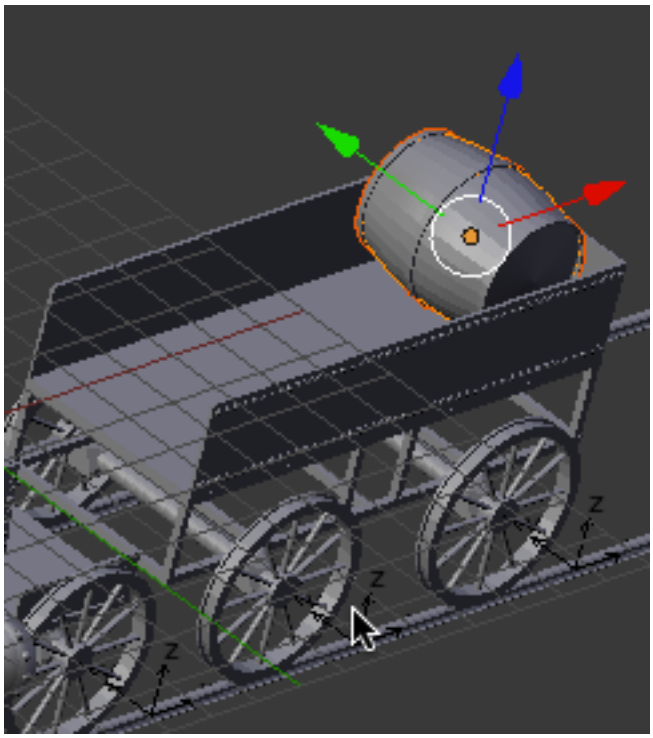


Do this on the other side of the barrel as well.

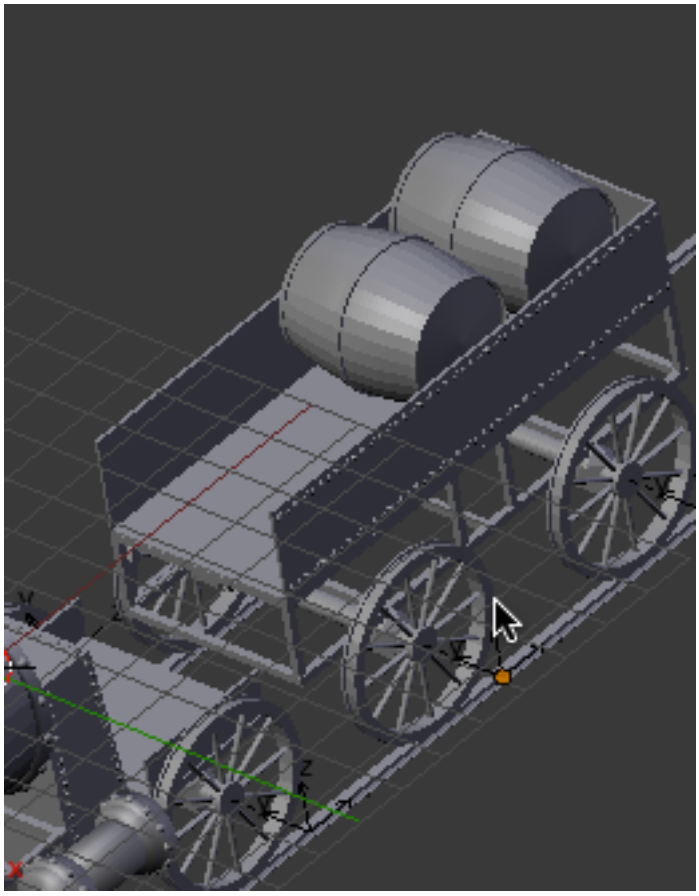


Select the barrel and the barrel rings objects, and press the MKEY and place them on layer 1. Go to layer 1.

Rotate the objects as needed and place them into the back of the car as shown below.



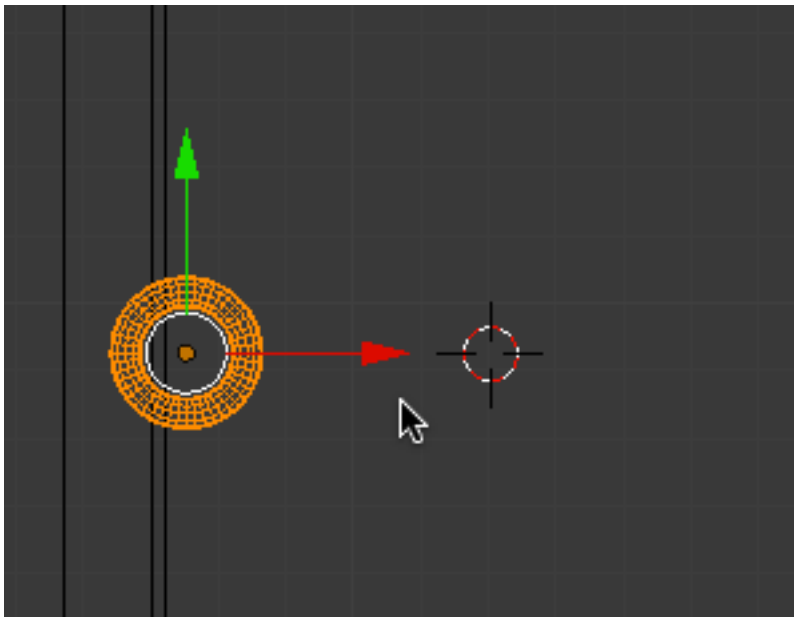
Make a duplicate next to it as shown below.



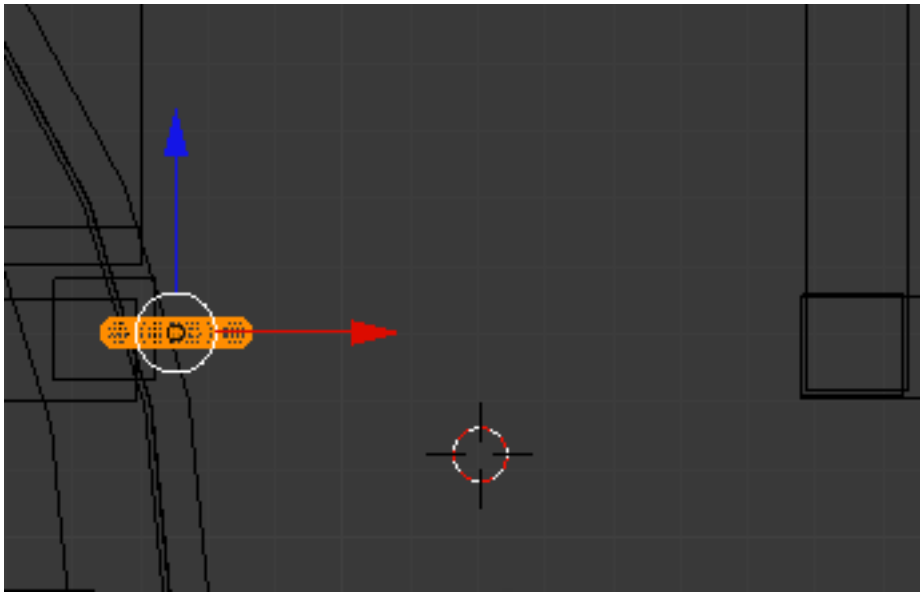
Save your Blender file.

We will next model the chain link between the engine and the car. Go to top view and zoom in to the area between the engine and the car. Place your cursor in the middle and press SHIFT-A and add a torus object.

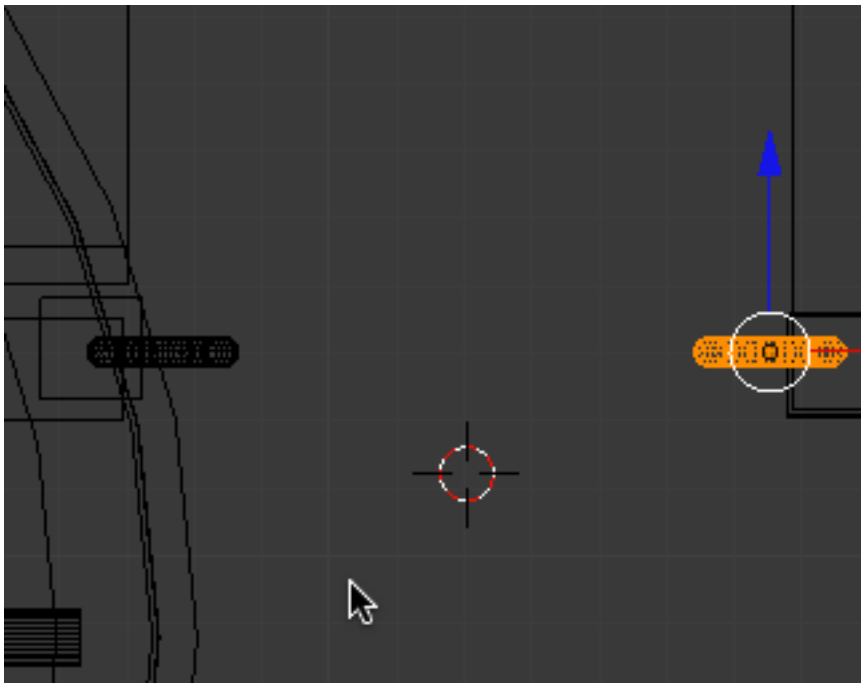
Go to wireframe display mode. Scale down the torus object and place it partially within the engine frame as shown below.



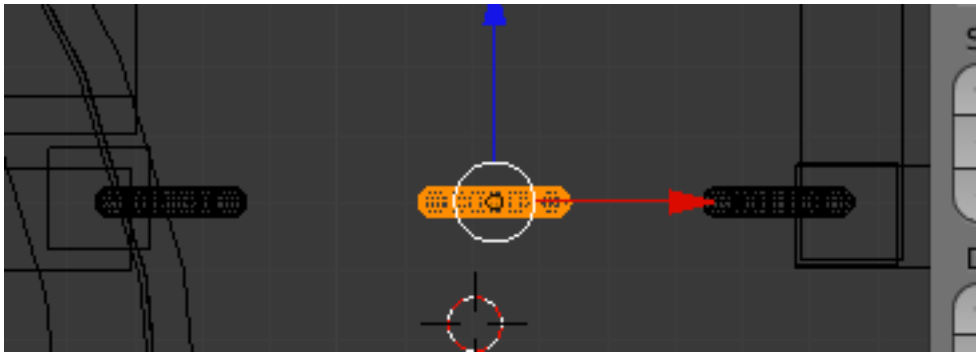
Go to front view and center it in the engine frame as shown below.



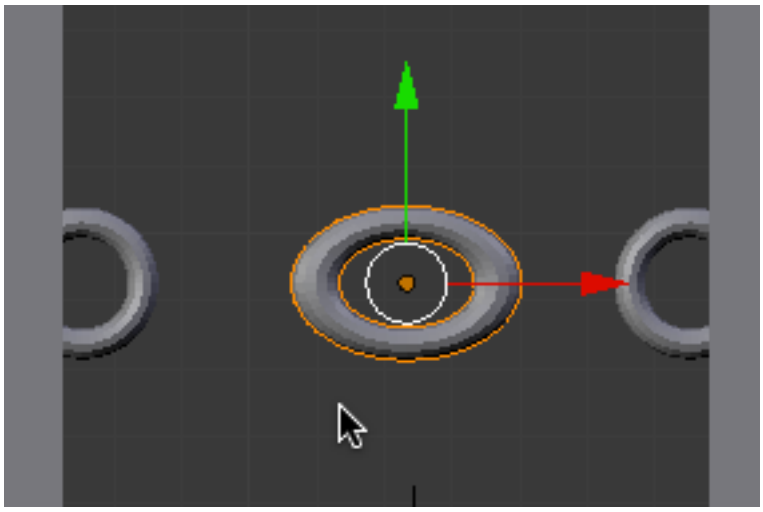
Name this object “Chain Link”. Make a duplicate and move it over to the car frame as shown below.



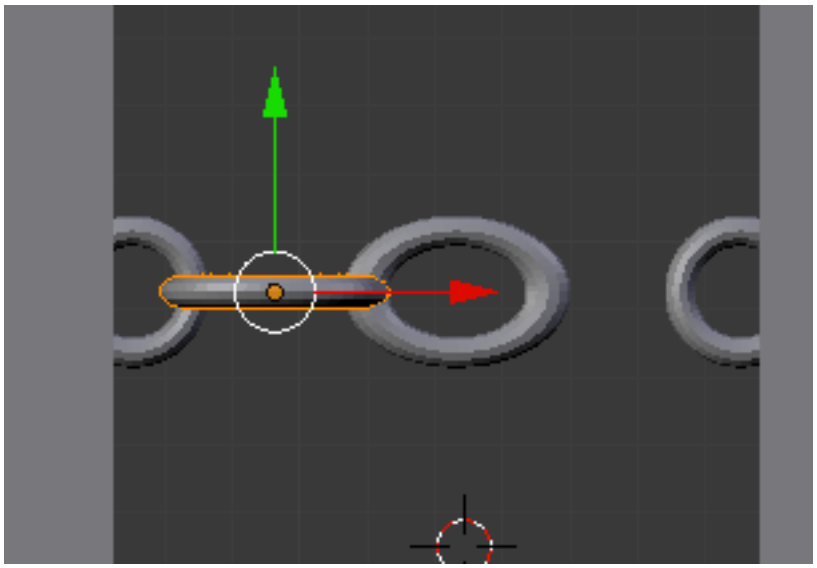
Make another duplicate and place it in the middle as shown below.



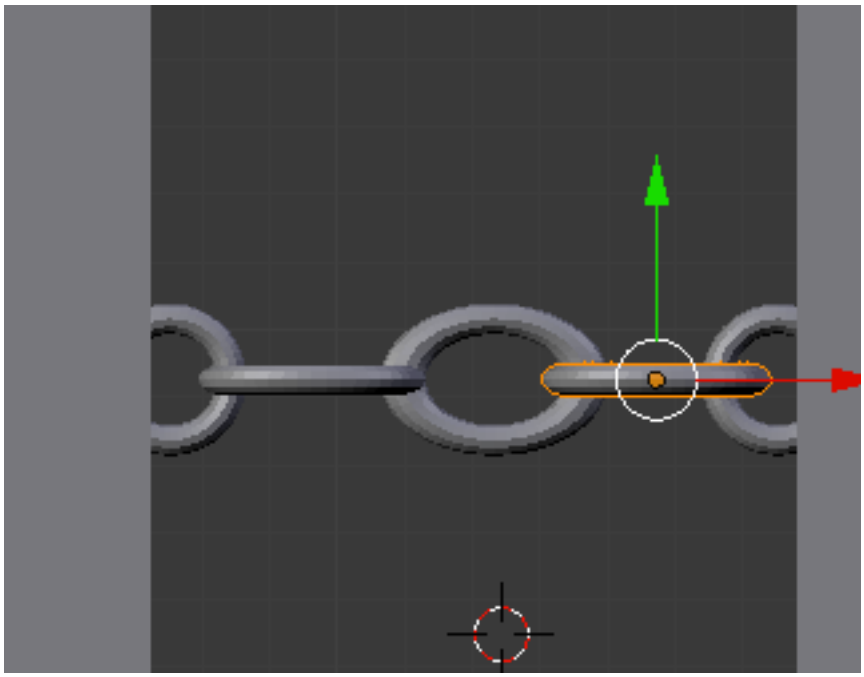
Go to top view. Scale this object along the X-axis as shown below.

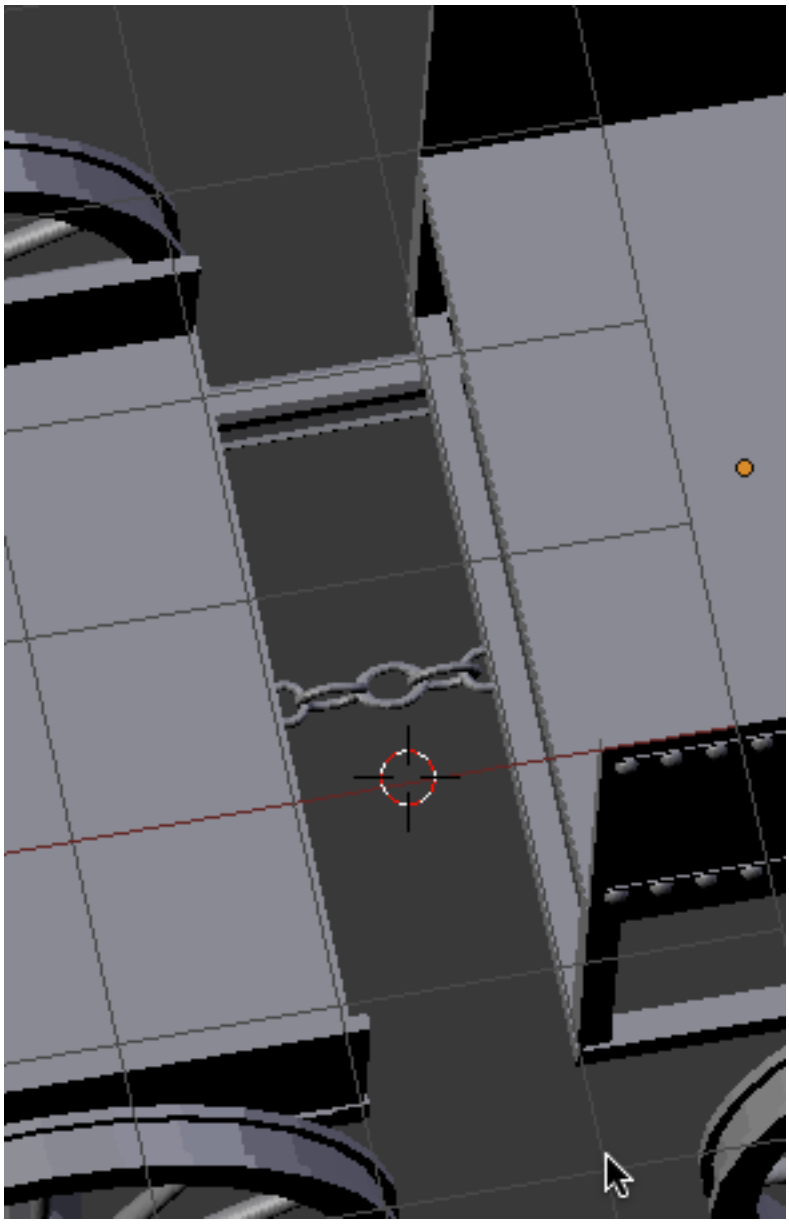


Press SHIFT-D, then press the RKEY followed by the XKEY followed by 90 then ENTER. This will make a duplicate and rotate it 90 degrees around the X-axis. Move this object to the left as shown below.



