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# Contraflow Heater Core

## 22" firebox with replaceable liner

## Front White Bake Oven

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## Material List for core

### Masonry:

- 170          1.25" x 4.5" x 9" firebrick splits
  - 250          2.5" x 4.5" X 9" firebricks
  - 4            55# bags of castable refractory for bake oven castings (3 piece set)
  - 4            55# bags of castable refractory for core capping slabs (2 piece set)
  - 2            55# bags of castable refractory for firebox floor casting
- Castable refractory: KS-4 or MC-25 from Harbison Walker, or equivalent
- Insulating base slab: one bag vermiculite plus one 80# bag of mortar premix.
- 2            pails Sairset or other refractory mortar
- 1/8" ceramic paper for the bakeoven gaskets and side channel gaskets (available from Northstone Heat Supply [northstoneheat.com](http://northstoneheat.com))

### Hardware:

- 1      base slab butterfly damper 5"x5" (custom made), or 1 UPO ash box/air intake door
  - 1      5.5" x 11" firebox floor grate (1B from Northstone Heat Supply (below), or equivalent)
  - 1      chimney shut off damper for either 8" round or 8"x12" rectangular flue
  - 1      steel angle iron 1/4" x 4" x 4" – weld on small angle iron brackets to hold firebrick split "heat shields" as in Figure 21.
- Firebox door, cleanout doors.

### Hardware sources:

<http://mha-net.org/html/hardware.htm>

## Foundation

Instructions for the foundation are beyond the scope of this heater core plan. This document: <http://heatkit.com/docs/foundation.PDF>

describes a foundation suitable for this heater, if there is a basement underneath. The foundation described in the above document requires, in addition, a 2" clearance to combustibles in order to meet current IRC or IBC building codes. This foundation provides an ashpit in the basement. Please note that it also requires a 6" air inlet, near the basement ceiling.

For slab on grade construction, ashes will be cleaned out immediately below the firebox door, via an ashbox door with air control (available from the hardware suppliers listed above). Combustion air in this case will enter through the ashbox door.

If you are building slab on grade and your local code still requires an outside air supply, please refer to this document:

<http://heatkit.com/docs/assembly/grade.PDF>

Please note that many of the construction documents, such as finishing instructions, for the Heat Kit core, also apply to this handbuilt core

<http://heatkit.com/html/assy-hk.htm>

However, please note that Heatkit does not provide support for this handbuilt core.

## Setting Firebricks

Firebricks are laid up with clay air setting refractory mortar (“Sairset”, or fire cement) with thin joints. Only enough clay needs to be used to completely fill the joint. No joint thickness needs to be built up - you are only filling in gaps and irregularities between the bricks. Although masons are used to trowelling firebricks, the best joints are obtained by dipping the bricks into mortar that has been thinned to the right consistency. It looks messy, but the cleanup is easy later with a sponge.

Refractory mortar normally comes in the bucket at trowelling consistency. For dipping, you will need to thin it with water. A drill powered drywall mud mixer works well for this. You can tell if the refractory mortar has the right consistency by floating a firebrick in it. It will sink about half way.

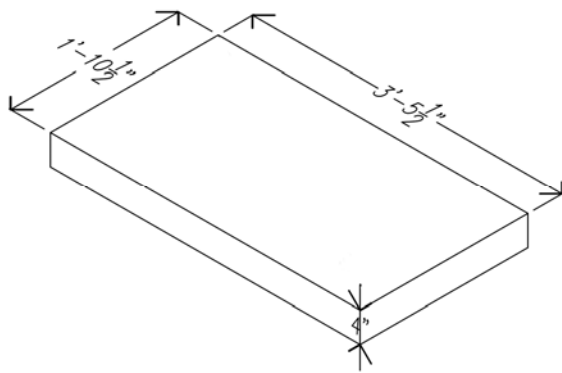
The firebox is laid up from standard firebricks. Standard firebricks are 4 ½” wide by 9” long by 2 1/2” thick. The thickness will vary between 2 ¼” and 2 ½” depending on the supplier. The dimensions given in these drawings assume a 4.5” firebrick module, and may need to be modified for non-standard firebricks.

## Slabs Required

The base slab (Figure 1) is cast from a 1:3 mix of vermiculite (or perlite) and portland cement. The remaining slabs are cast from castable refractory, available from refractory suppliers such as RHI or Harbison Walker.

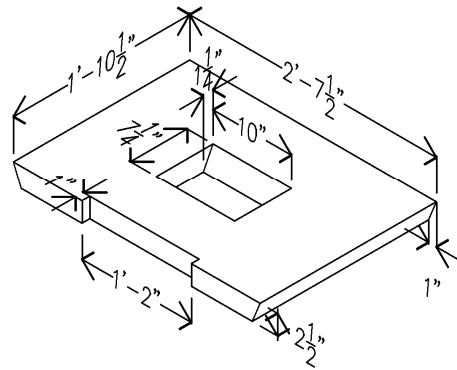
It is very important to take certain precautions when casting refractory slabs under on-site conditions. These techniques are beyond the scope of these instructions. However, you will find an excellent article explaining them by Marcus Flynn, a very experienced heater mason from Montreal, here:

[http://www.pyromasse.com/castable\\_e.html](http://www.pyromasse.com/castable_e.html)



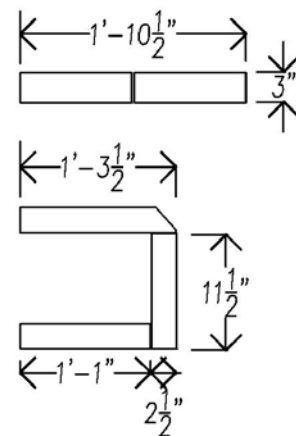
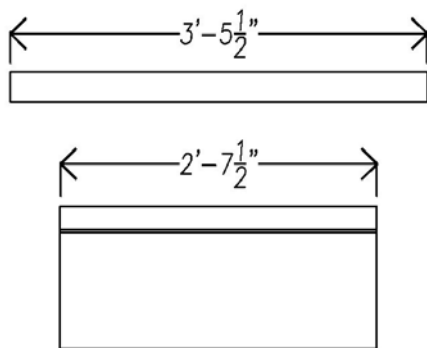
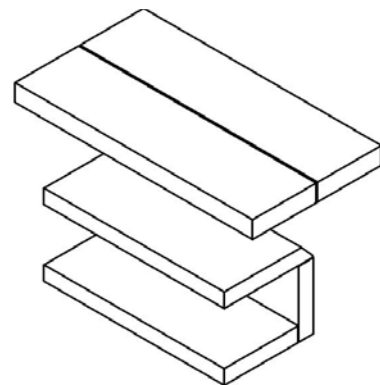
**Figure 1**

Base slab.



