DESIGN AND FABRICATION OF BALL MILL USING LOCALLY AVAILABLE RESOURCES

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ABSTRACT
In Nigeria, potters have been concerned with sourcing of materials for fabrication of ceramics equipment such as the ball mill since the imported ones appear to be beyond reach due to cost. These efforts seem not to have yielded much desired result because the equipment is still not common. This may be attributed to the cost of the materials for fabrication of such equipment even when they are locally sourced. Lack of production of ceramic equipment makes the setting up of small ceramic outfit difficult thus retarding the growth of ceramic industry in Nigeria. However, in the attempt to improve the chances of supply of ceramics equipment, these researchers embarked on the design and fabrication of a manual ball mill for use in studio ceramics production. Materials for the fabrication are locally sourced. A technical drawing of the equipment is made, parts were fabricated into shapes, assembled and a minimal low cost fabricated ball mill is made. It is hoped that this effort would enhance the possibilities of sustenance of ceramic cottage industries in Nigeria.

Introduction
Ceramics is a branch of industrial art that is concerned with the production of household objects from clay and subjecting them to heat treatment for permanence. Production of objects in ceramics, milling of materials such as glaze, clay and other ceramic chemicals is an unavoidable process. To do this required the use of equipment such as the ball mill. The unavailability of the equipment in Nigeria and other basic equipment required for ceramic production and effective studio practice due to cost propelled potters to fabricate using locally sourced materials. In spite of the efforts made by Nigerian potters, the equipment is still not available. No wonder Bazunu and Odokuma (2008) observed that, in Nigeria today, a metal sculptor can walk into a building equipment store; pick up an arch-welding machine, angle grinder, a vice, assorted clamps, metal cutters and a host of both manual and motorized equipment with much ease, but it is perhaps near impossibility for a Nigerian potter to walk into any equipment store and pick up any well finished equipment on a cash-and-carry bases.

In the attempt to find solution to the problem of equipment, Onu (2006) designed and fabricated a crank kick wheel using a combination of wood and metal. He observed that the aim is to stop dependency on foreign made wheels which cost a fortune to import and which has deterred a lot of people from going into ceramics production and those already in it left in despair. In another attempt, Egede (2011) also constructed an electric wheel having considered the difficulties involved either in cash or technicalities of the imported ones. Beside the above, Agberia (2000) fabricated clay extruder also in the attempt to solve the problem of equipment in Nigerian ceramic industry. He opined that in Nigeria however, because of the growing concern and interest for greater exploration of new ceramic forms and as a result of the urgent and aggressive need for full capacity utilization policy, it has

become necessary to improvise in the absence of non-availability of vital tools. Therefore, in the same vain to curb the problem of equipment plaguing the ceramic industry, hence this effort is made to design and fabricate a manual ball mill. All of these efforts and many others not mentioned in this work have yielded some tremendous results.
However, a ball mill is a mechanical device that grinds clay, glaze and other ceramic chemicals into smooth particles as it rotates. It is equipment required to reduce rigor when milling clay, during glaze mixing and in the process of milling other ceramic chemicals together. Pitelka (2007) regarded ball mill as a mechanically revolving vessel in which ceramic materials can be placed along with water and flint pebbles or high fired porcelain slugs used for fine-grinding of clay and glaze materials. In line with Pitelka, Speight and Toki (2004) defined ball mill as a rotating porcelain jar filled with approximately half-full with flint pebbles or porcelain balls that revolve and grind dry wet glaze materials or pigment into powder or refined liquid state.

Wikipedia, the free Encyclopaedia (2008) wrote that, a ball mill is a type of grinder used to grind materials into extremely fine powder for use in mineral dressing, processes, paints pyrotechnics and ceramics. It further explained that, a ball mill is a type of grinder, a cylindrical device used in grinding or mixing materials like ores, chemicals, ceramic raw materials and paints. In describing its operation, it noted that ball mills rotates around a horizontal axis, partially filled with material ranging from flint pebbles and stainless steel balls can be used as grinding media.