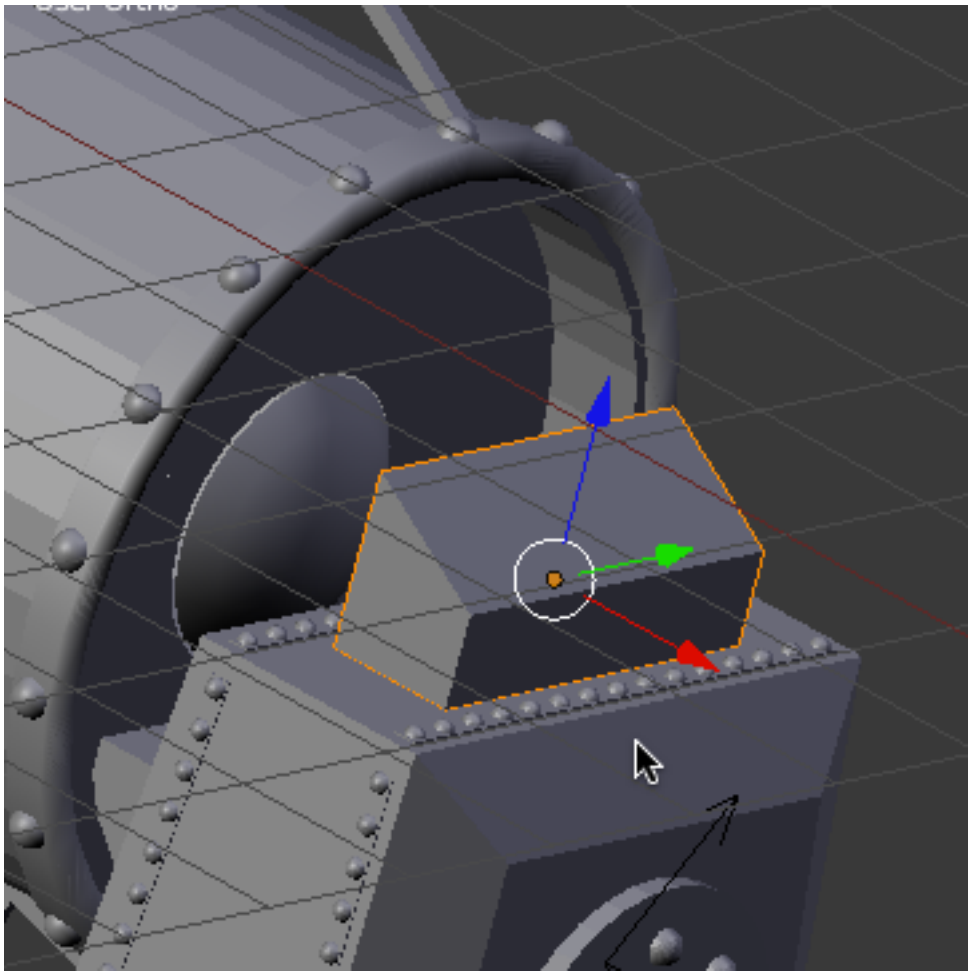
Make a duplicate of this object and move it to the right as shown below.



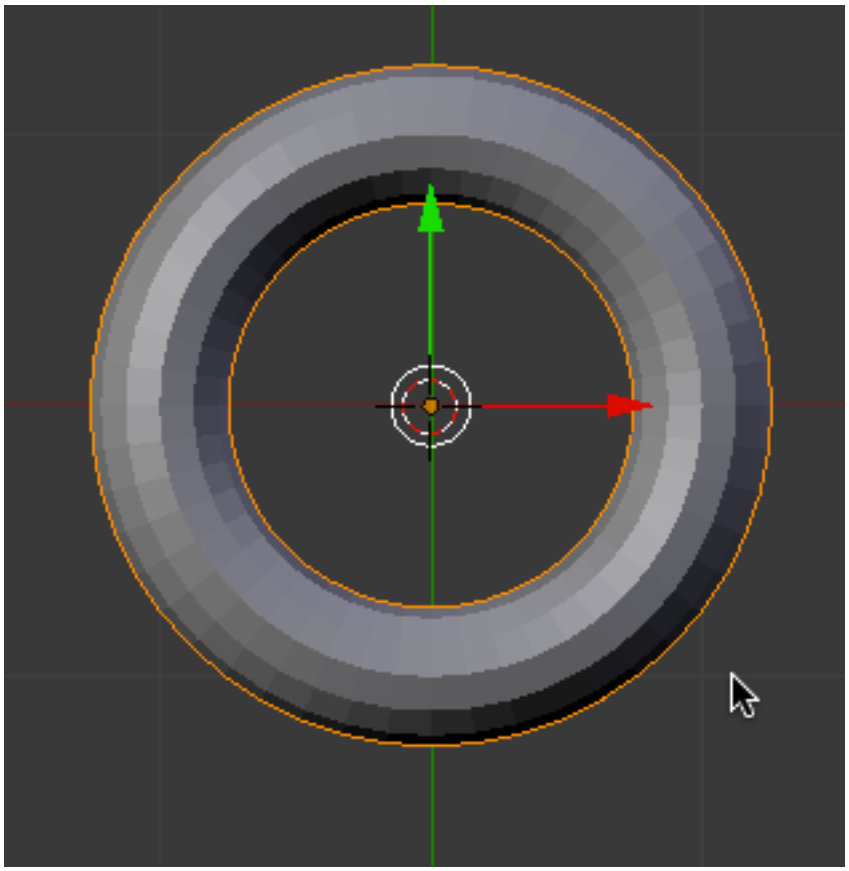


Save your Blender file.

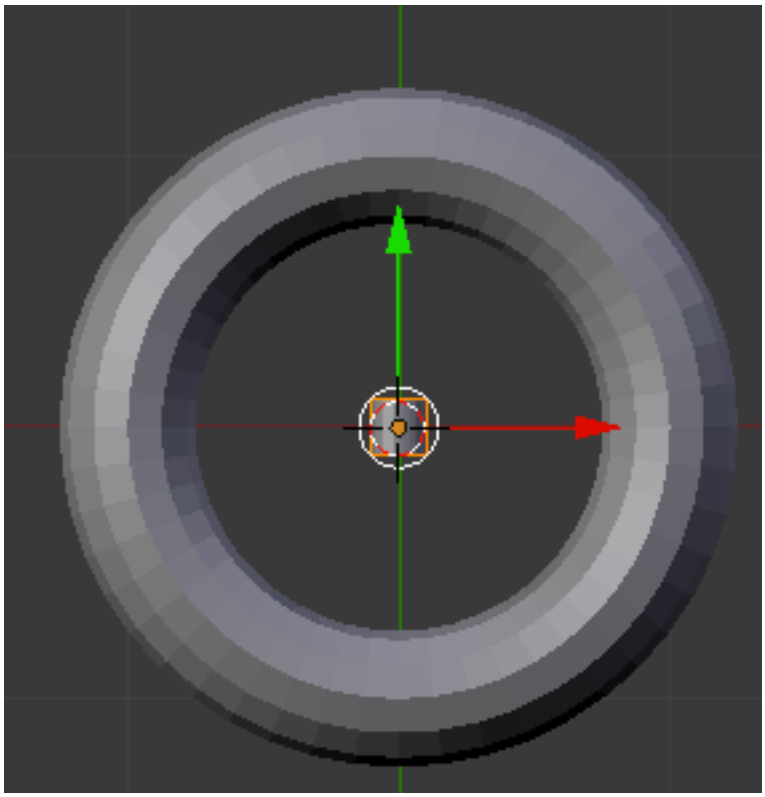
Model a simple control box fashioned out of a cube with a slanted side. Place this object on top of the furnace as shown below. Name this object “Control Box”.



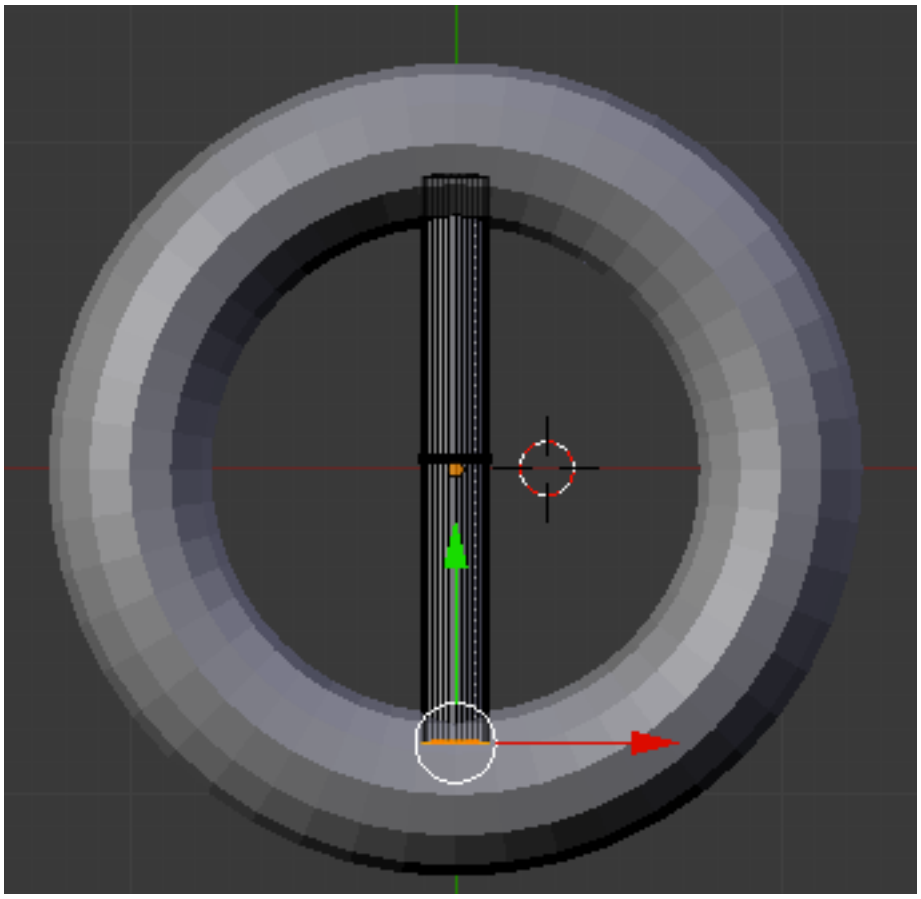
We will model some simple valve controls for the control box. Go to layer 2, which should be empty. Place your cursor at X, Y, Z=0. Go to top view. Press SHIFT-A and add a torus object.



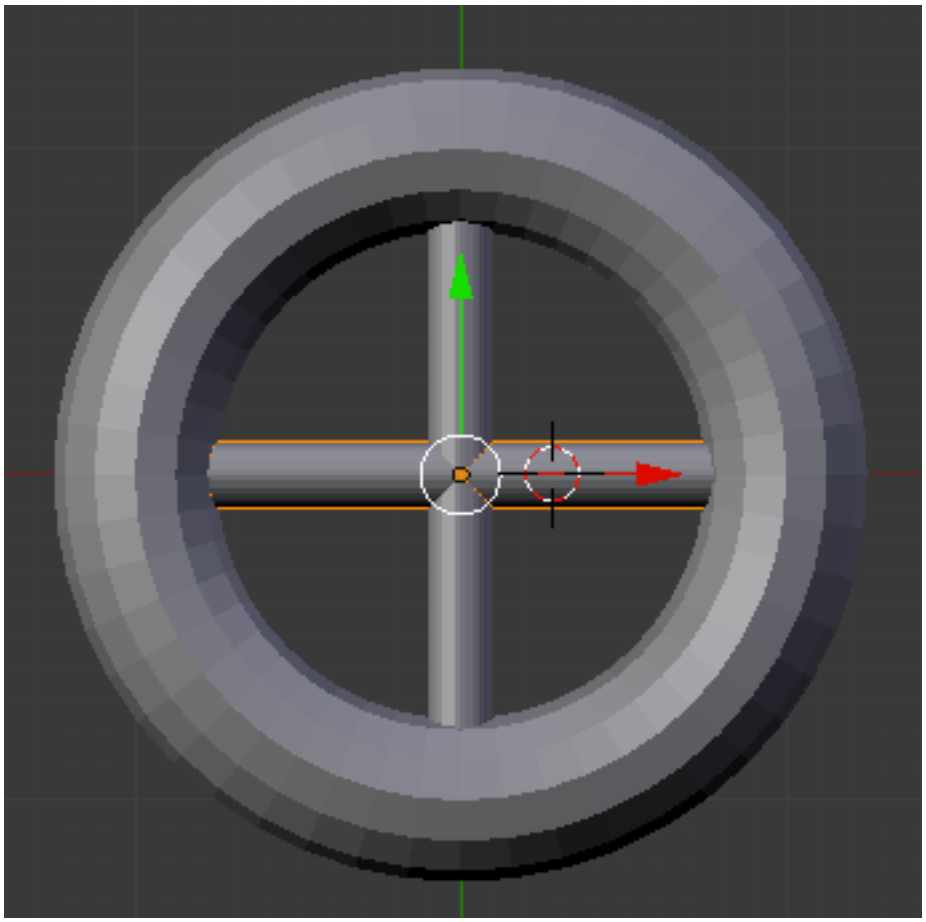
Press SHIFT-A and add a tube object. Set the X rotation to 90 and scale it down as shown below.



TAB into edit mode and move the top and bottom vertices as shown below.

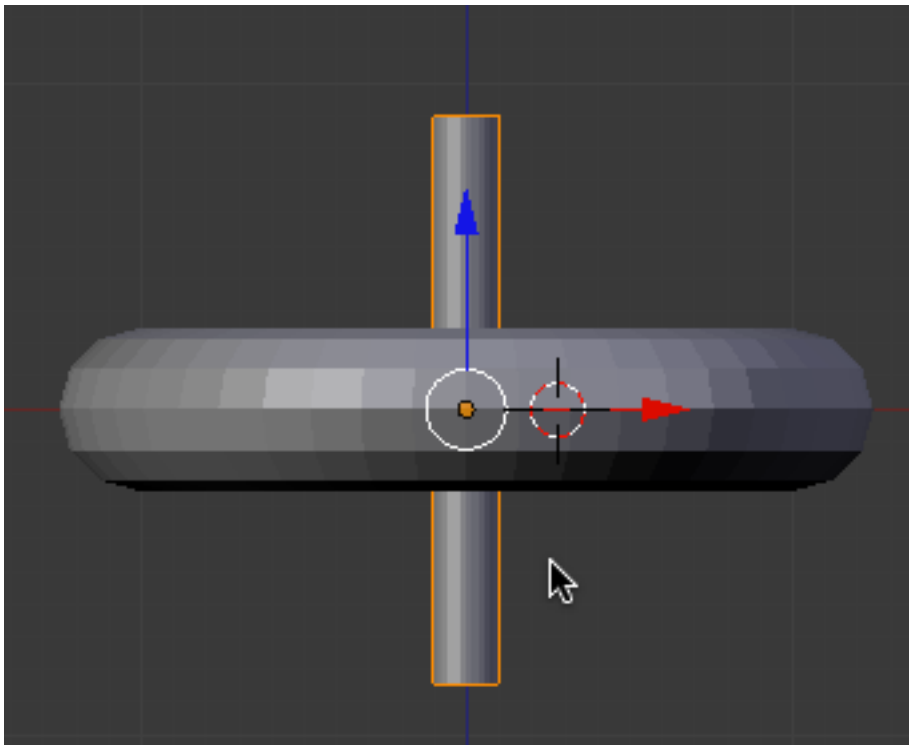


TAB out of edit mode. Press SHIFT-D followed by the RKEY followed by the ZKEY followed by 90 then ENTER. This will make a duplicate rotated 90 degrees around the Z-axis.