**Figure 2**

Firebox floor slab. Note the angle at the back of the hole.

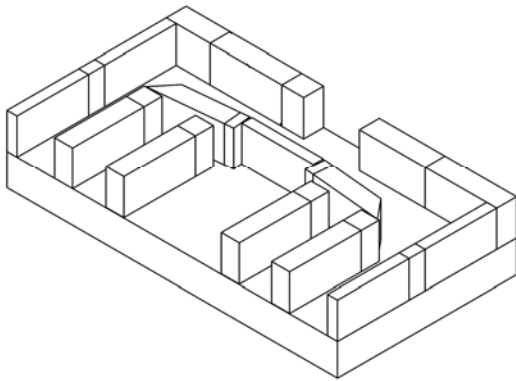


**Figure 3 – the 3 bake oven slabs and the 2 piece ceiling slab**

## Assembling the Bottom End

The bottom end of a contraflow heater is the most complicated part of the whole job. The two downdraft channels connect here, underneath the firebox. As well, the chimney connection and the cleanout openings for the particular installation need to be determined and located here.

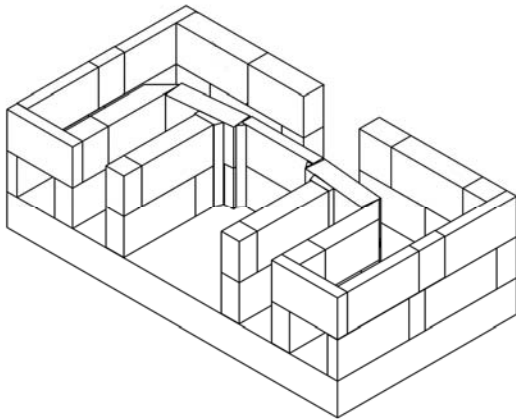
This plan shows a rear exit chimney, and front cleanouts. The chimney can be connected anywhere along the rear or sides. The cleanouts location can also vary, and should allow adequate access to remove fly ash that drops off at the bottom of the channels over the years.



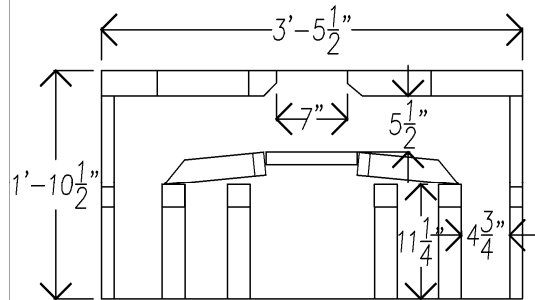
**Figure 4**

First course. Note the cleanout openings in the front, and the chimney opening in the rear.

A rear connecting channel joins the two downdrafting side channels.

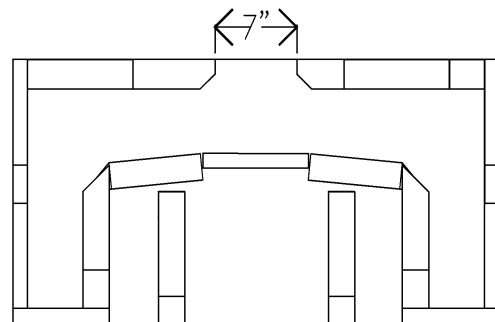


**Figure 6**



**Figure 5**

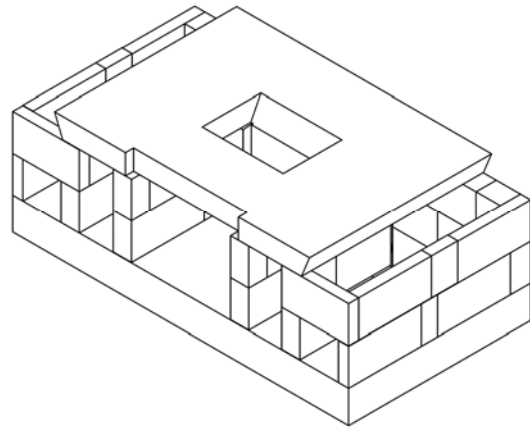
Layout diagram. Note the firebrick split to allow clearance for the grate over the connecting channel.



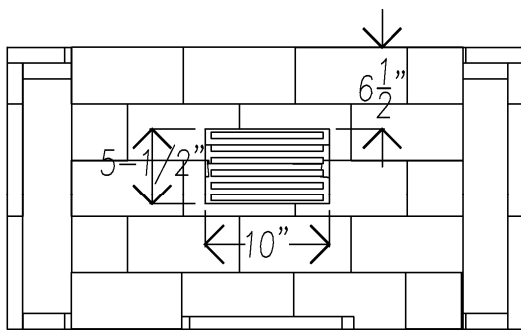
**Figure 7**

## Firebox and Heat Exchange Channels

Install the firebrick floor slab onto a bed of refractory mortar.

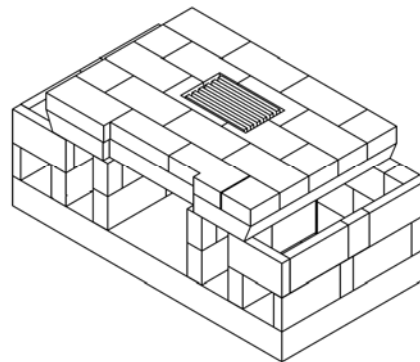


**Figure 8**



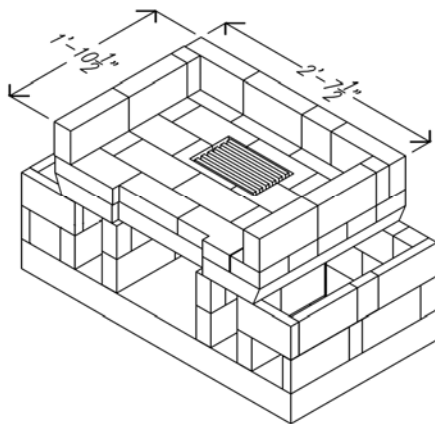
**Figure 9**

Firebrick lining for the floor.



