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2/23/11

Practicum 4: Build a Furnace

Our bloomery furnace will be of a moderate size: 3 feet in height, not including the 1 foot platform it will be constructed on. The bottom of the bloomer will have a 1.5 foot internal diameter for adequate fuel and ore space, while tapering to 1 foot at the top to better restrict air flow. The walls will be built 4 1/2 inches thick brick, followed by a 1/2 inch ceramic lining to protect the structure. Three tuyeres will be equally spaced around the bloomery to ensure the even introduction of oxygen. They will have a 10 degree downward angle to ensure the entire shaft (as opposed to the upper portions) receives oxygen, and to better concentrate bloom formation, which tends to occur nearest to the tuyeres. The tuyeres themselves will be 3 inches in diameter, and project 2 inches into the furnace itself. A 6x6 inch opening will be placed on one wall equally spaced between two tuyeres for slag and bloom removal; there will be a sealable door.

Our furnace will be built on a brick platform, which will guard against moisture from the ground and act as a good insulator for the bottom part of the bloomery, which will be partially embedded in the platform. The actual furnace will be constructed from materials designed to withstand very high temperatures ($\sim 2000^{\circ}\text{C}$). For the structure, we will use a high-quality refractory brick. The brick will then be covered with a ceramic insulation. Our tuyeres will also be made of ceramics to keep our incoming air as hot as possible, while keeping our mechanical bellows rig and our workers as cool. In total, we will need roughly 1400 refractory bricks and .75 cubic feet of ceramic insulation for our furnace. Additionally, we will need about 1620 regular bricks to build our platform.

The brick platform will be placed on level ground, since it is being constructed in an open field in Rhode Island, and in the center a small pit will be dug that will constitute the bottom most portion of the furnace. Once the pit is created the furnace will be constructed around it and then coated with a thin ceramic lining to ensure it is well insulated. The ceramic tuyeres will be constructed separately from the furnace but will be completed on a similar time scale, as they require time to dry. Once these elements are constructed the bellows will be connected to their heating apparatus. Upon the completion of each of these individual parts the entire structure can be assembled and connected to the power source.

Roughly, it seems as though construction of the furnace would take around two days. The furnace should not need to rest much before it is used; the bricks we are using to construct it do not require much resting time. Full heating would probably take a few hours to occur, perhaps half a day at the most. Based on data from Senn et al. the furnace would probably take in 25 kg of ore and 110 kg of charcoal fuel per smelt.

Because air flow is one of the few directly controlled variables in a bloomery smelting system, it is especially important to design a practical and functional air delivery system. Our bloomery will be supplied with air through bellows, which will be pumped by a worker on a bicycle. A mechanical system will convert the periodic motion of the bicycle's wheels to the

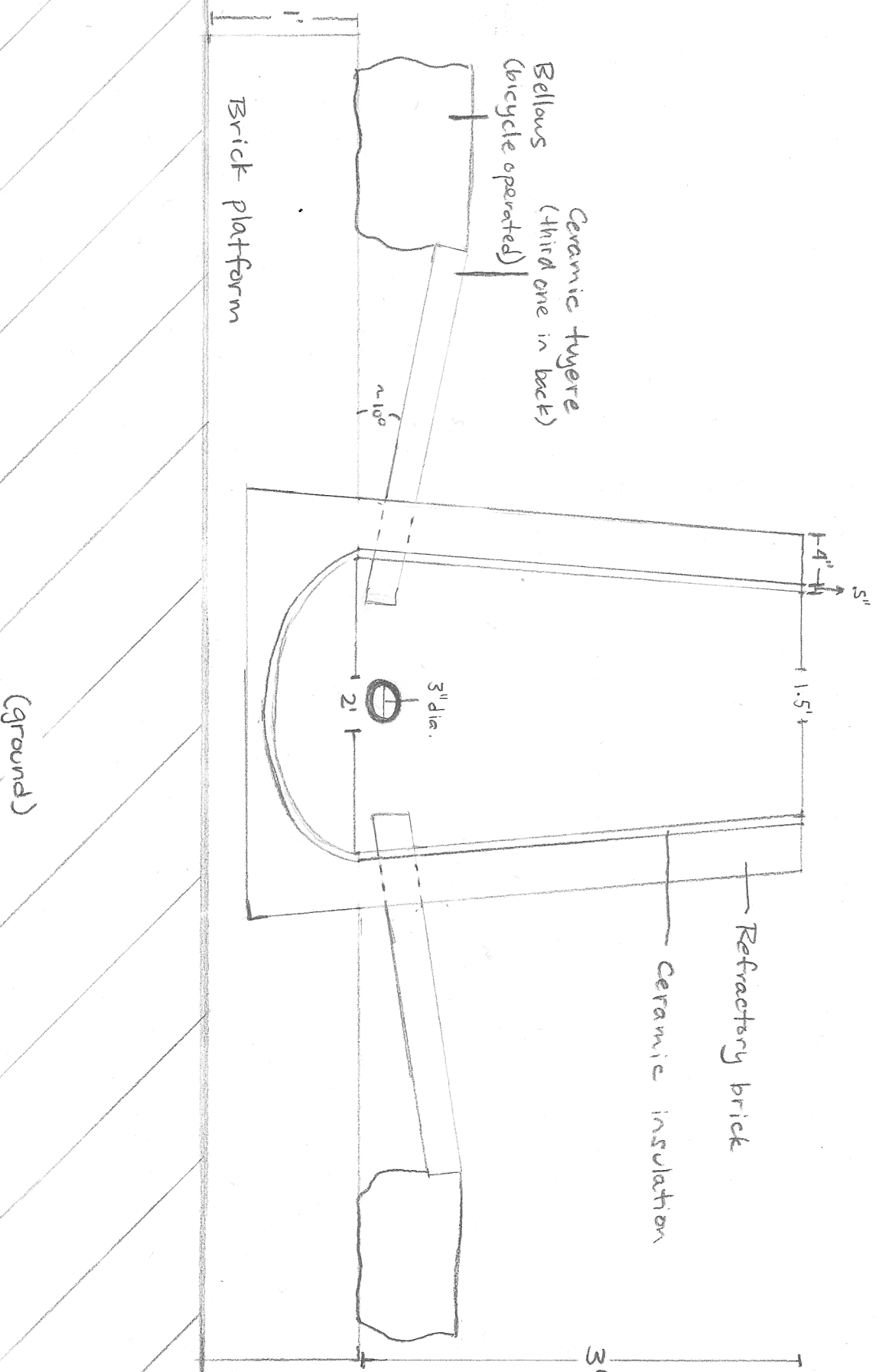
periodic motion of the pumping bellows. Using the bicycle as a power source has two distinct advantages. First, it allows the worker providing power to the bellows to work more comfortably, as the motion of riding a bicycle is a comfortable and natural one. Second, the rate of pumping of the bellows can be more precisely controlled this way, by either monitoring the pace of the bicyclist or by manipulating the different gear ratios present on the bicycle. Preheating the air is desirable, as it helps optimize the reducing conditions in the furnace, and this could potentially be accomplished by including a heating mechanism in the bellows themselves, such as electric heating coils.

Works Cited

Senn, M. et al. 2010. Tools to qualify experiments with bloomery furnaces, *Archaeometry*, 52(1).

* Drawings follow. Please note that the scale is 1 in. = 1 ft.

IRON BLOOMERY SECTION



IRON BLOOMERY ELEVATION