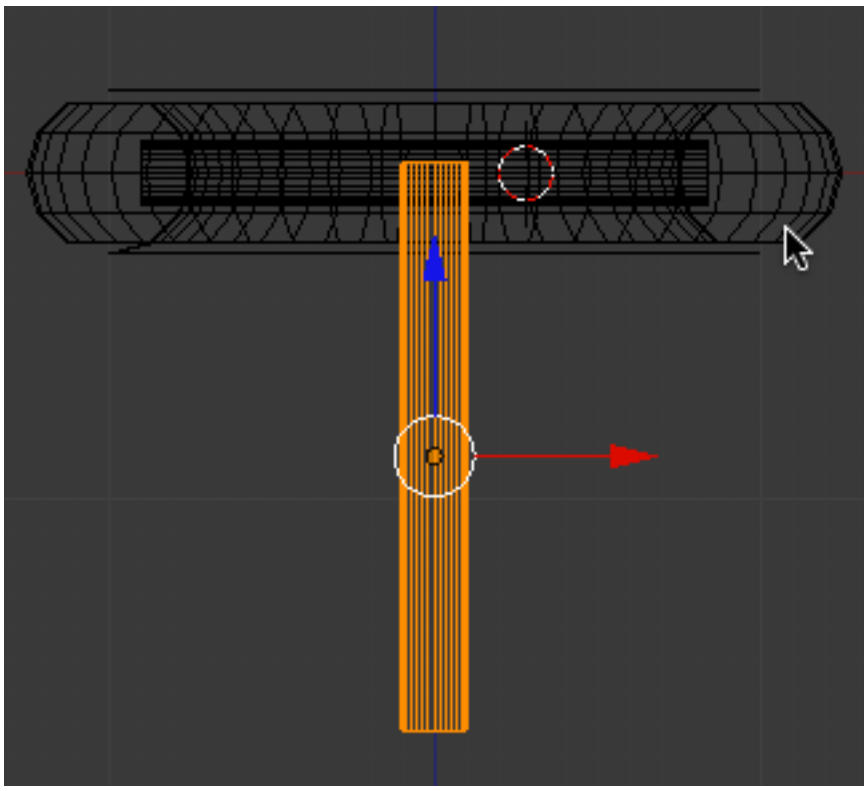


Now press SHIFT-D followed by the RKEY followed by the YKEY followed by 90 then ENTER.  This will make a duplicate rotated around the Y-axis.

Go to front view.

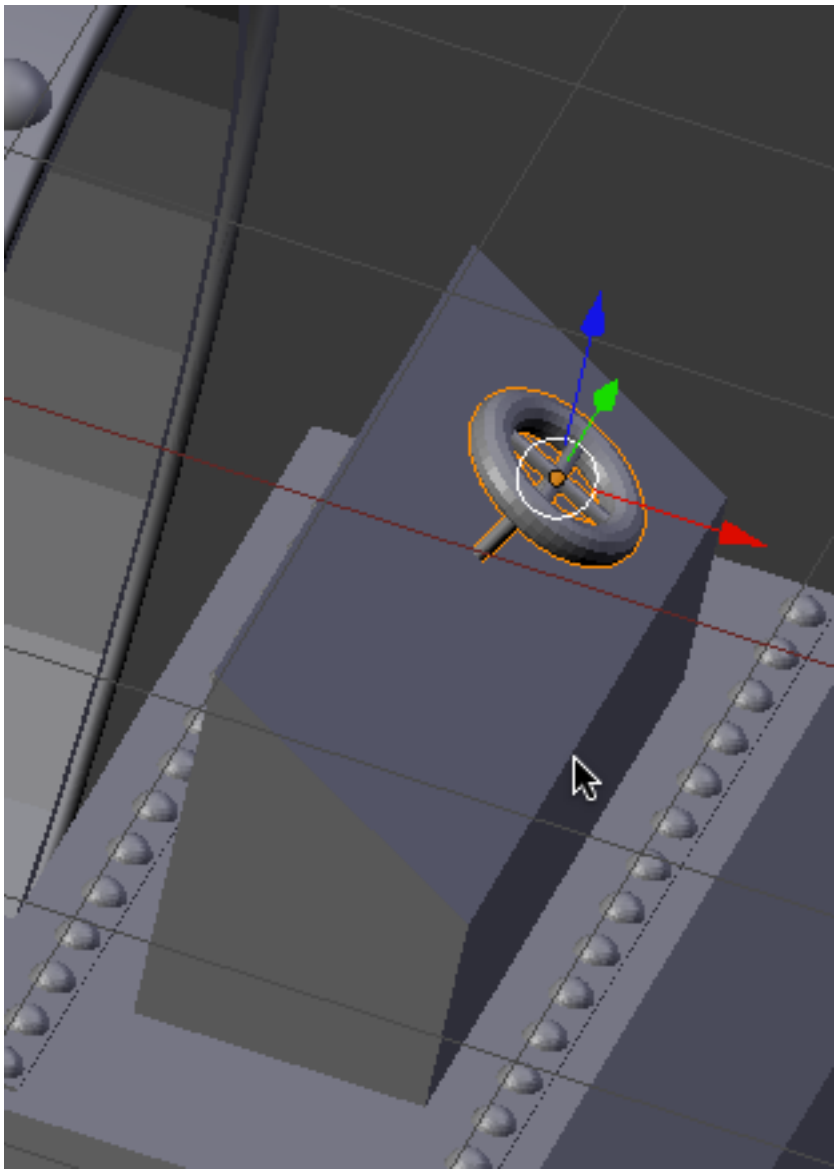


Go to wireframe display mode and move the tube object down along the Z-axis as shown below.

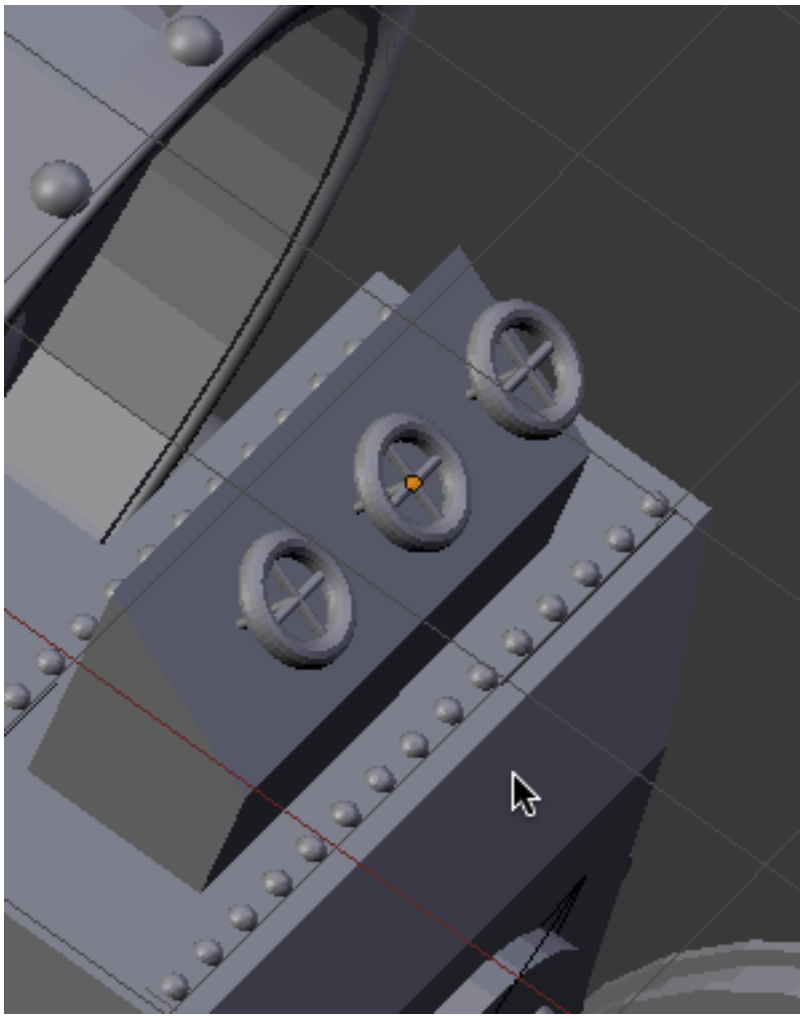


Select all of the objects and press CTRL-J and join them into one object named “Control Valve”. Press the MKEY and place the control valve object on layer 1. Go to layer 1.

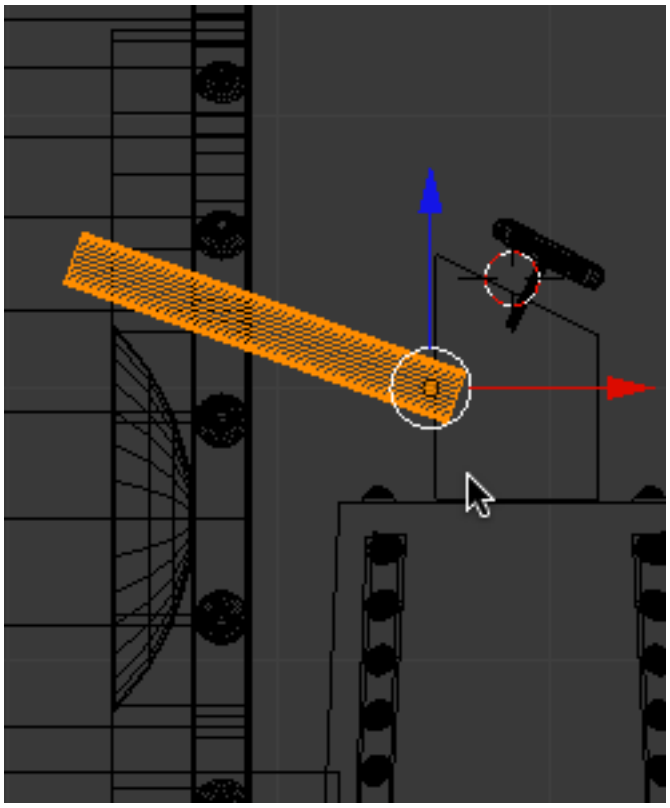
Scale down the valve and rotate it and place it on the control box object as shown below.

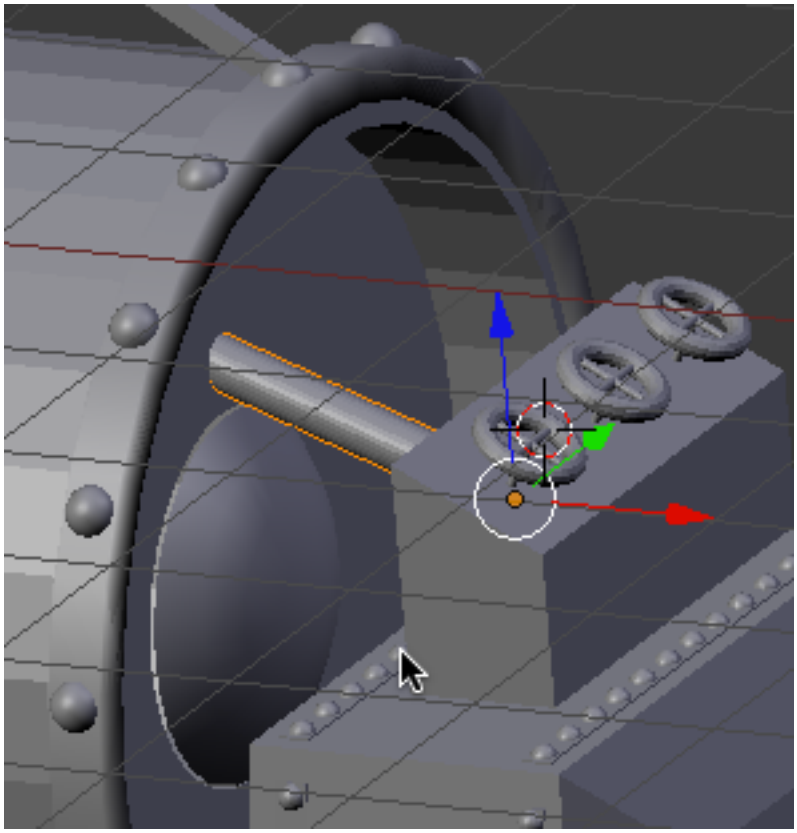


Make 2 duplicates and place them to either side of the original.



Model a simple tube that runs from the control box to the boiler object as shown below. Name this object “Pipe”.



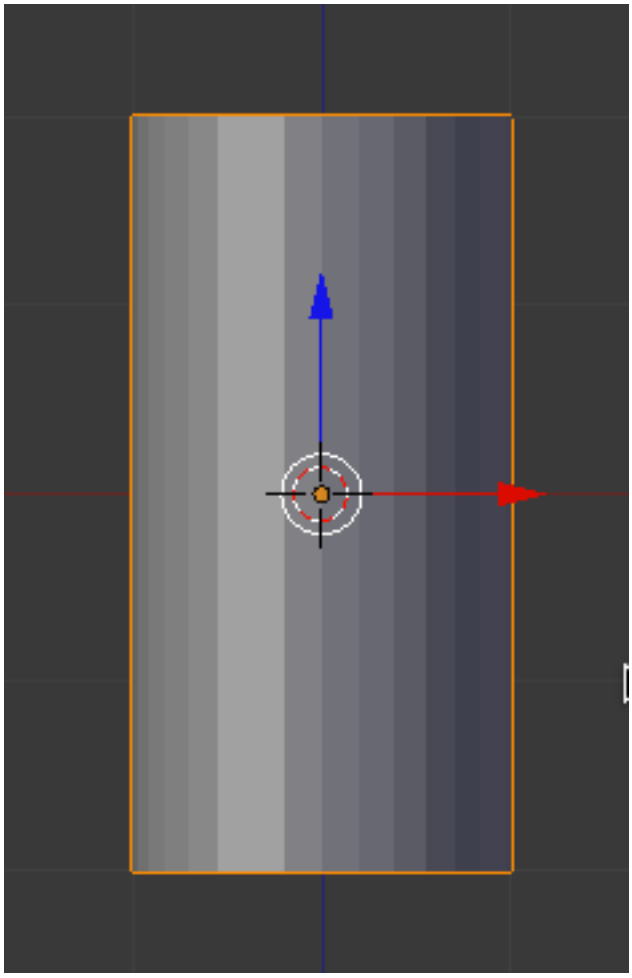


Save your Blender file.

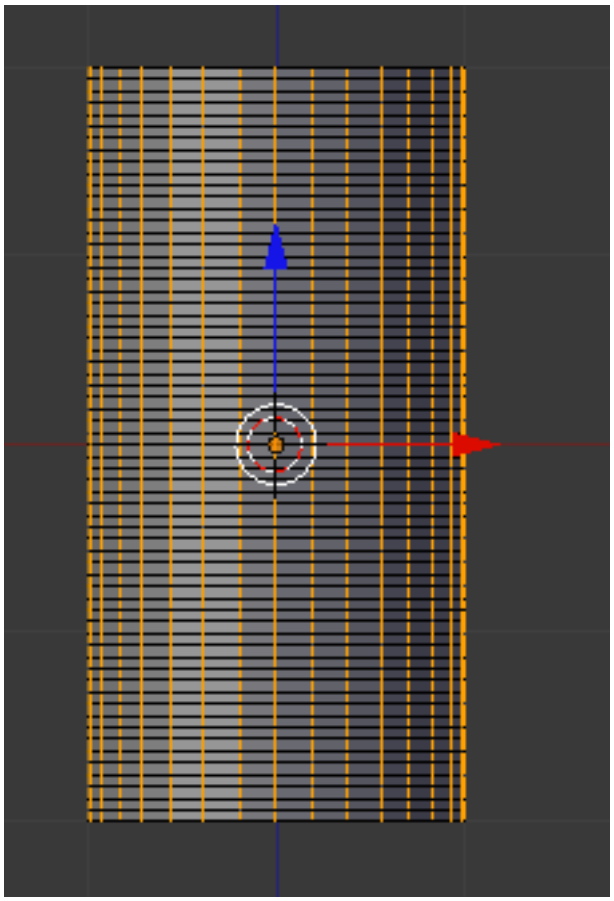
We need to add some more piping to the model. One way of dealing with pipe is similar to the real world. That is, model a pipe fitting and extend the pipe from the fitting to the length needed.

Go to layer 2, which should be empty. Place your cursor at X, Y, Z=0. Go to top view. Press SHIFT-A and add an UNCAPPED tube object.

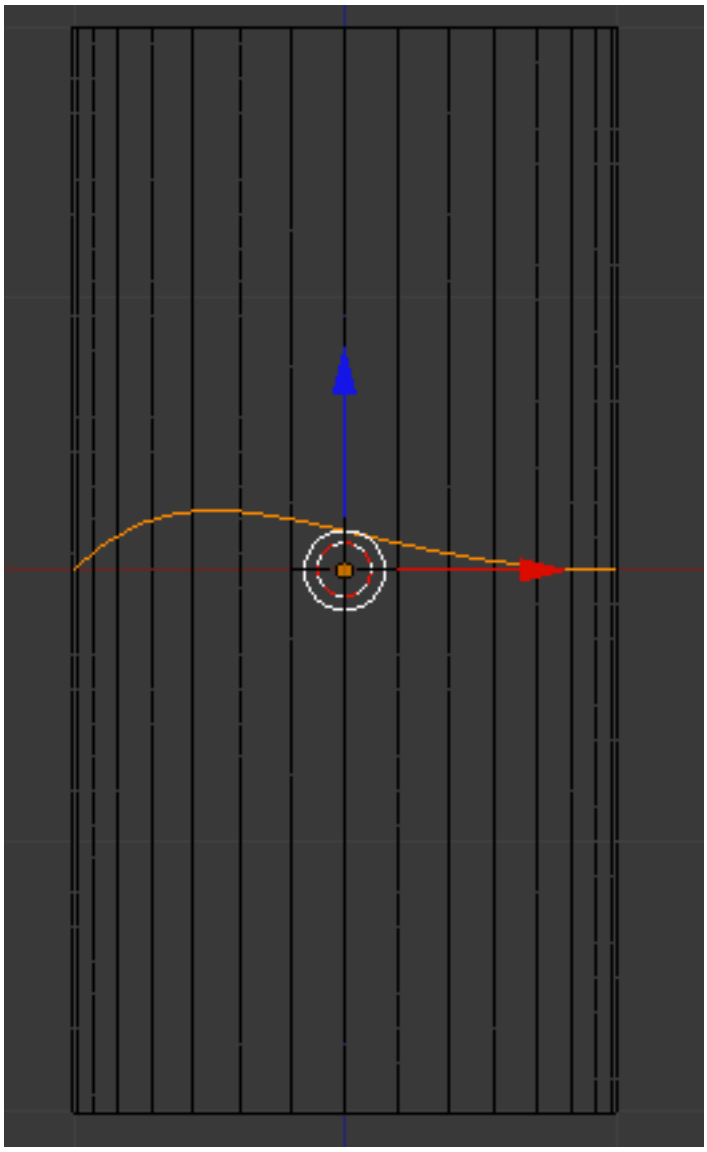
Set the dimensions to 2 x 2 x 4. Go to front view.