According to Rowland (2005) a ball mill is a device that can be used to grind chemicals much more easily and to a fine consistency than can be done by hand with a mortar and a pestle. He added that it is often useful to grind chemicals in order to increase their surface area. He further describe a ball mil as a key piece for grinding crushed materials, and it is used in production lines for powders such as cement, silicates, refractory materials, fertilizer, glass ceramics, dressing of both ferrous and non-ferrous metals etcetera. Milling of ceramic chemicals especially glazes makes it more homogenous and even consistency when applied on wares.

Beside the above, studio practice ceramics and ceramics production process entails a lot of techniques among which is milling. It is a process of reducing raw materials like clay into small fine particles in quick succession using machinery like ball mill. Thorough milling of ceramic glazes and other raw materials to their finest particle sizes enhances the quality and aesthetic value of ceramic products. Florez (2008) observed that apart from the common ball mills, there is another type of ball mill called planetary ball mill. She stated that the planetary ball mills are smaller than the common ball mills and mainly very small sizes.

In line with Florex, Odesola et-al (2000) wrote on a fabricated crusher called harmer mill capable of crushing rocky materials into powder. Also, Elsevier (2000) opined that, different types of high-energy rotating ball mill have been developed. These include the spex vibrating mill, planetary ball mill, high energy rotating cell loaded with several hardened steel balls.

In view of the above, these researchers deemed it fit to conduct a research on the fabrication of the ball mill using locally sourced materials as a measure to alleviate the challenges faced by ceramists in Nigeria. This effort is also a means of opening up the minds of future researchers in the direction of fabricating equipment for successful ceramic production. Materials were locally sourced, fabricated into shapes and sizes, assembled to achieve the ball mill which was tested for functionality.

It is expected that this study will improve studio ceramic practice in Nigeria by creating attitude of fabrication of equipment where necessary. It will also create job opportunities for young ceramists and other graduates as a result of the need to fabricate equipment. This effort of fabrication in large quantities will improve the nation’s economy thus addressing the bleak future of Nigerian economy as observed by (NEEDS 2005) and self-reliance instead of depending on foreign made equipment.

Equipment required for fabrication of parts of the Ball Mill
- Welding machine.
- Welding rods.
- Pipe threading wrench.
- Lathe machine.
- Measuring tape.
- Angle grinder.
- Spanners.
- Hacksaw.
- Cutter.

Materials used for construction of the ball mill
- 1x1mm angle iron
- 25mm rod
- 5mm flat pan
- 36mm pipe
- Bolts and nuts
- 3mm plastic sheet
- 6205 industrial bearings (4)
- Anti-rust paint.
- Gloss paint
- 2 ½ x2 ½ mm angle iron

Fabrication of parts of the ball mill
The Frame
The frame is made with 2 ½ x2 ½ mm angle iron measuring 80mm in length, 66mm in width and 76mm in height. It has a re-enforcement of 1x1mm flat irons at the top and a squared pipe at the bottom holding the four legs together with an opened end serving as the collection point. The angle iron at the two sides and the top 1x1mm flat irons serving as re-enforcement on the top has two holes each in the centre while one of the top horizontal 2 ½ x 2 ½ mm irons also has a hollow in the centre which the stopper is screwed on.

The Tank
The tank is made with metal pipe measuring 36mm in diameter, 50mm in length with a 16mm opening in the centre with a lid serving as the feeder point. One end of the pipe is permanently blocked with 5mm metal flat pan. The other opened end has a metal ring measuring 15mm in diameter welded round the pipe with ten holes at intervals in its end above the pipe. To ensure the coverage of the second opened end, a 5mm metal pan measuring 51mm in diameter with ten holes is made. A 3mm plastic sheet measuring 51mm in diameter is glued onto the circular pan to serve as a seal to guide against leakage. The pan is screwed firmly using ten bolts and nuts size to cover the opened side of the pipe. A 25mm stainless steel rod (shaft) is welded running across the centre of the pipe through the two side caps or covers of the tank. One end of the shaft is fabricated in cube shape and a threaded end.