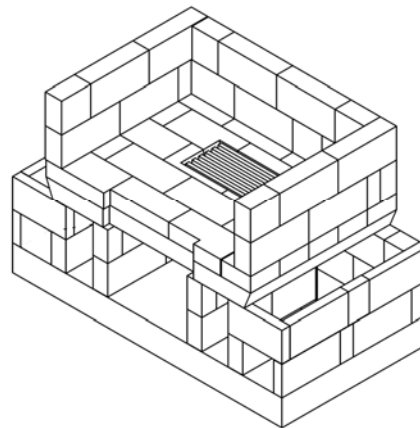
**Figure 10**

Note the 1" notch in the front for a combustion air channel



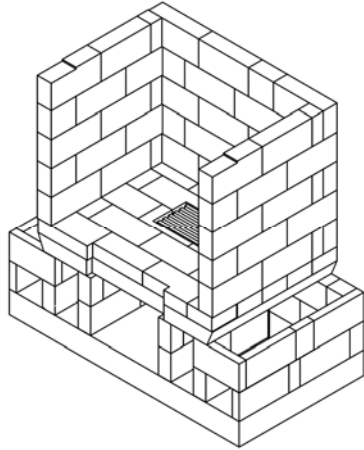
**Figure 11**

Firebox is built with an inner and outer shell. Layout for outer shell. Short sidewall cut piece is 2". Cut in rear wall is 4.25"



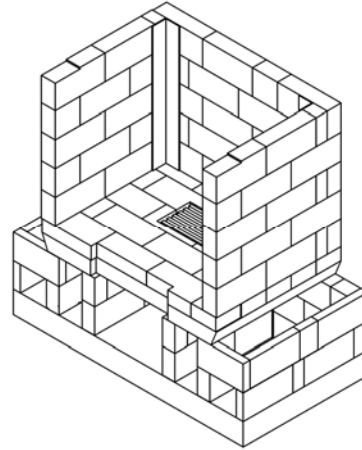
**Figure 12**

Second course of firebox. Each sidewall has a half brick. Rear has a half and a 4.25"



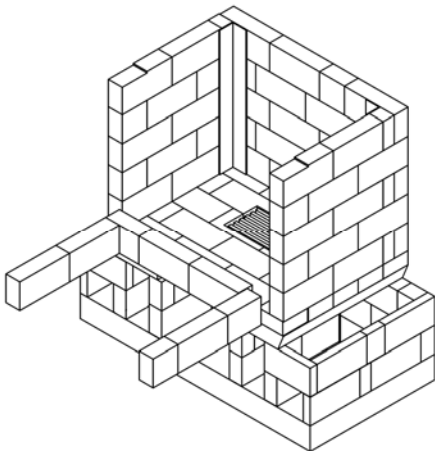
**Figure 13**

Firebox is five courses. Note 1/4" notch in top front bricks, to allow for angle iron firebox lintel.



**Figure 14**

Inner firebox is laid up dry against the outer. Use cardboard strips or ceramic paper to create and expansion joint in the rear corners as shown.

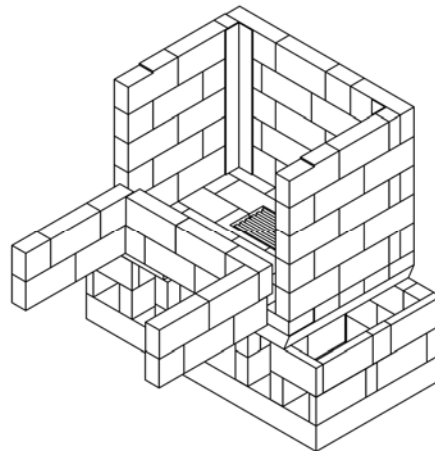


**Figure 15**

Inner layout starts with a half brick on the right.

Each course has two 6" cuts. Cut end is always buried in a blind corner.

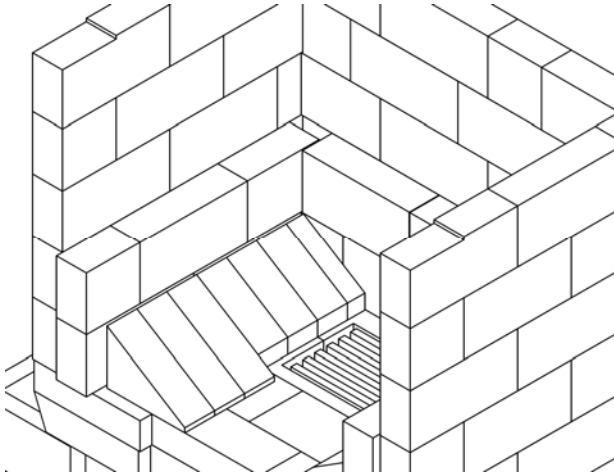
This is the part of the core that will show. Select firebricks to avoid cracked bricks, and to avoid chips showing on the front face.



**Figure 16**

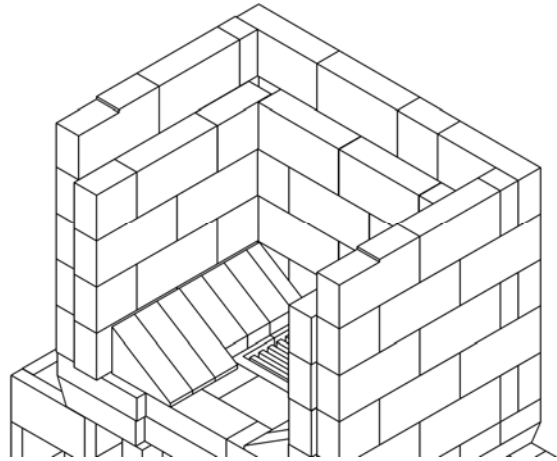
Second course is reverse of the first, starting with the half brick on the left.



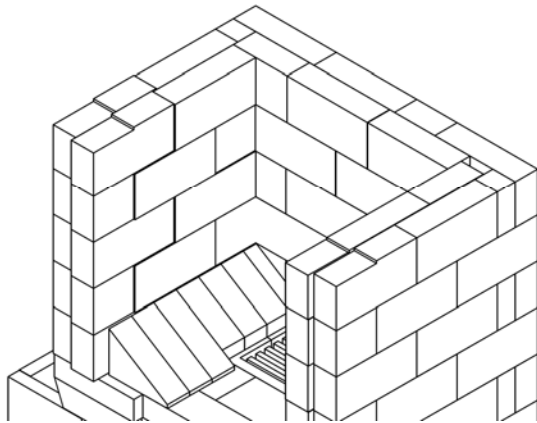


**Figure 17**

Detail showing angled cuts to create a floor slope. This detail can be added later in the construction sequence