TAB into edit mode. Press CTRL-TAB and select edge select. Box select the center edges of the tube and press the Subdivide 6 times (we need plenty of vertices to model this pipe fitting).

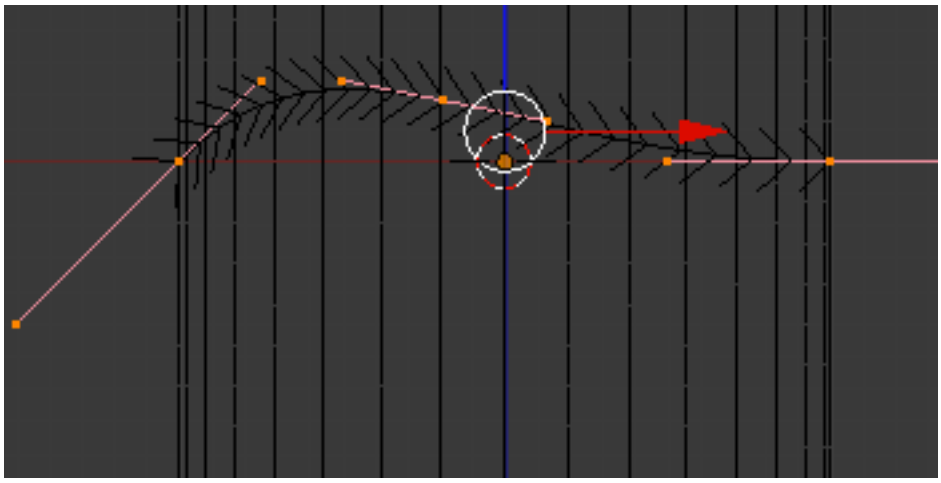


TAB out of edit mode. Press SHIFT-A and add a Bezier Curve object. Set the X rotation to 90 degrees.

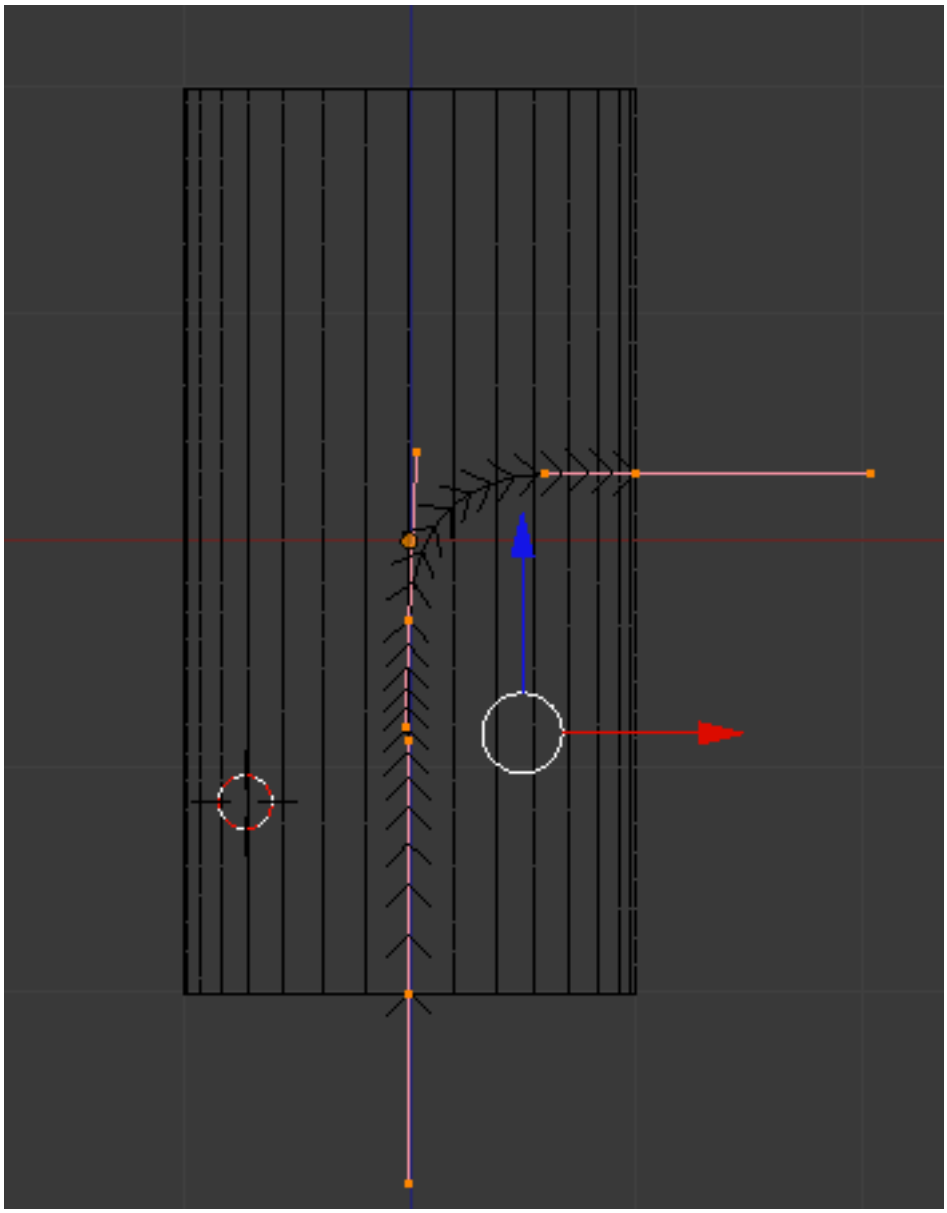


TAB into edit mode. Select all of the control points and control handles and press the Subdivide button.

This will add a third control point in the center of the curve object.

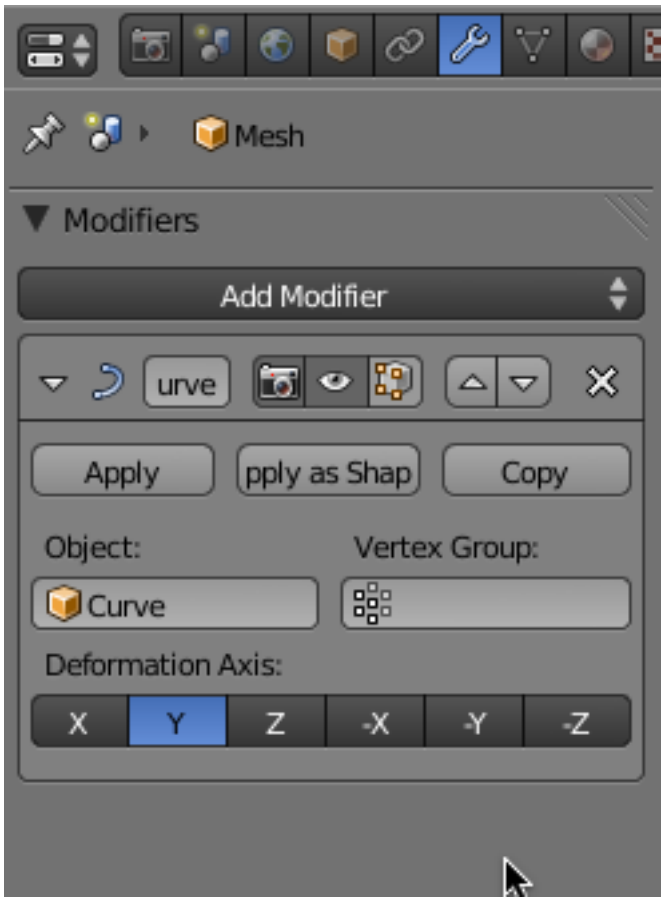


Adjust the control points and the handles to make the curve object look like below.



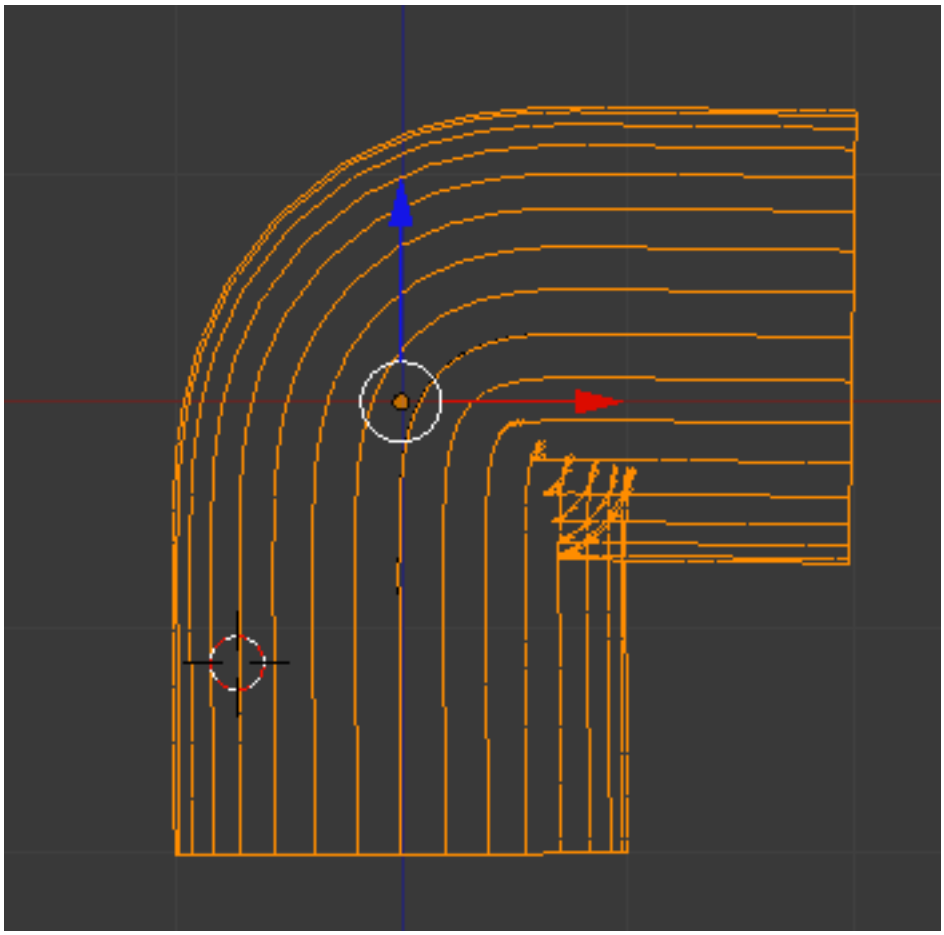
TAB out of edit mode. Select the tube object. Add a Curve modifier to it. Select the Bezier curve as the “Object”.

Set the Deformation Axis to Y.



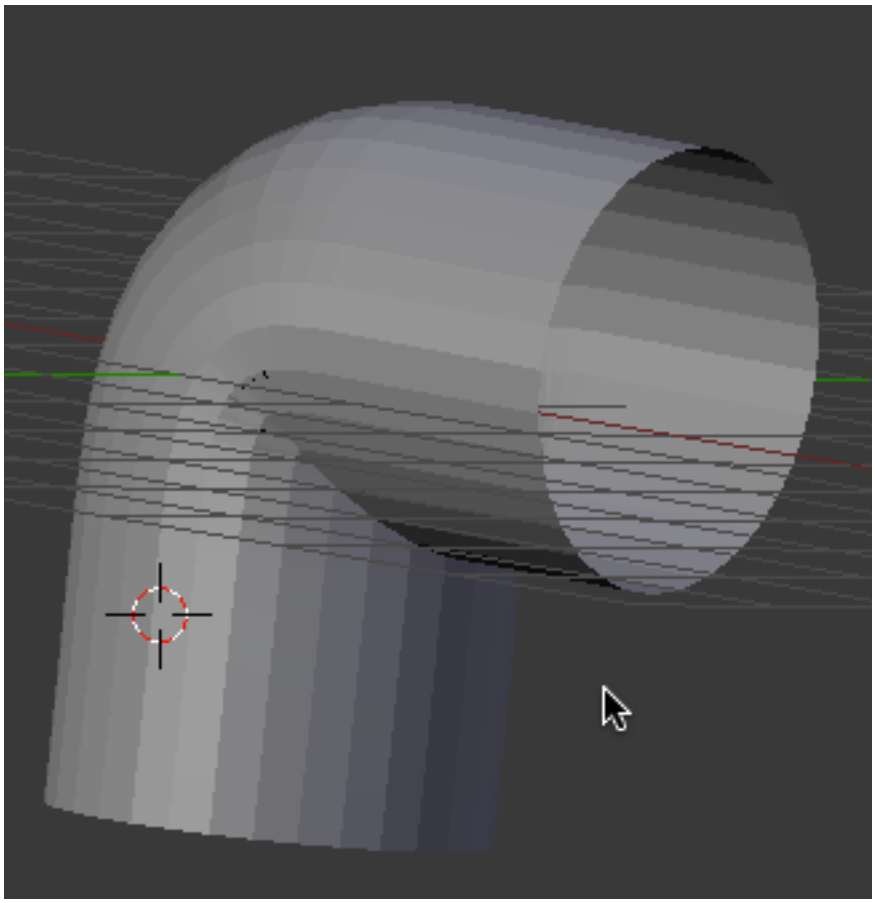

This will deform the tube object into a 90 degree pipe fitting.

Note: you may have to select the curve object and TAB into edit mode and adjust the control points to get the tube to deform as shown below.

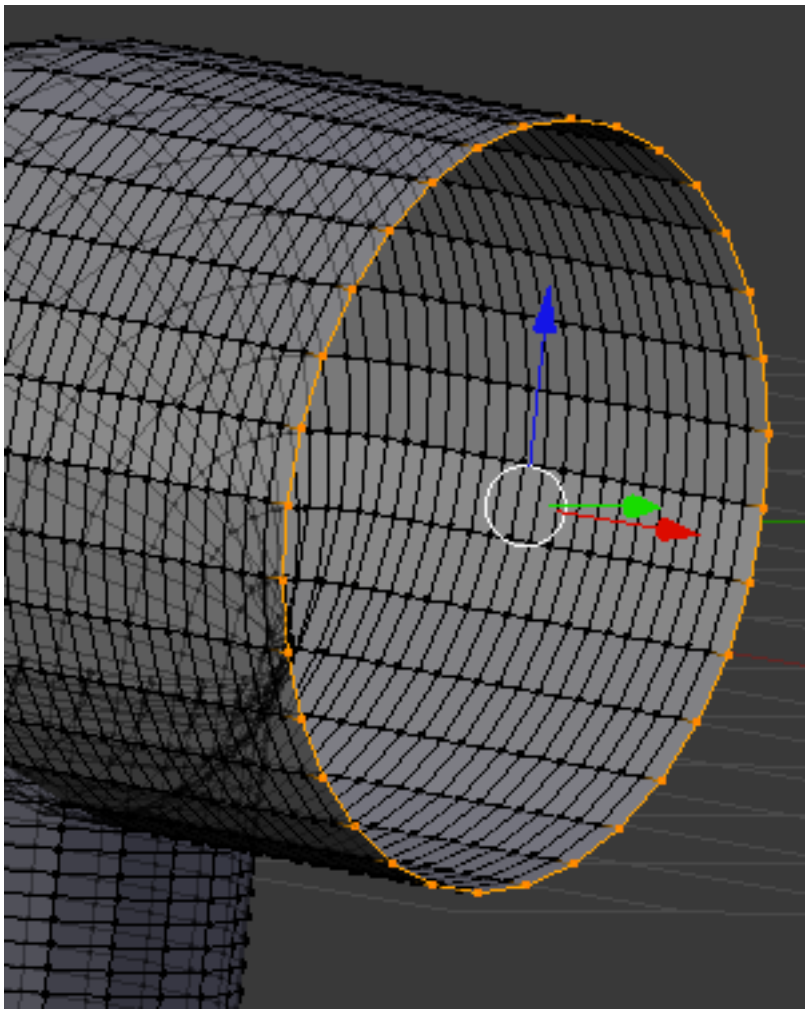


When you have the tube object deformed, as you want it, APPLY the curve modifier. Once the curve modifier has been applied you can delete the Bezier curve object.