The Turning Handle
The turning handle is made with a 16mm metal rod circular in shape. It measures 40mm in diameter. A 5mm flat metal pan with a squared shape hole in the centre is welded across to serve as reinforcement. A handle is attached firmly to the right end of the metal pan.

The Bearings, Bolts and Nuts
There are four 6205 industrial bearings used. The choice of this size of bearing made considering its strength and the weight of load it will carry. A total of twenty bolts and nuts of different sizes were used.

The Milling Balls
The milling balls are metals balls; they are twenty in number.

Assembling of parts in steps
Step 1:
The first step is to fix two industrial bearings on each side of the 25mm stainless steel rod (shaft) running across the tank.
Step 2:
The tank is mounted on the frame and having ensured that the bearings tally with the holes in the frame, it is screwed firmly against the frame using bolts and nuts.
Step 3:
The installation of the turning handle is the last step. The squared shaped hole in the centre of the turning handle is keyed into the squared shaped end of the shaft. To ensure a firm grip of both of the, it is screwed with a bolt.

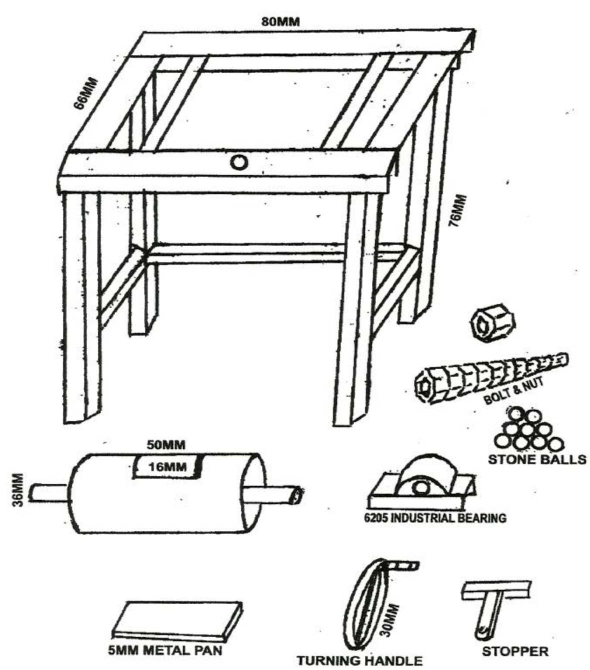
Testing the ball mill
The equipment was tested by milling glaze with it and it is successful. The plastic sheet used prevented leakage while the industrial bearings made its turning easy without the exertion of much energy. In another test of milling clay into slip, the strength of the industrial bearings and the firm nature of the

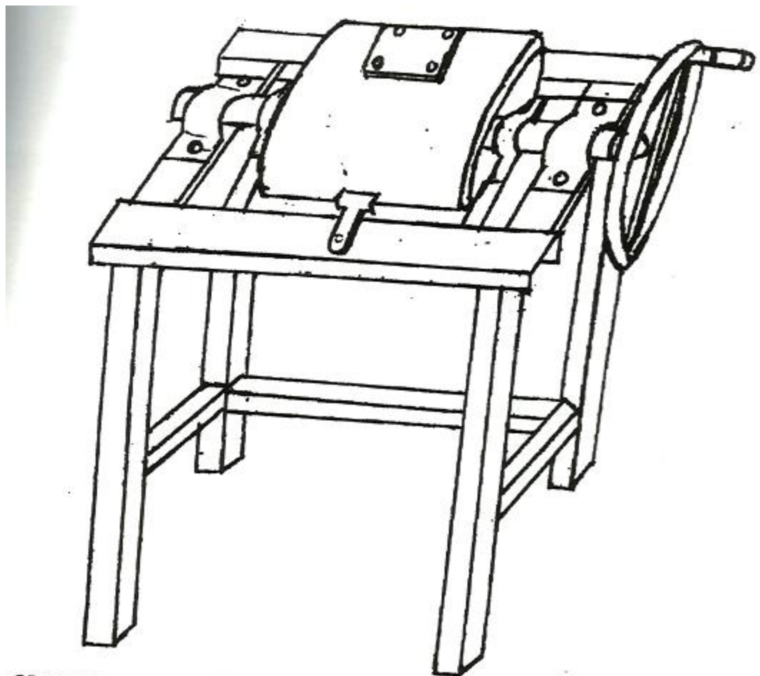
frame made it easy to carry the weight with ease.