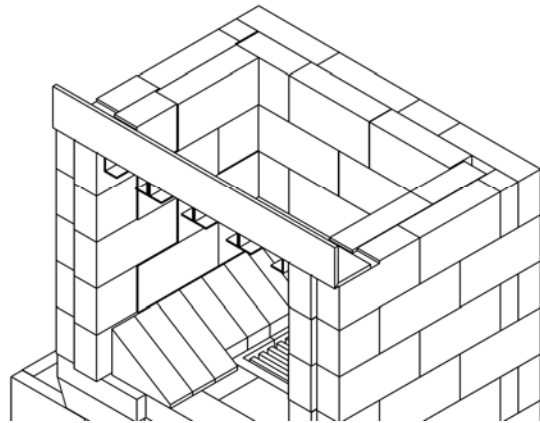


**Figure 18**



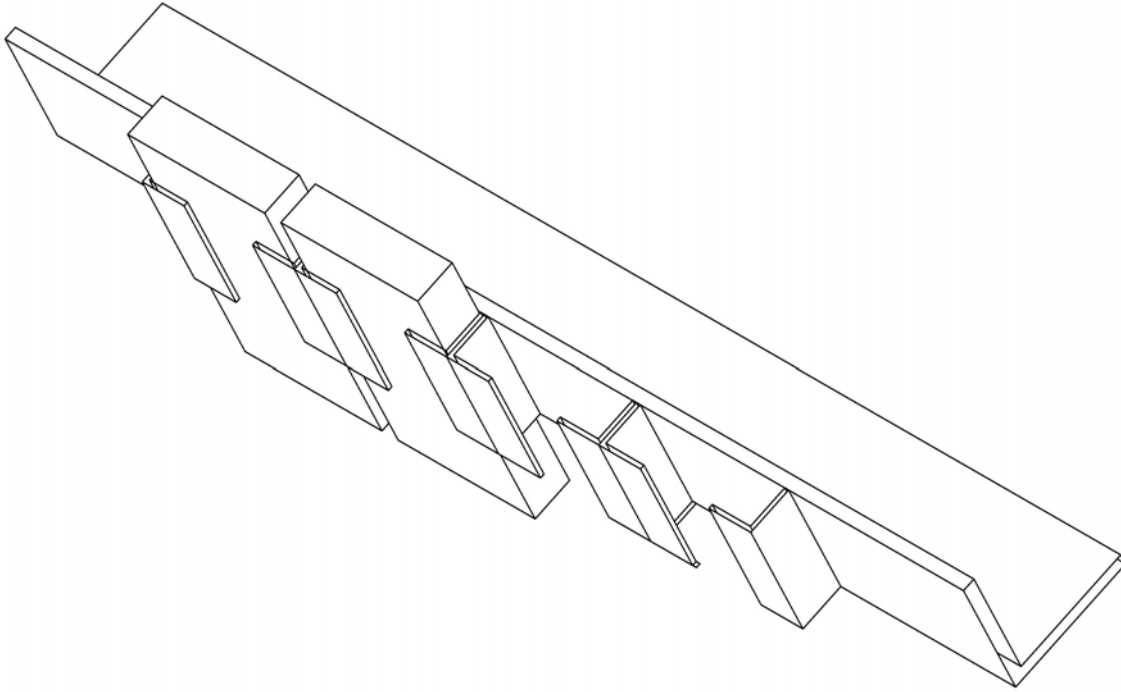
**Figure 19**

Note the 1/4" notches to receive the angle iron



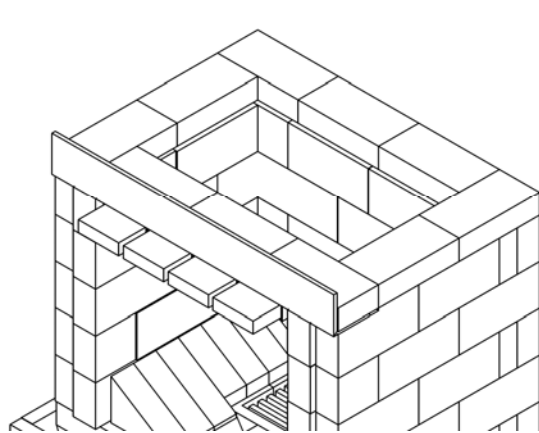
**Figure 20**

Angle iron lintel is 4"x4"x1/4" and is 31.5" long. Angle iron brackets are welded to the bottom to allow firebrick splits to be slid in, to act as heat shields for the lintel.



**Figure 21**

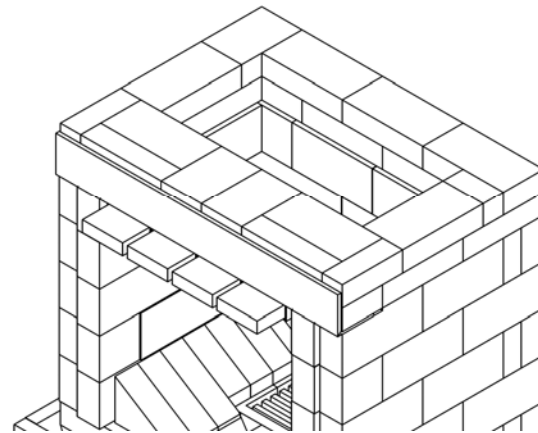
View of firebox lintel from below, showing welded on brackets



**Figure 22**

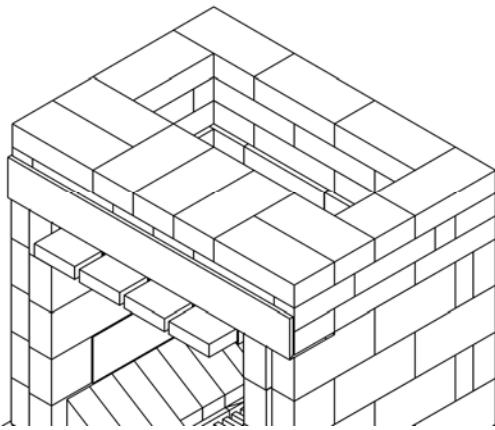
The heat shields are slid forward to also protect the facing lintel later.

Next course is full bricks laid as stretchers.