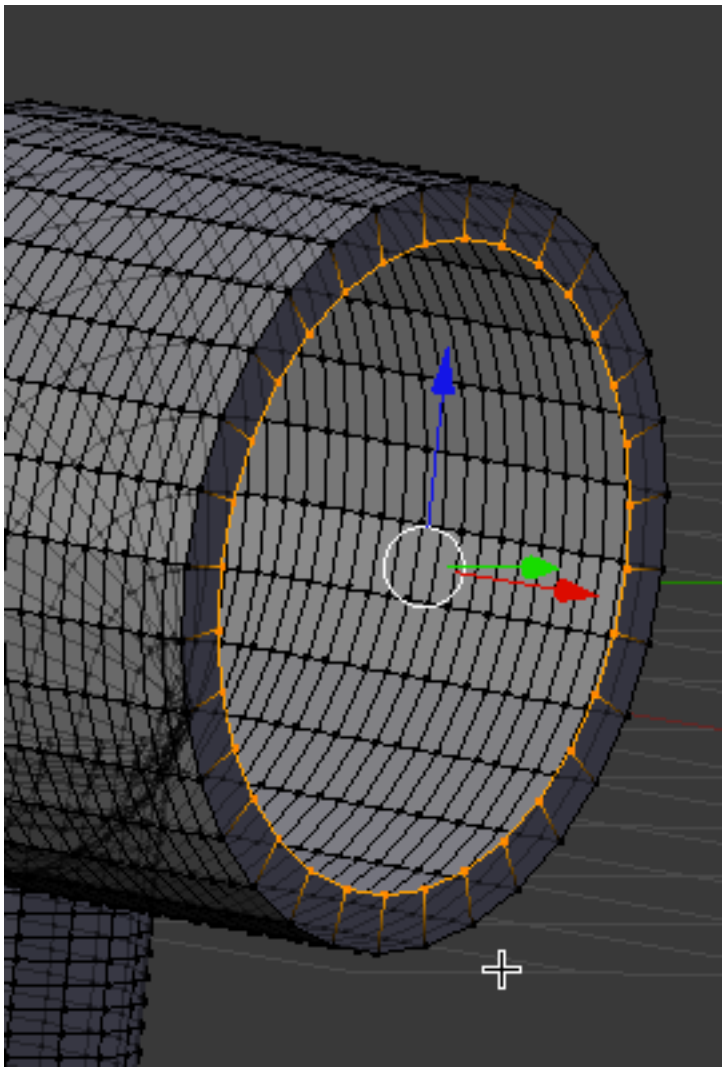
Name this object “Pipe Fitting”.



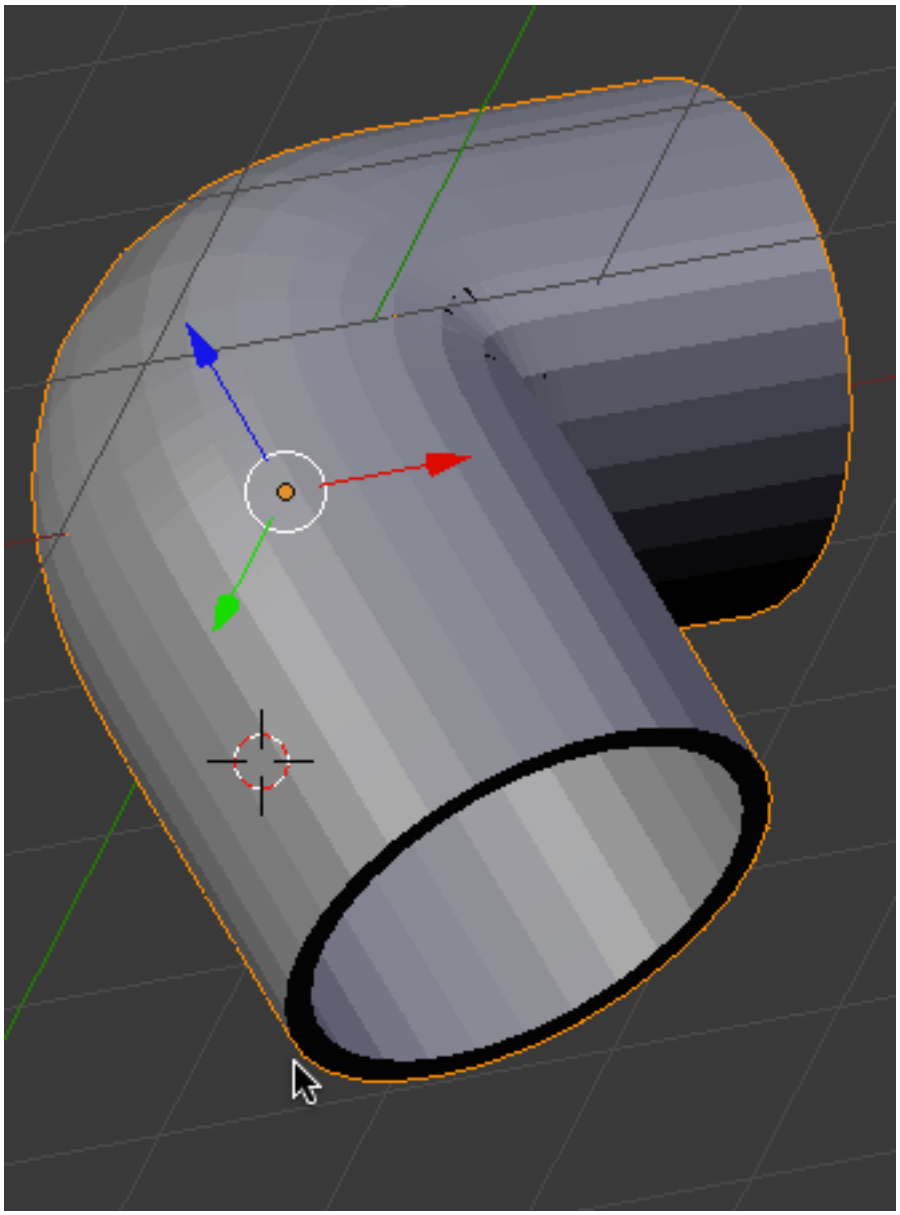
Select the pipe fitting object and TAB into edit mode. Press CTRL-TAB and go to vertex select mode.  Hold your ALT KEY down and select one of the vertices on the edge of the fitting.  This will select the whole loop of vertices.



Press the EKEY followed by the SKEY and extrude/scale the vertices in a bit as shown below.



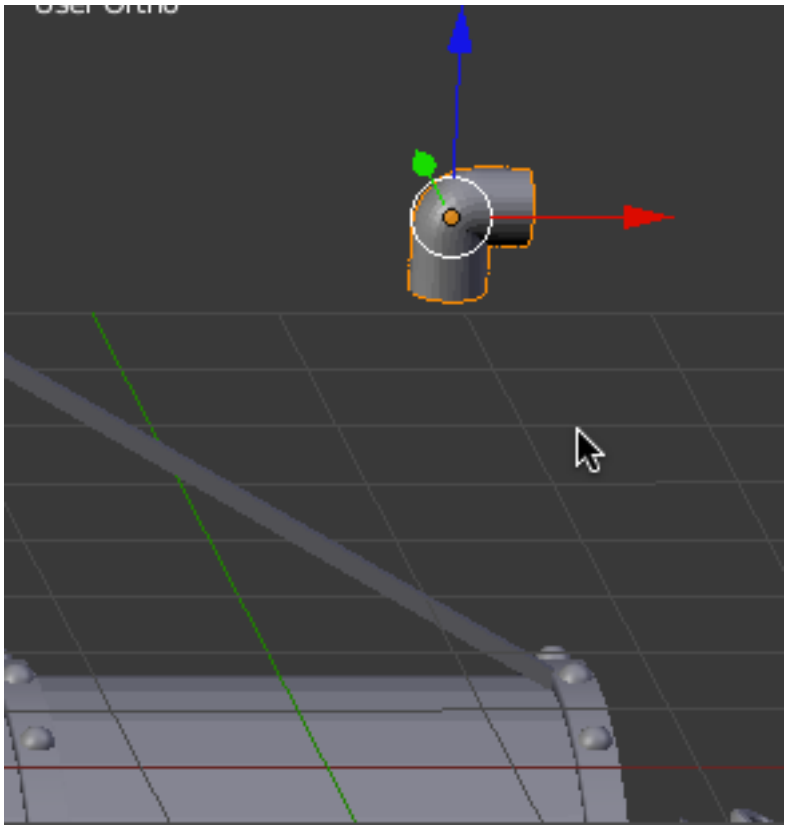
Do the same on the other side of the fitting.



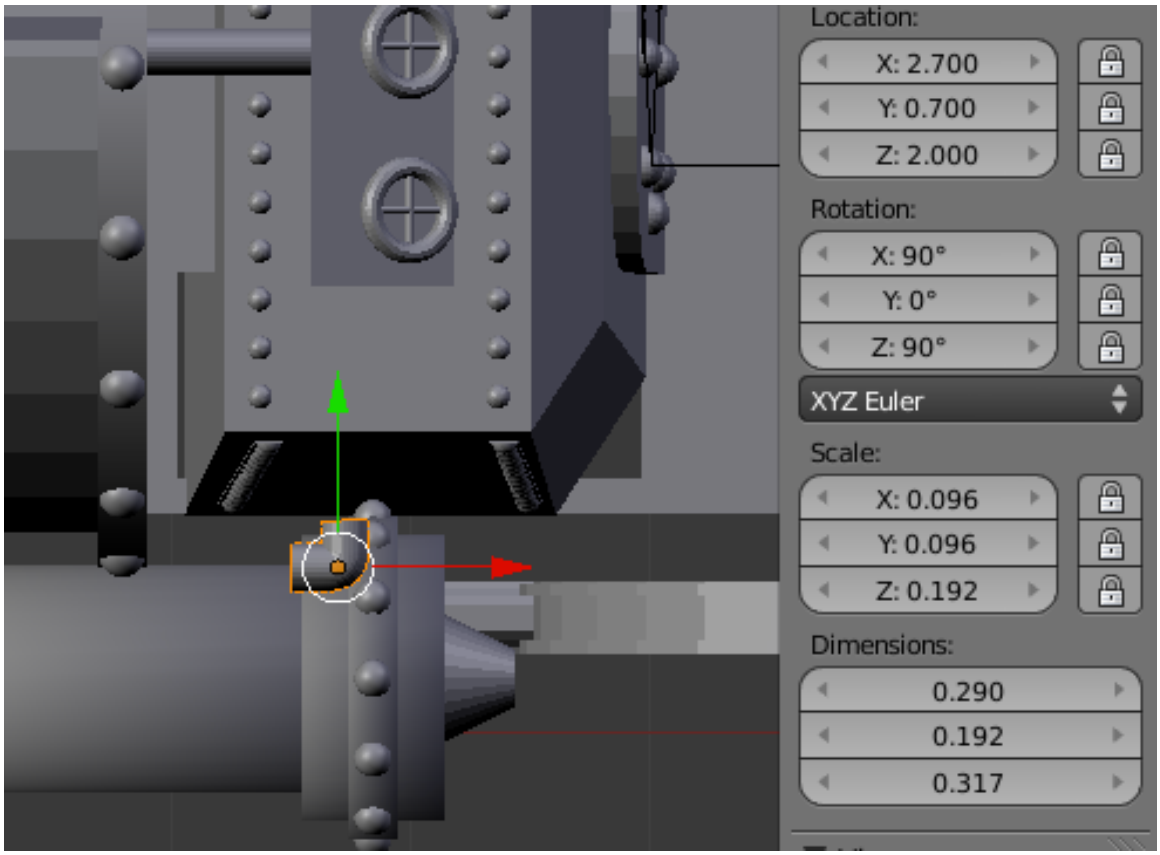
Place the pipe fitting object on layer 1. Go to layer 1.

Save your Blender file.

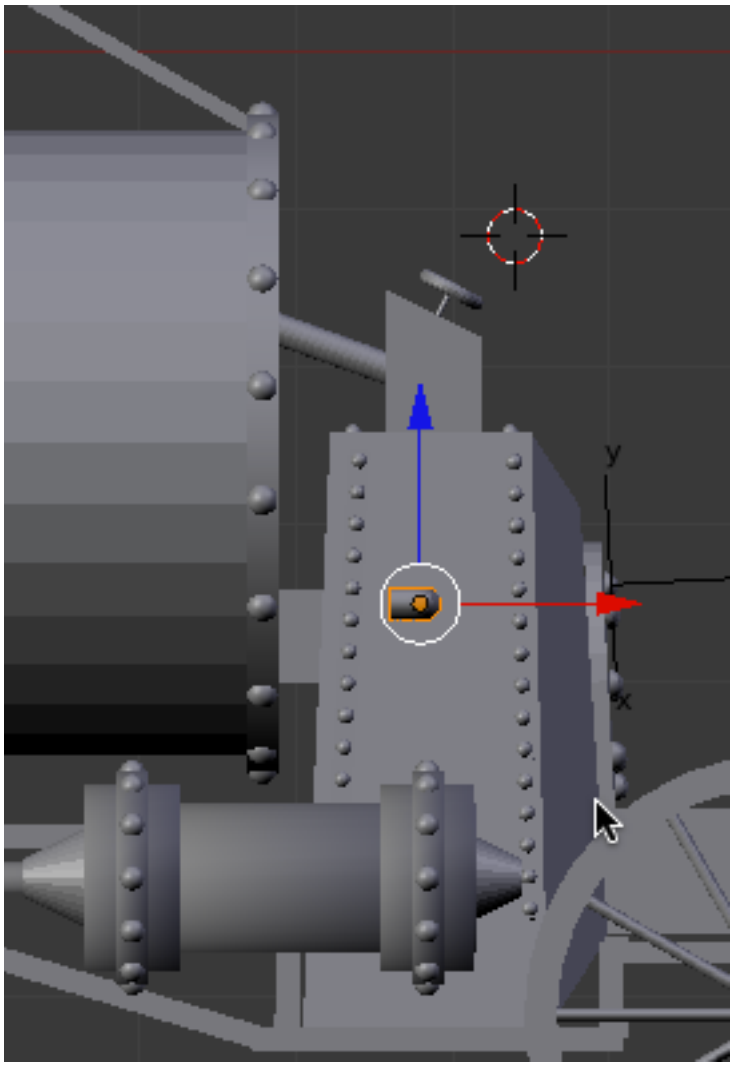
Scale the pipe fitting down and set it aside. We will use this object as a template for a number of objects.



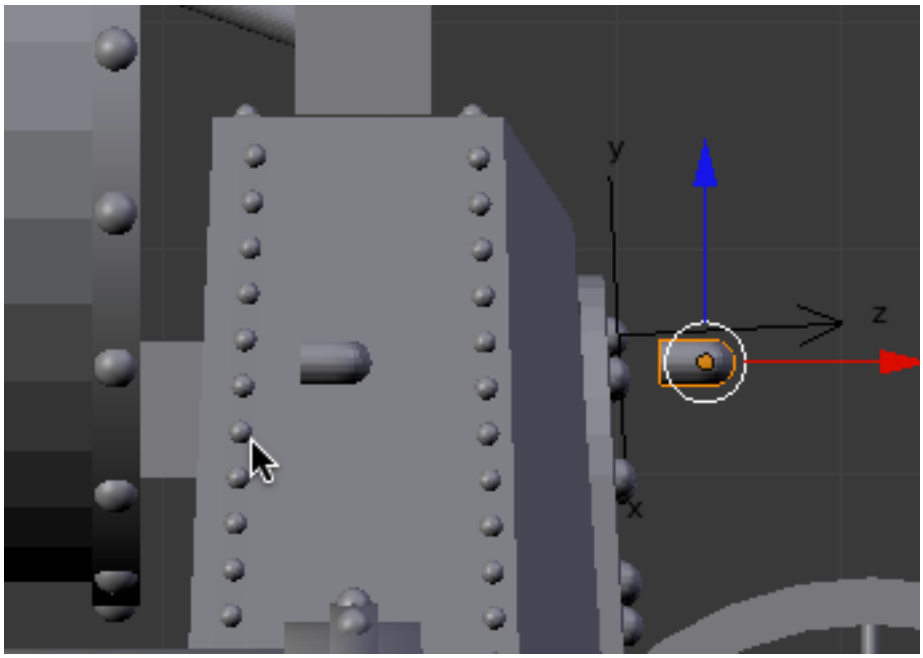
Make a duplicate of the pipe fitting object. Set the X rotation to 90 degrees and set the Z rotation to 90 degrees. Scale it down a bit and place it (in top view) to the side of the furnace as shown below.




Go to front view and position the pipe fitting a shown below.

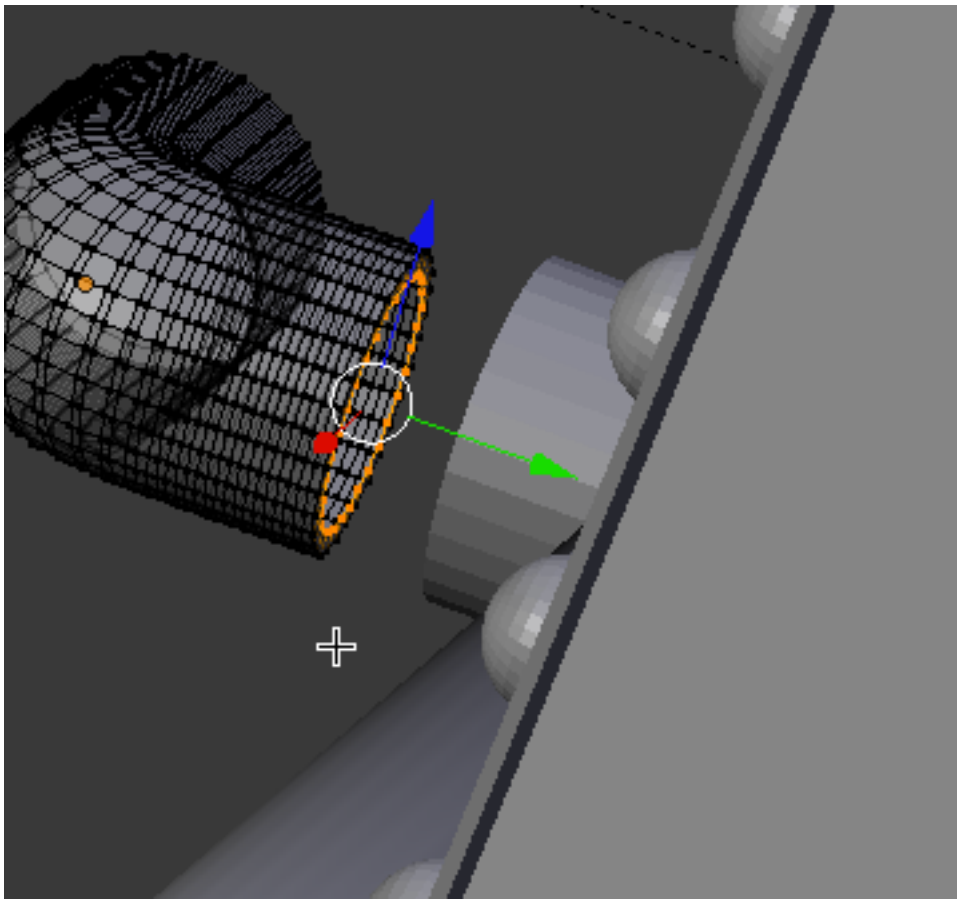



Make a duplicate copy of this fitting and move it to the right. (we will use this later).