Conclusion

The equipment is found to effective. It is constructed with very minimal cost since some of the materials used were locally sourced. It is simple in nature and manually powered. This makes it easy to adopt in ceramics production. Maintenance is also easy due to its simple technical nature. Therefore, the ball mill is recommended for use as it will enhance ceramics production and studio practice in Nigeria.

TECHNICAL DRAWING OF THE EQUIPMENT (BALL MILL) WITH DIMENSIONS





COMPLETE TECHNICAL DRAWING OF THE EQUIPMENT
(BALL MILL)

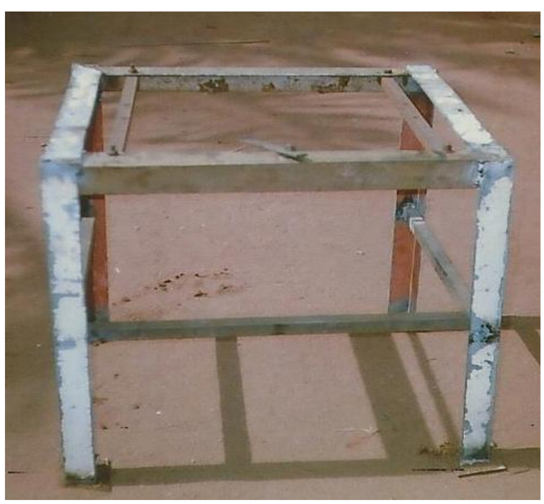


Plate 1: The frame.

Plate 2: The tank

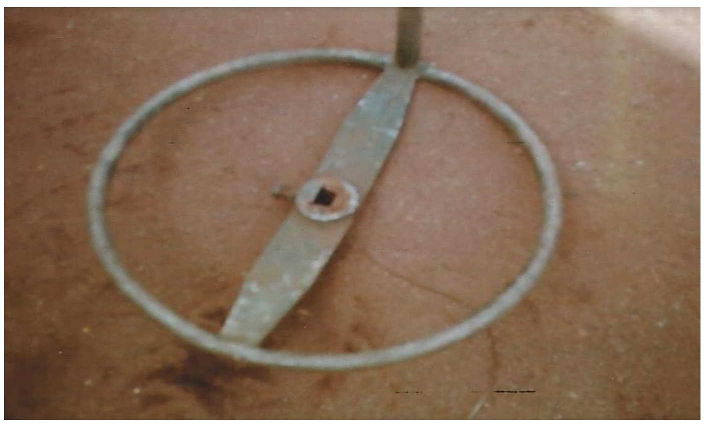


Plate 3: The turning handle.

Plate 4 The bearings

Plate 5 The milling balls.

Plate 6: The tank with two industrial bearings fixed on each side of the shaft.

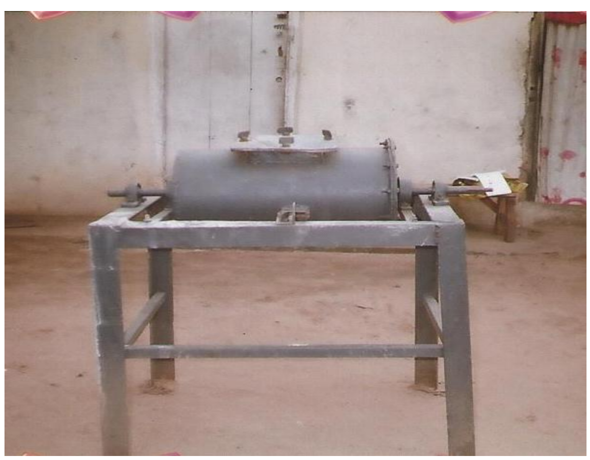


Plate 7: The tank mounted on the frame.

Plate 8. The complete ball mill.

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