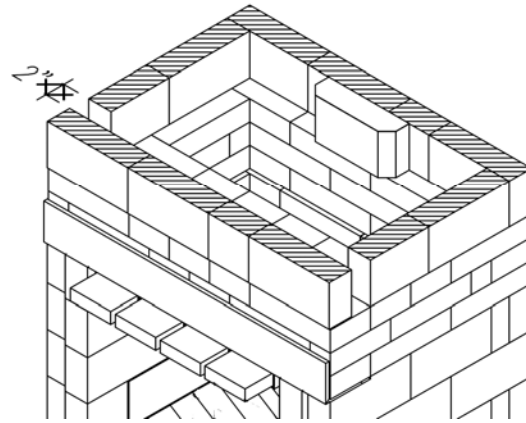


**Figure 23**

Cuts shown are soaps (bricks ripped lengthwise), and  $\frac{3}{4}$  bricks (= 6.75" long)



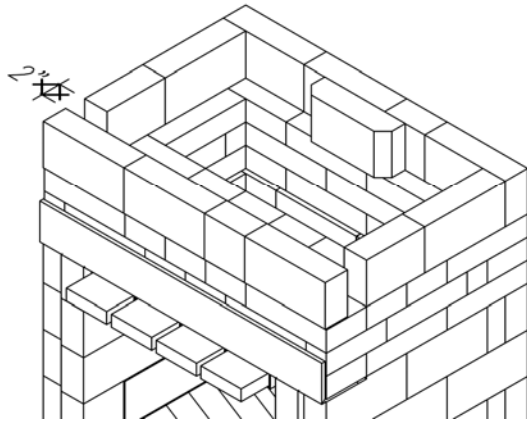
**Figure 24**



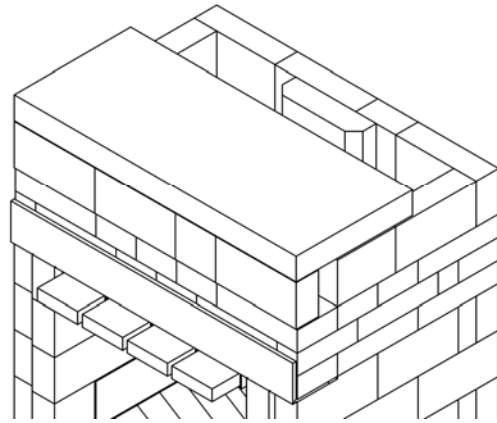
**Figure 25**

Base for oven. Two 2" bypass slots are left to boost oven floor heat.

Hatching is shown for clarity.

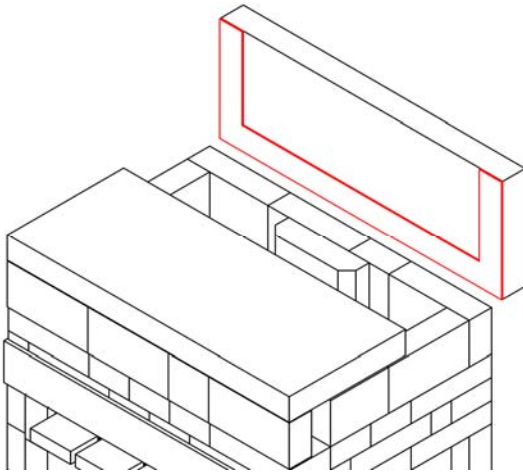


**Figure 26**



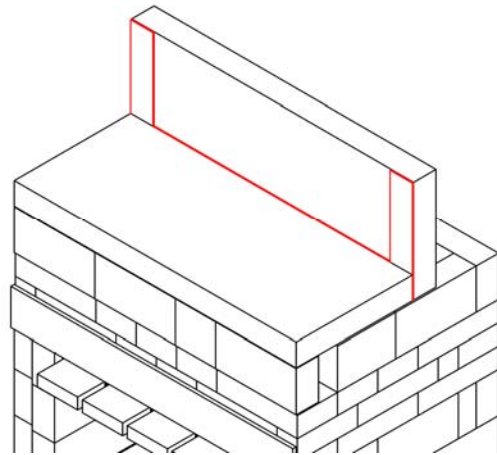
**Figure 27**

Oven floor slab is installed in a bed of refractory mortar and levelled. Clean up mortar squeeze out under slab.



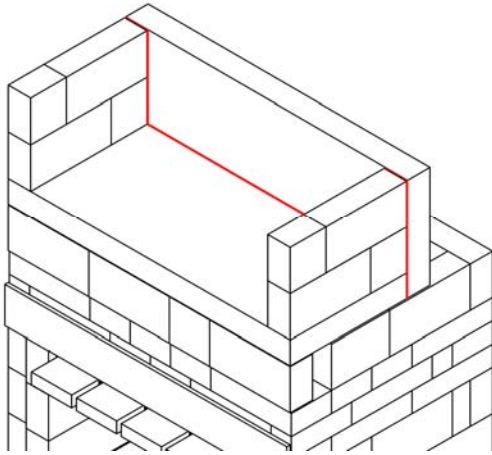
**Figure 28**

Gaskets are cut from 1/8" ceramic paper and adhered to slabs with dabs of refractory mortar or silicone



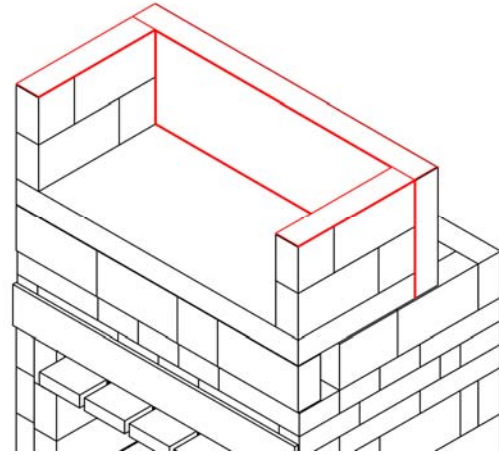
**Figure 29**

Slide oven back in place. It sits dry.



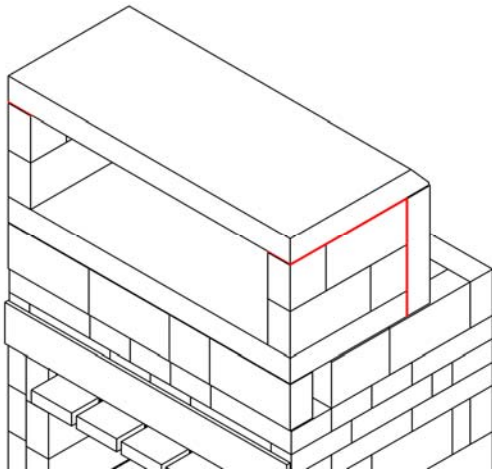
**Figure 30**

Side walls are brick. Use a dry joint against the gasket.

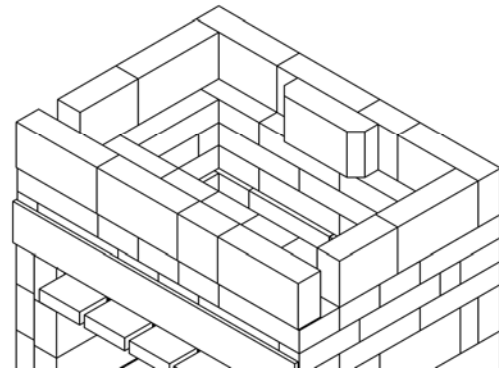


**Figure 31**

Gasket on top.