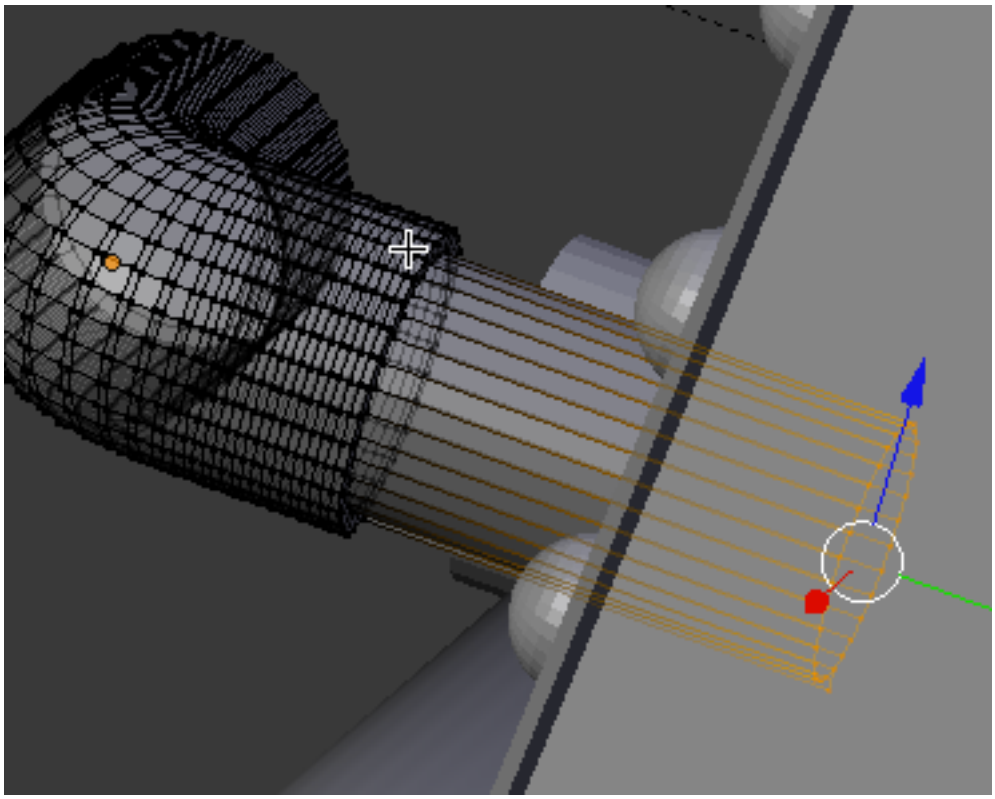


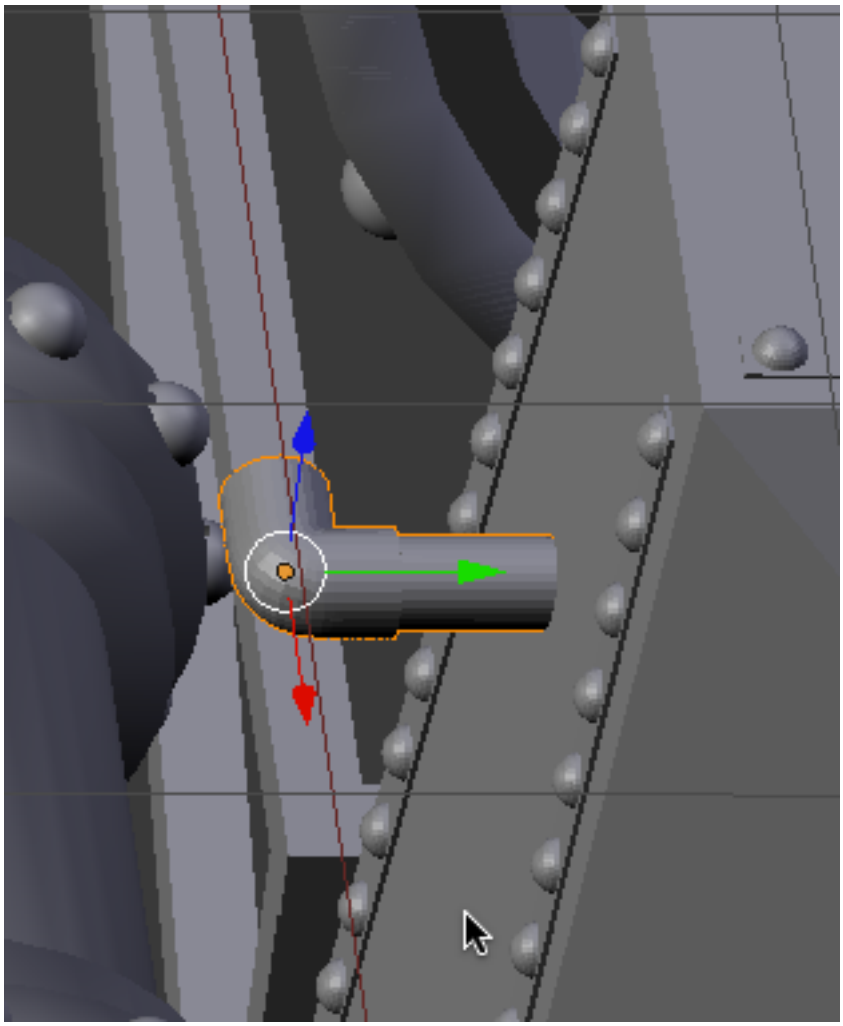

Re-select the first duplicate that was positioned to the side of the furnace object.

Tab into edit mode. Rotate and zoom your view so you can see the side of the fitting facing the furnace object. Hold your ALT KEY down and select the inner edge of vertices as shown below.

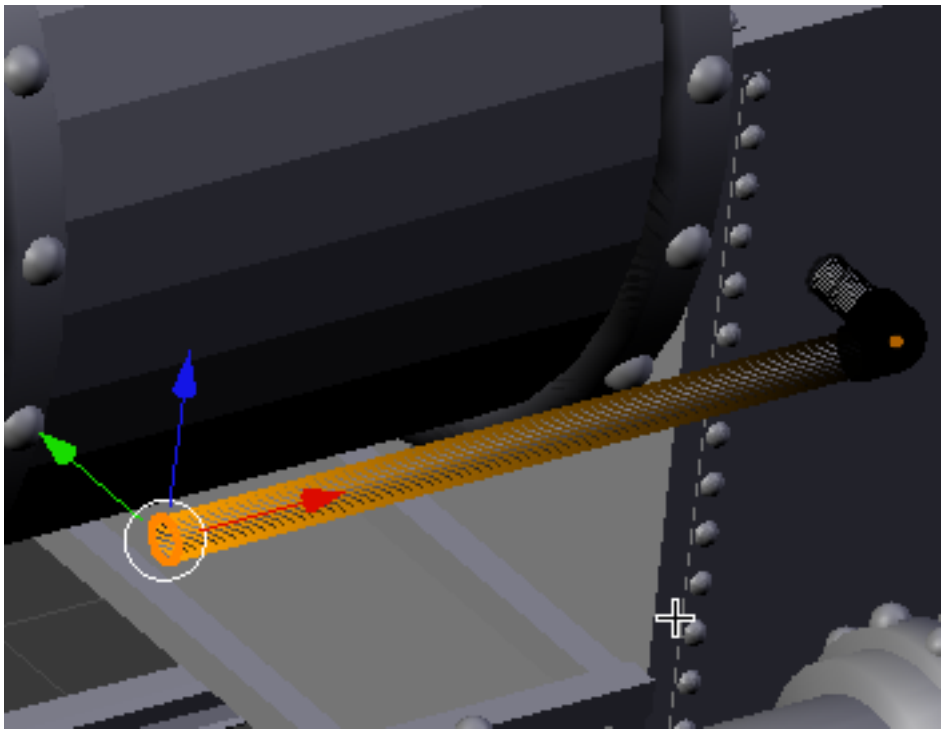


Press the EKEY and extrude the vertices along the Y-axis into the furnace as shown below.



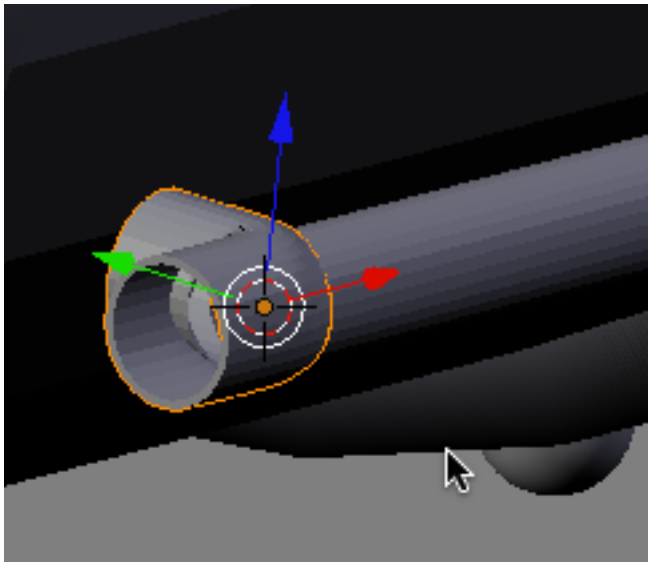


Select the inner rim of vertices on the other side of the fitting and extrude them out along the X-axis as shown below.

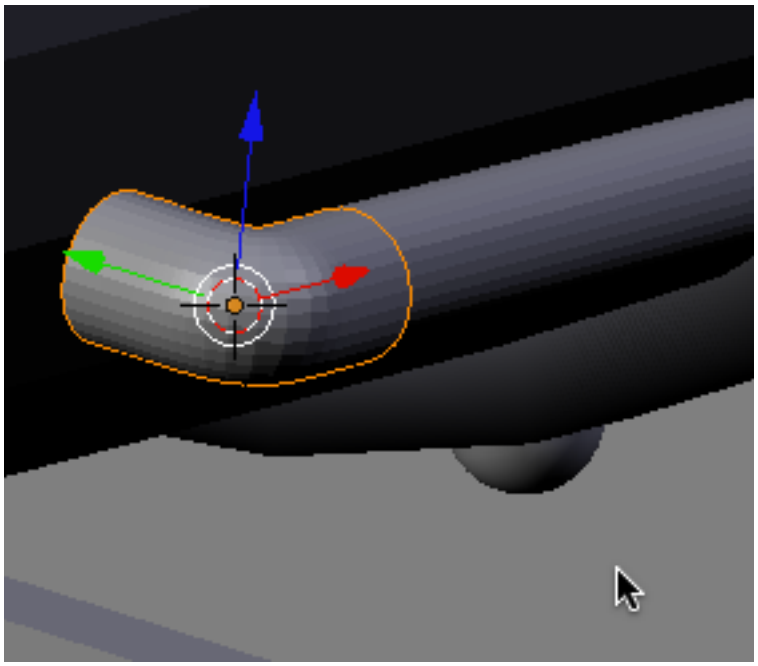


While still in edit mode and the vertices selected press SHIFT-S and snap your cursor to the selected. This will place your cursor in the center of the pipe at that end.  TAB out of edit mode.

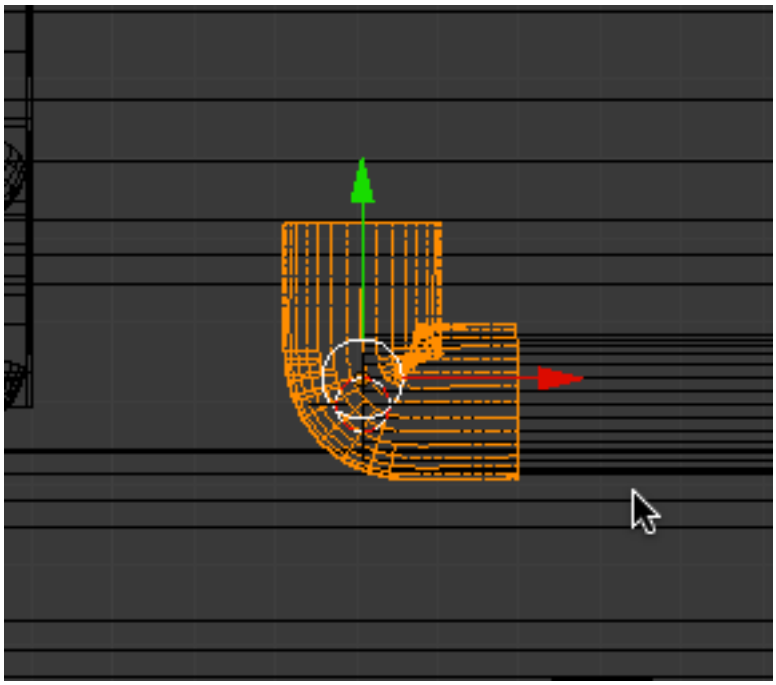
Select the duplicate fitting that we set aside. Press SHIFT-S and snap the selected object to the cursor. This will place the object at the end of the extruded pipe.



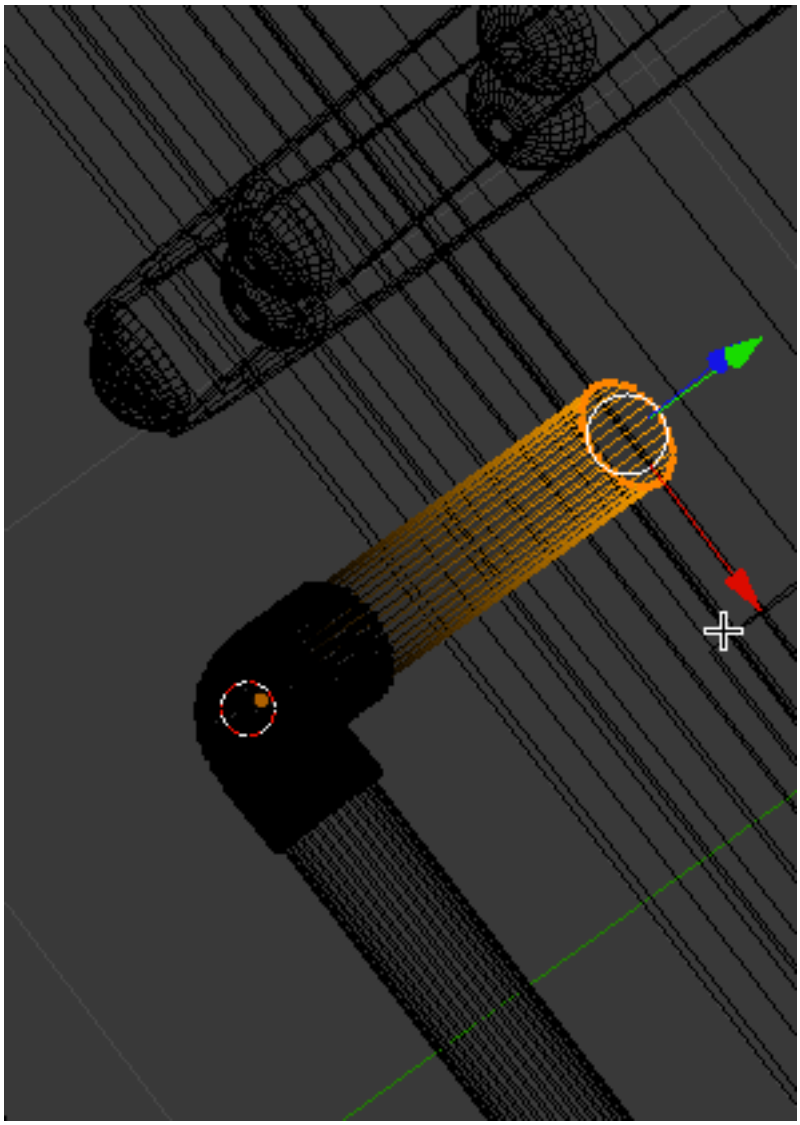
Press the RKEY followed by the ZKEY followed by -90 then ENTER. This will rotate the fitting around the Z-axis -90 degrees.



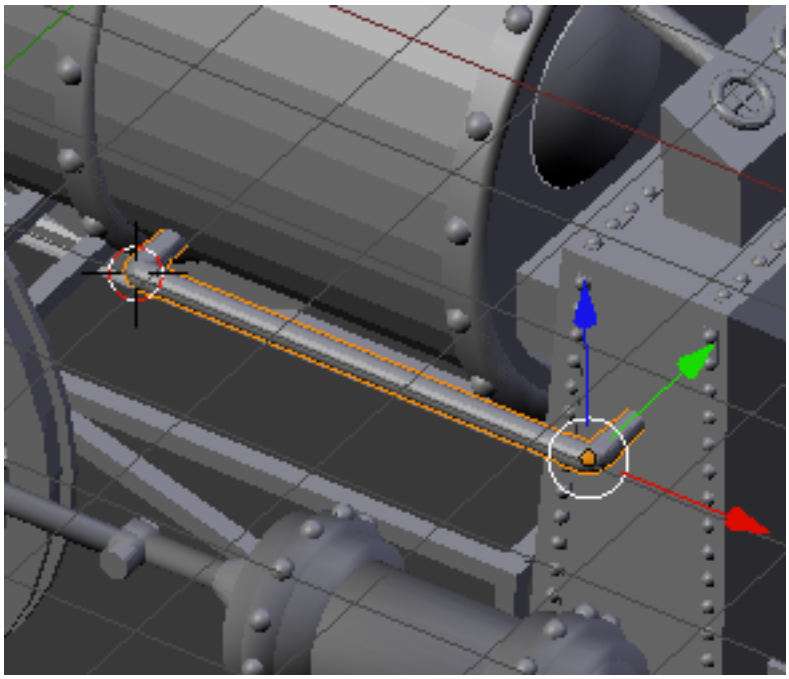
Go to top view and center the fitting on the pipe.



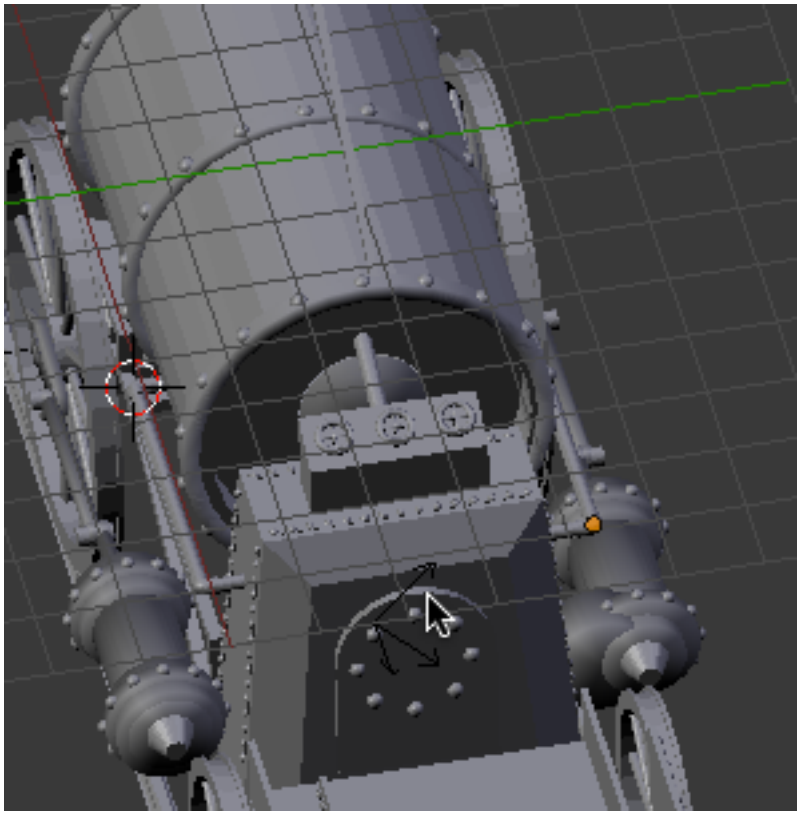
Rotate and zoom your view so you can see the side of the fitting facing the boiler. TAB into edit mode and select the inner ring of vertices and extrude them along the Y-axis into the boiler object as shown below.



TAB out of edit mode. Select the 2 objects and press CTRL-J and join them together into one object named “Pipe 1”.

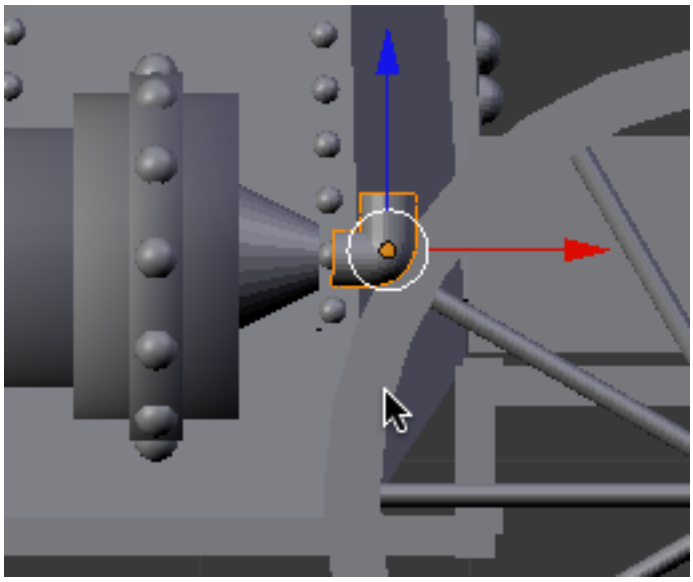


Make a duplicate copy of the Pipe 1 object and move it to the other side of the engine. Rotate it 180 degrees about the X-axis and position it. Name the duplicate object Pipe 2.

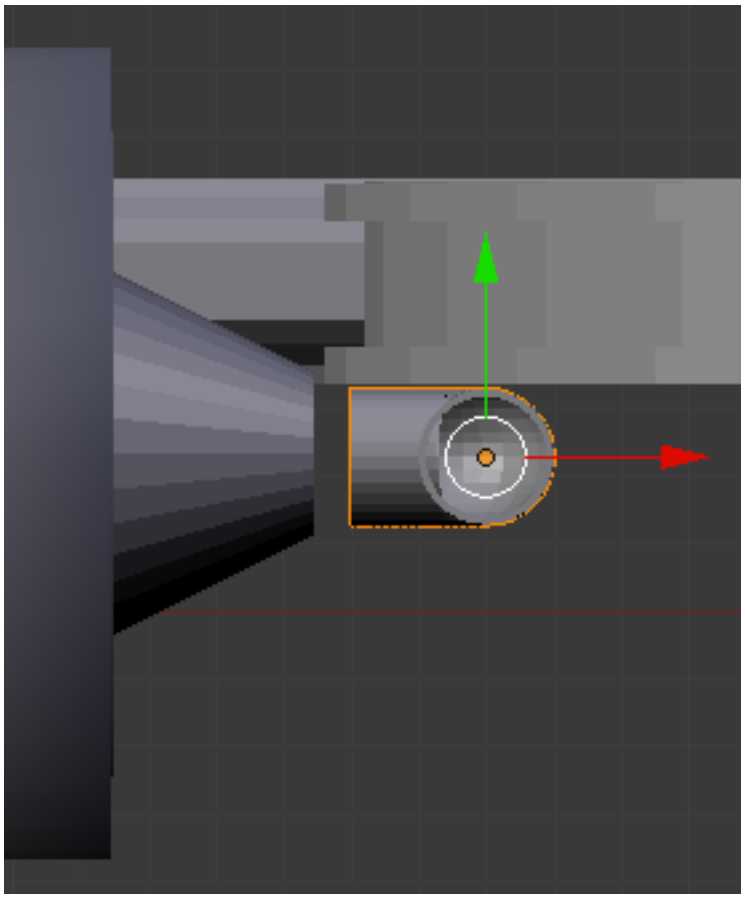


Save your Blender file.

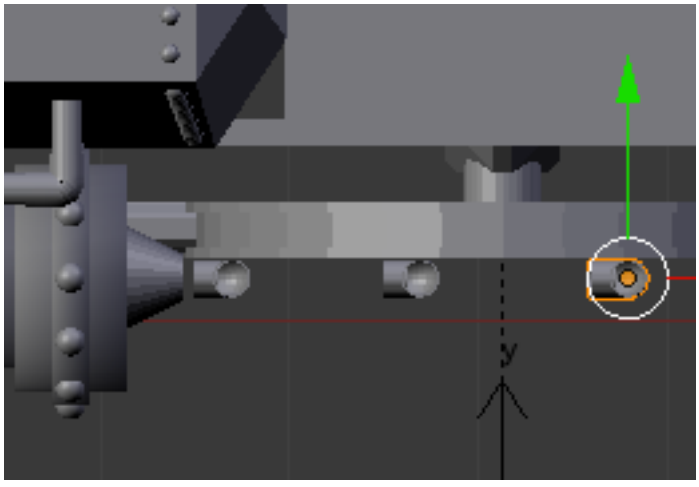
Select the original pipe fitting we brought over from layer 2. Rotate it 180 degrees around the Y-axis. Scale it down and position it as shown below on the left piston object.



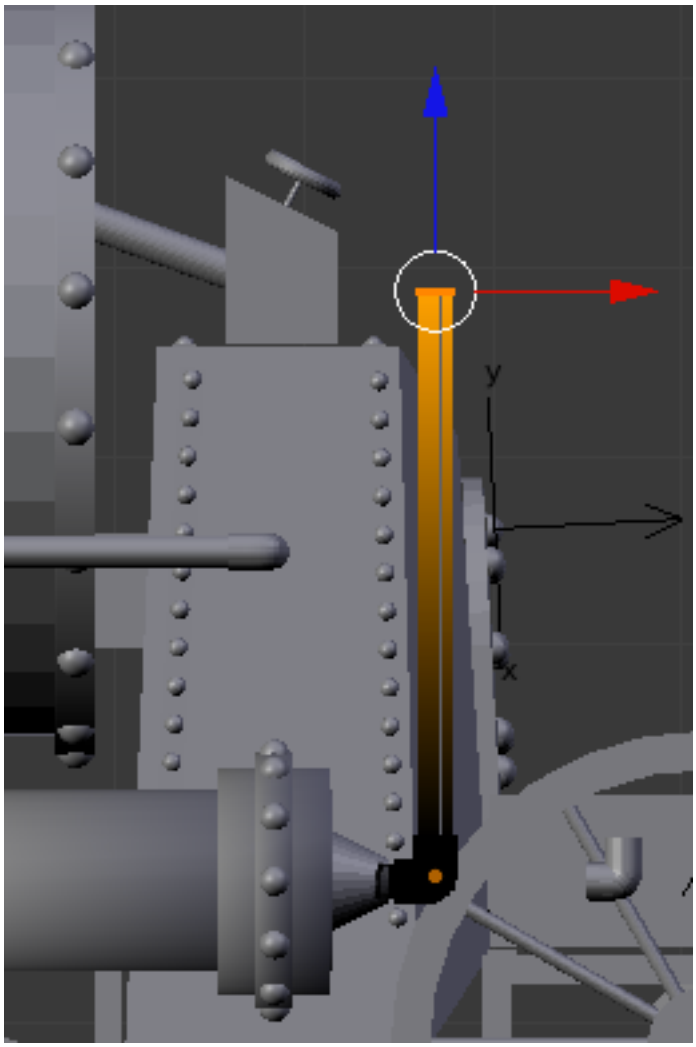
Go to top view and position the object as shown below.



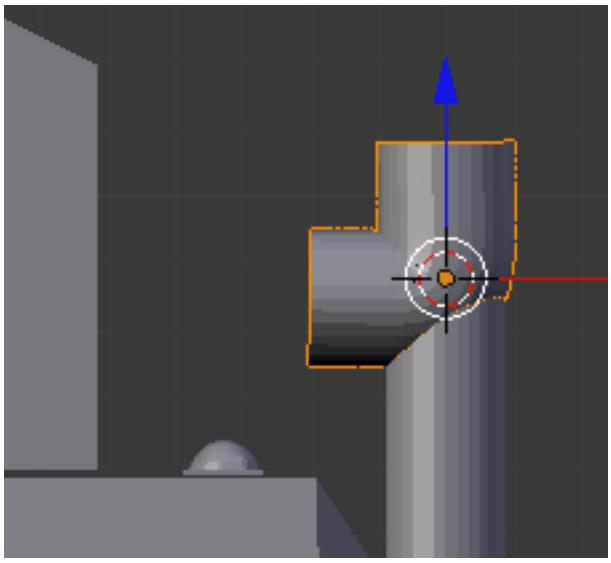
Make 2 duplicate copies and set them aside for later.



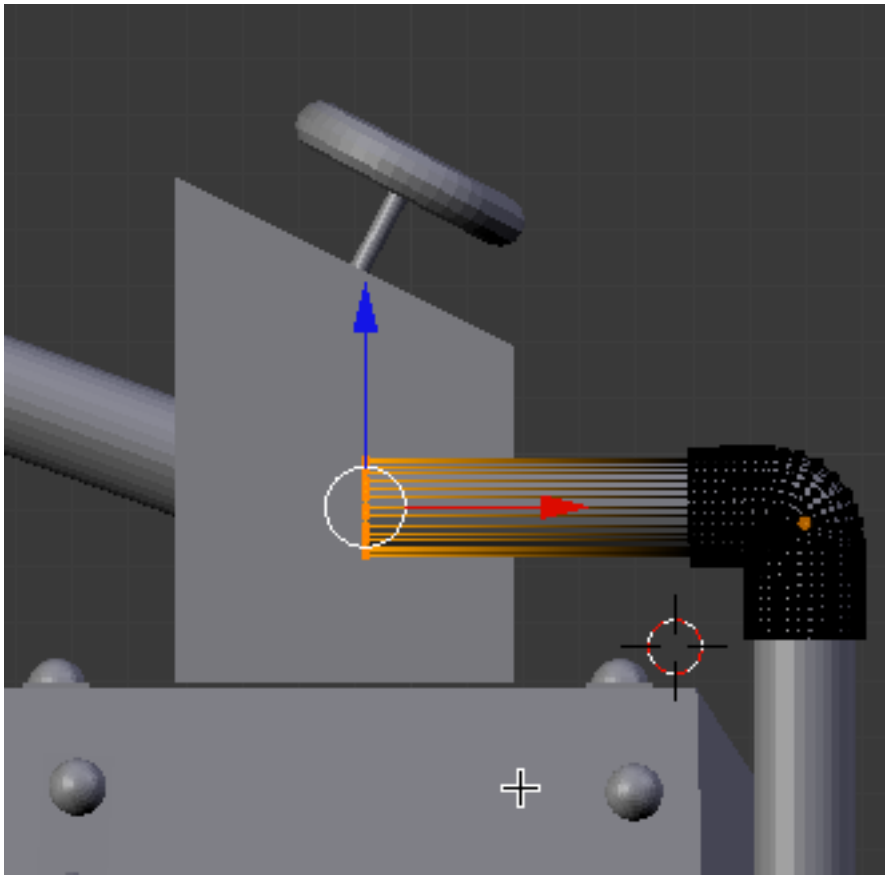
Select the first fitting and extrude one set of inside vertices along the X-axis into the piston and extrude the other set of vertices up along the Z-axis as shown below.



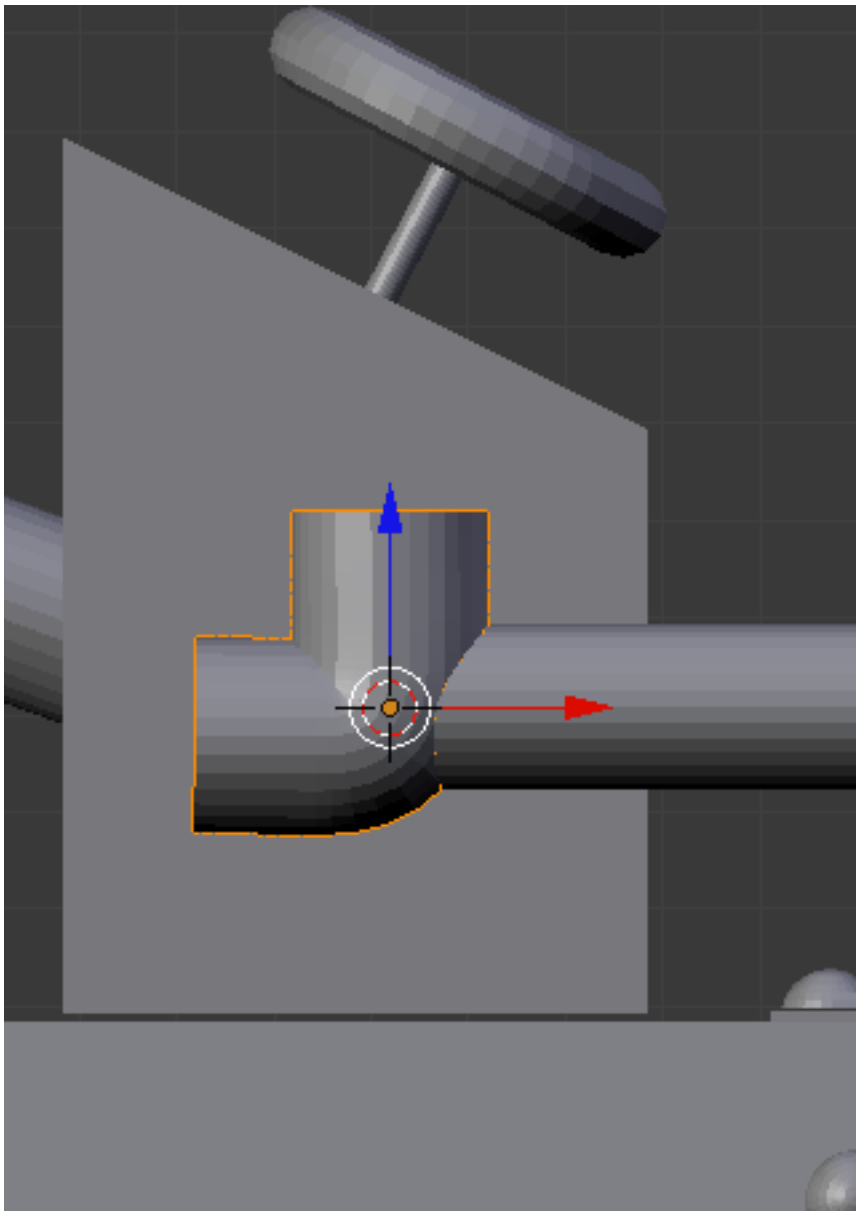

Press SHIFT-S and snap your cursor to the selected. TAB out of edit mode and select one of the duplicate pipe fittings. Press SHIFT-S and snap the fitting to the cursor.