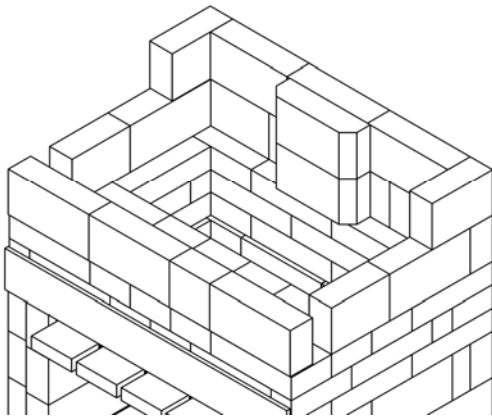
**Figure 32**



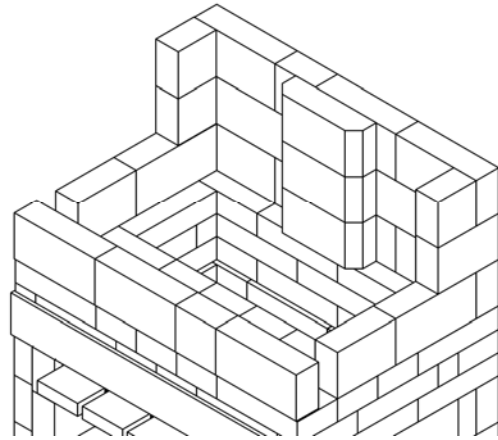
**Figure 33**

Oven is not shown, for clarity.

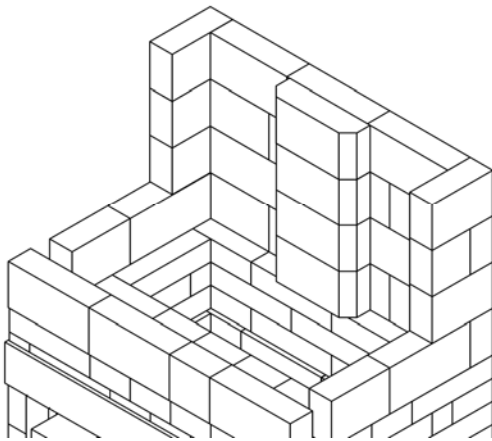
Continue building up around the back as shown.



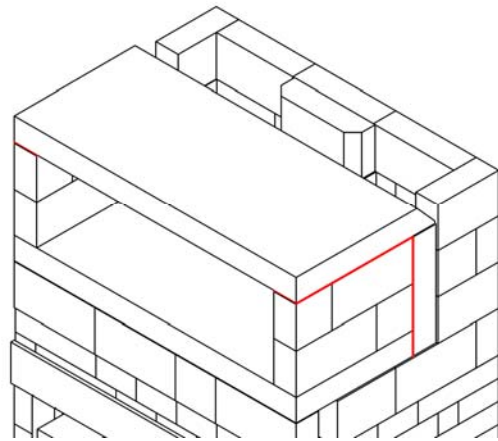
**Figure 34**



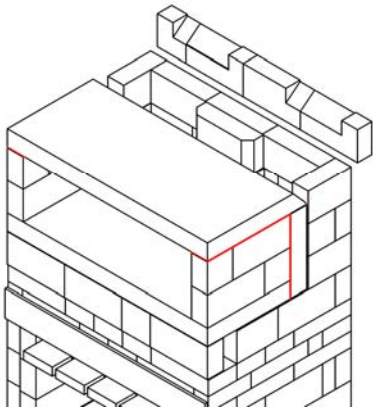
**Figure 35**



**Figure 36**

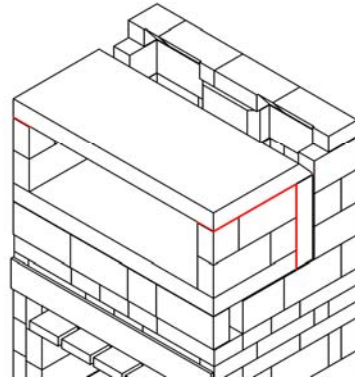


**Figure 37**



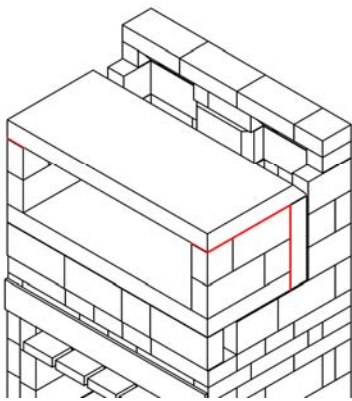
**Figure 38**

Transition bricks to cap off flared out rear side channels. Show tilted up for clarity.

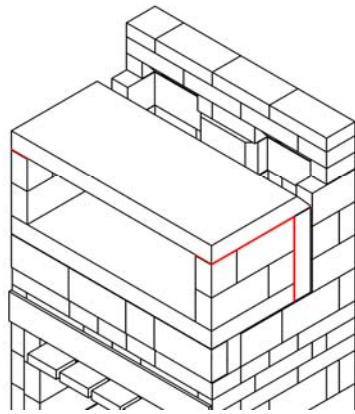


**Figure 39**

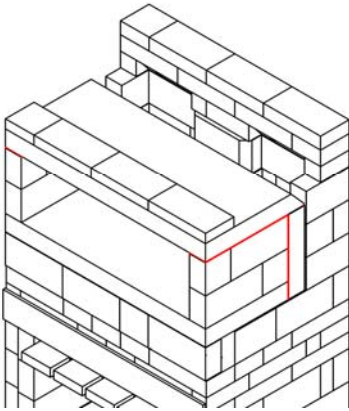
Same as Figure 38, bricks in place.



**Figure 40**

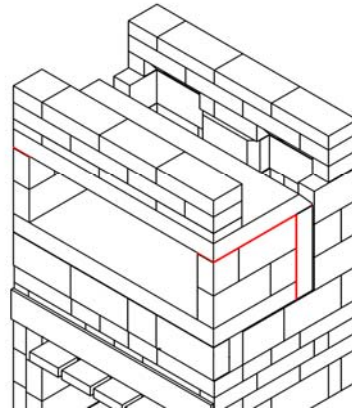


**Figure 41**

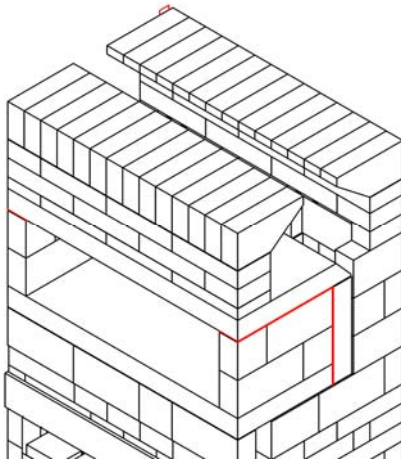


**Figure 42**

Adjust height so that front and rear coursing is level. Splits are shown here.

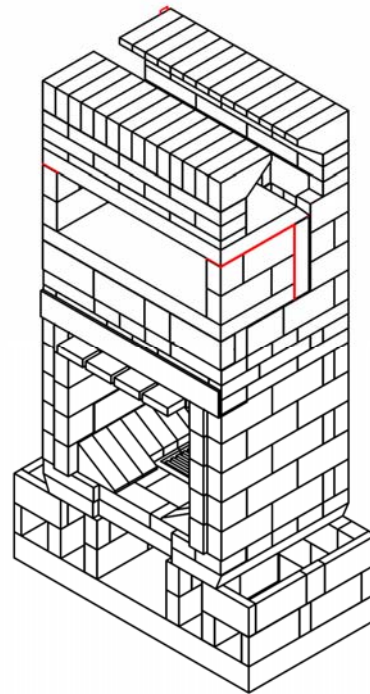


**Figure 43**



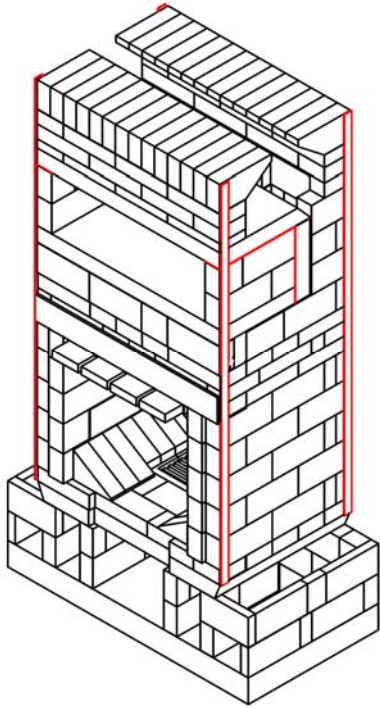
**Figure 44**

Angled transition header course to carry ceiling slabs.



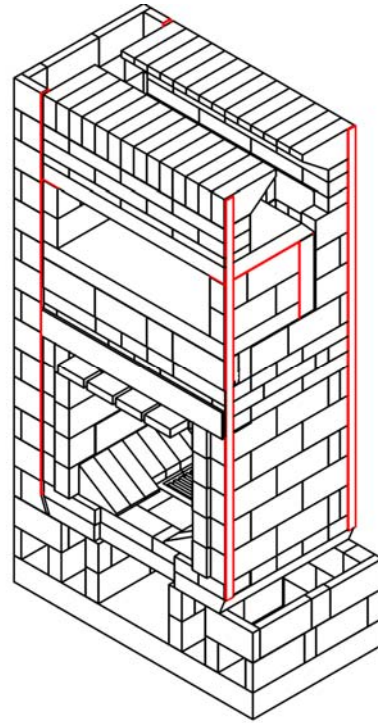
**Figure 45**





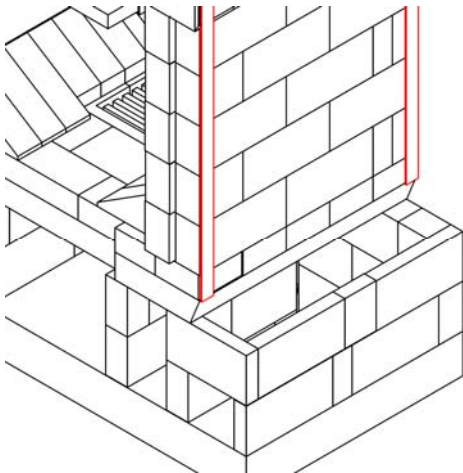
**Figure 46**

Glue on a ¼" thick strip of ceramic paper, or ceramic fibre to provide an expansion joint where the side channels will meet the firebox



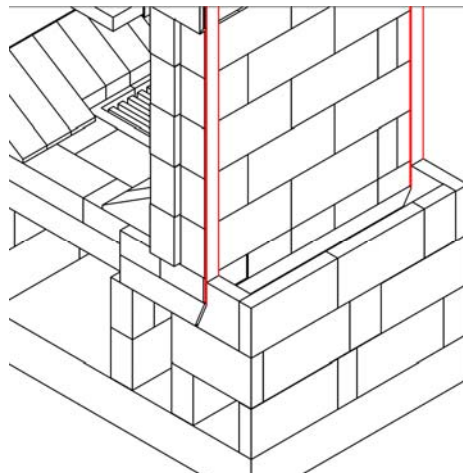
**Figure 47**

Left side channel is shown completed



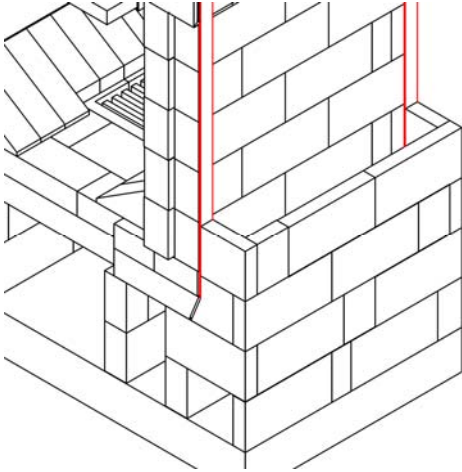
**Figure 48**

Build up side channels with firebrick splits.

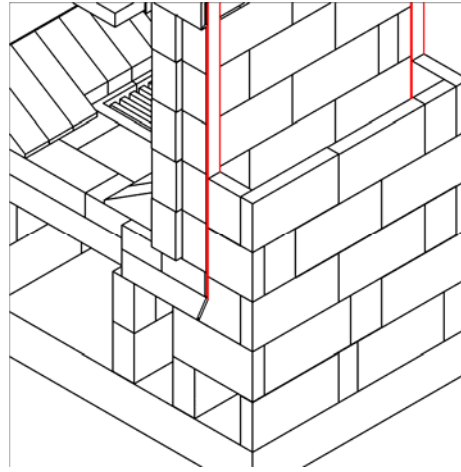


**Figure 49**

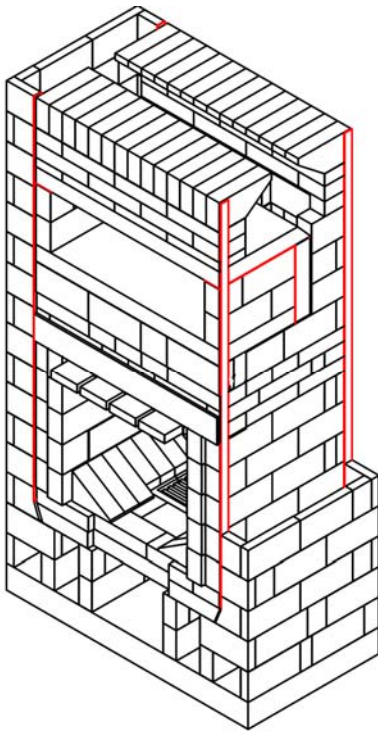
Use the bond pattern shown.