Rotate the fitting 180 degrees around the X-axis. TAB into edit mode. Select the inner ring of vertices and extrude them out along the X-axis as shown below.

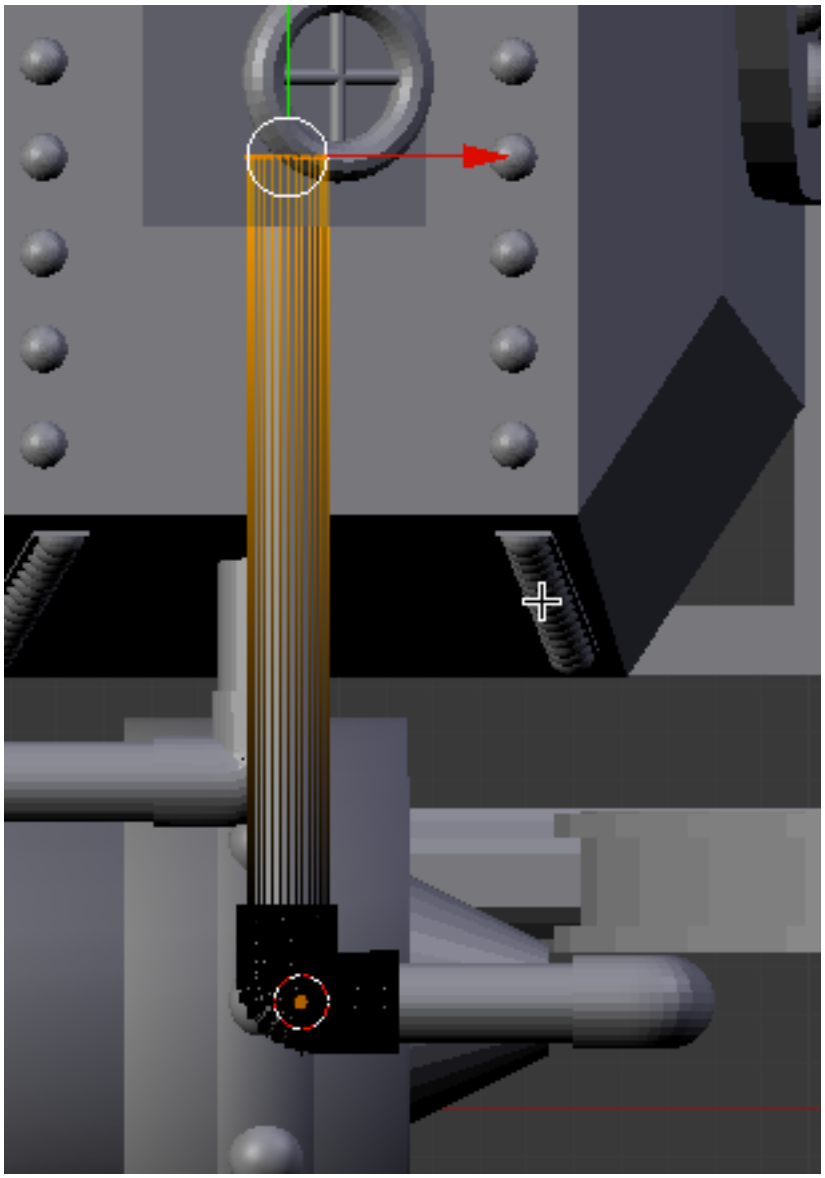


Press SHIFT-S and snap your cursor to the selected. TAB out of edit mode. Select the last duplicate fitting and press SHIFT-S and snap the fitting to the cursor.

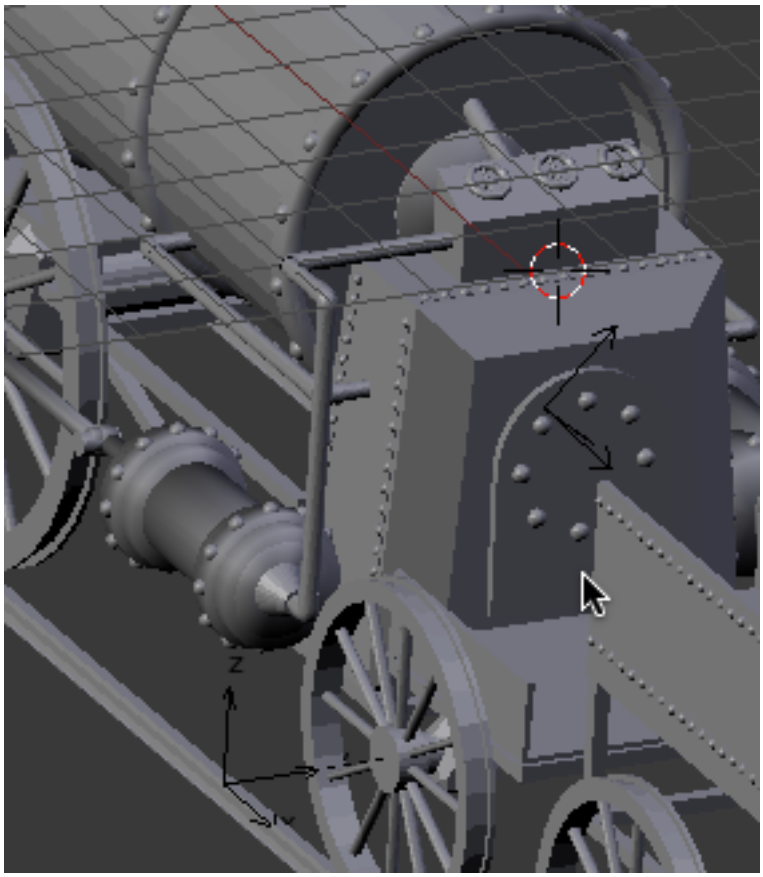


Rotate the fitting 90 degrees around the Y-axis and the rotate it -90 degrees around the X-axis.

Select the inner ring of vertices and extrude them into the control box along the Y-axis.

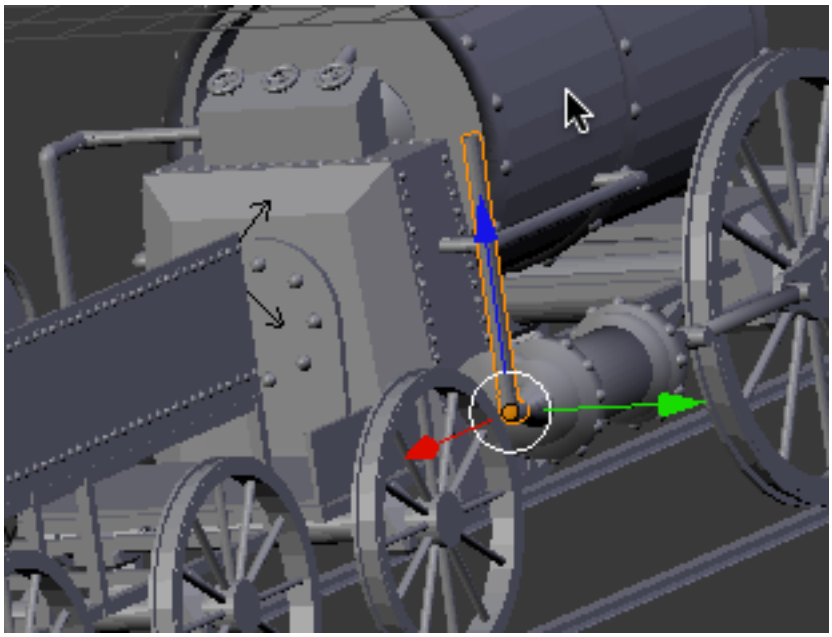


TAB out of edit mode.



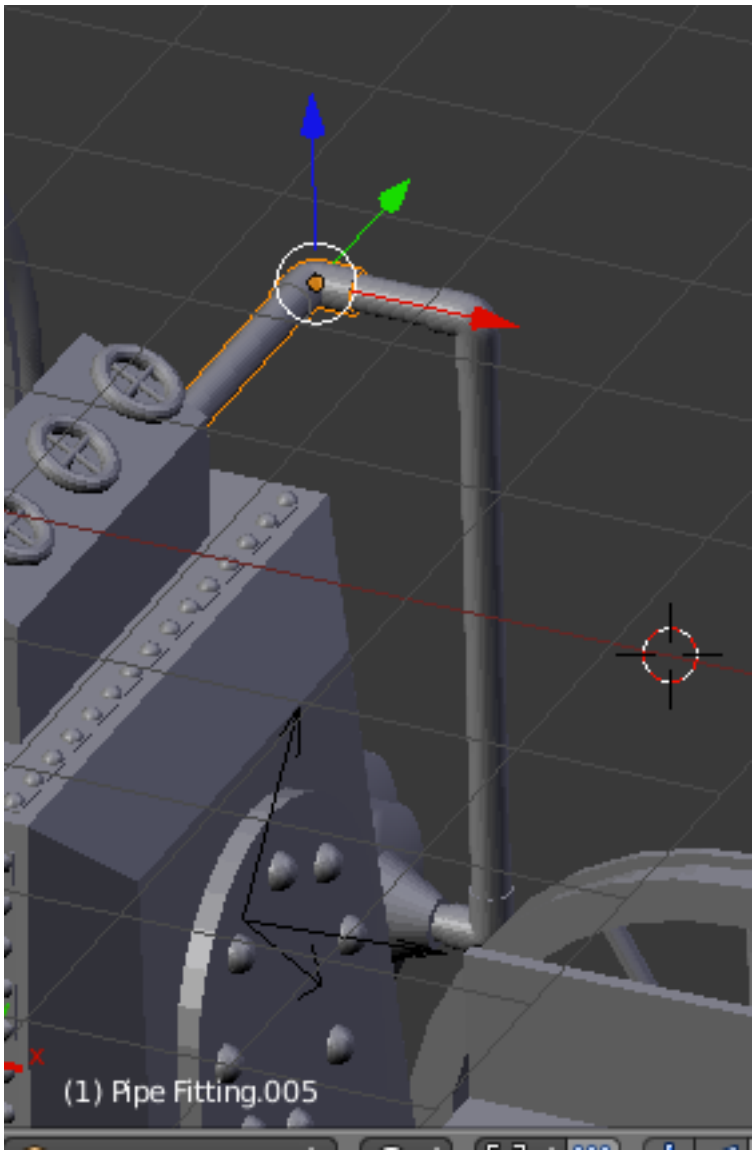

Do not join these 3 objects together because we need to rotate them separately to duplicate them on the other side of the engine.

Select the first section (by the piston). Press SHIFT-D and move the object into position along the Y-axis on the other side of the engine.



Select the second section and duplicate it and move it along the Y-axis and position it on the other side of the engine.

Select the third section and duplicate it. Rotate it 180 degrees around the X-axis and position it on the other side of the engine.



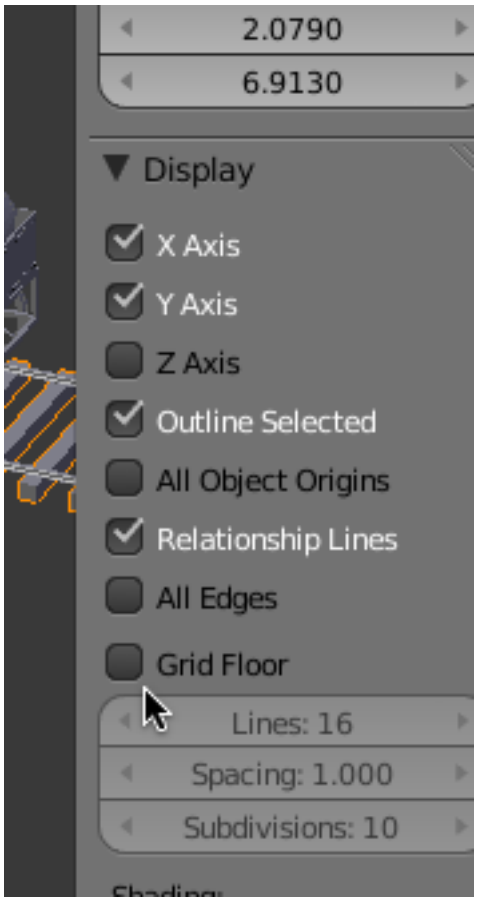

Select the first 3 pipe objects on the left of the engine and press CTRL-J and join them into one object. Name the object “Pipe-3”.
Select the second set of pipe objects, we placed on the other side of the engine, and press CTRL-J and join them into one object. Name that object “Pipe 4”.

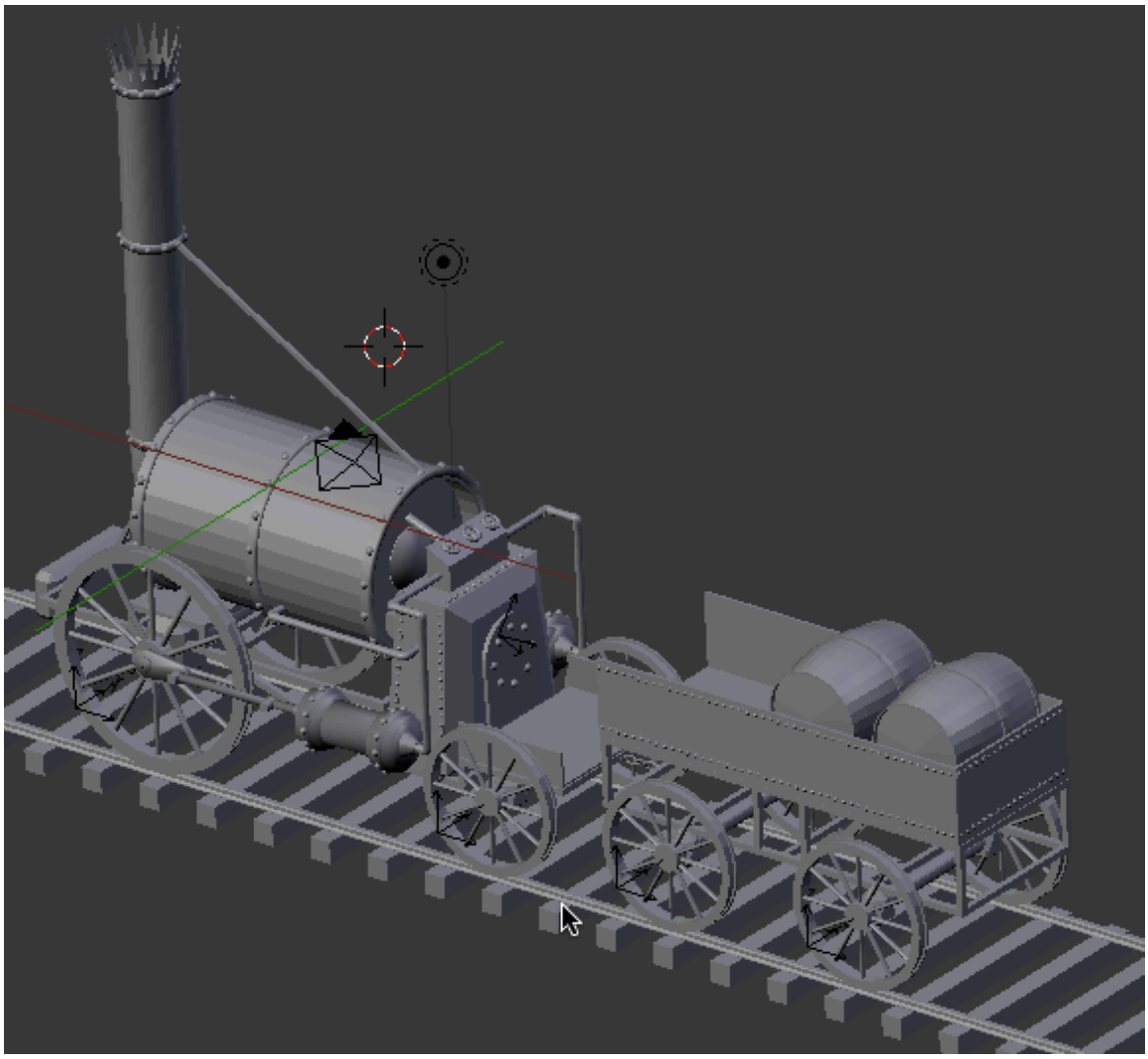
Save your Blender file.

Go to layer 20. Select the camera and lamp object and place them on layer 1

Go to layer 10 and select the rail tie object and place it on layer 1.

Go to layer one and turn off the grid floor by un-checking the box in the 3d editor viewport properties panel.


2.0790
6.9130
Display
X Axis
Y Axis
Z Axis
Outline Selected
All Object Origins
Relationship Lines
All Edges
Grid Floor
Lines: 16
Spacing: 1.000
Subdivisions: 10



Save your Blender file.

This is the end of the “The Rocket Steam Locomotive – Modeling” tutorial. There is a third tutorial named “The Rocket Steam Locomotive – Animation”.

A completed .blend file of this tutorial named “RocketSteamLocomotiveModeling.blend” can be downloaded HERE.

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