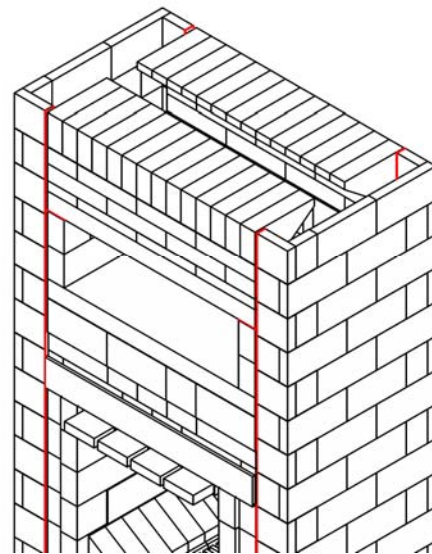
**Figure 50**



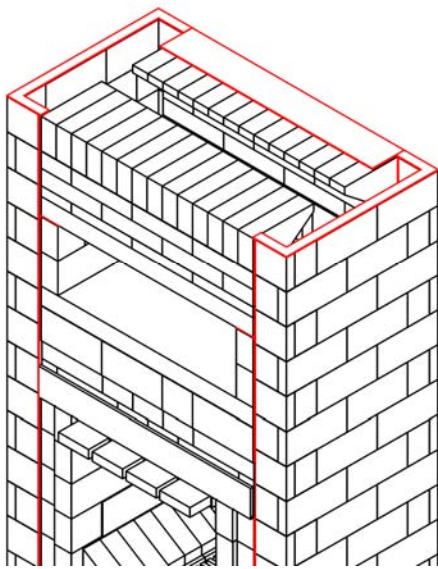
**Figure 51**



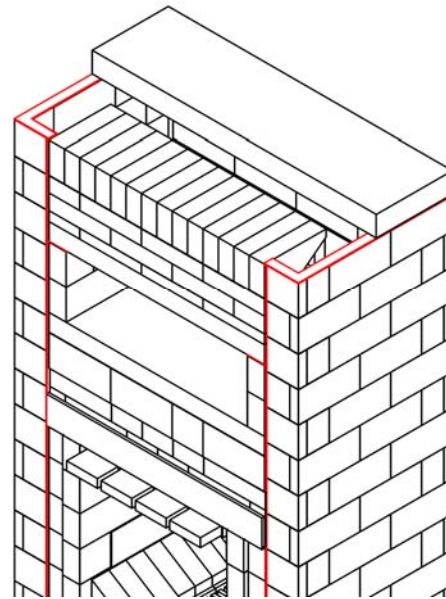
**Figure 52**



**Figure 53**

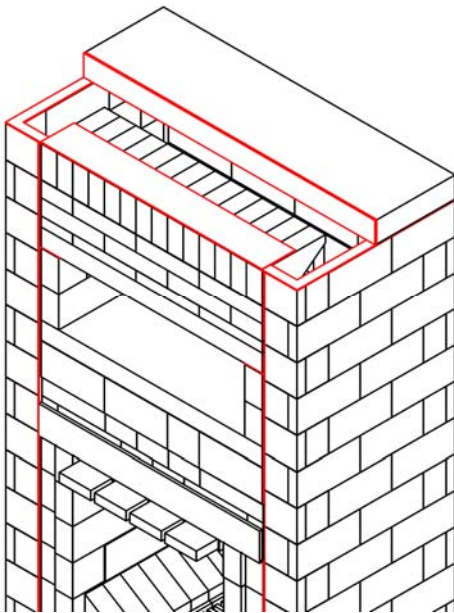


**Figure 54**



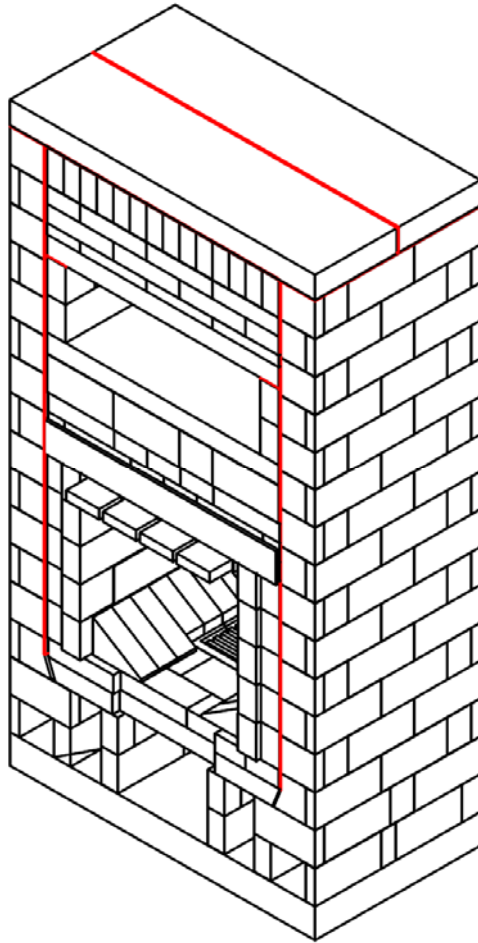
**Figure 55**

Lay down ceramic paper gasketing as shown to receive the ceiling slabs, which sit dry.



**Figure 56**

Use a gasket between the two ceiling slabs as shown.



**Figure 57** Completed core.

## Facing

For information on doing the facing, refer to the photo sequence from the 2008 Wildacres workshop, which is located here:

<http://mha-net.org/docs/v8n2/wildac08c.htm>

The finishing instruction for the 22" Heat-Kit heater also apply to this core, and are located here:

<http://heatkit.com/docs/assembly/Finish.PDF> (English)

<http://heatkit.com/docs/finish/Finish.F.pdf> (French)

Tempcast also publishes some finishing information specific to their door and air system:

<http://www.tempcast.com>