DESIGN AND FABRICATION OF MANUAL STUDIO GLAZE BALL-MILL

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Abstract: In availability of basic tools for ceramic development and maintenance has been a challenge to many ceramists in developing countries. Ball mill is one such equipment that is lacking. Ball mills are used for making glaze preparations, to further decrease the particle size of ceramic materials into a minute state. Most potters fabricate their own tools and machines in their effort to be self-reliant. To this end, this paper, "design and fabrication of manual studio glaze ball-mill" details an illustrated step-by-step procedure for designing and fabricating basic Studio Glaze Ball mill, using locally available materials in order to minimize cost. The machine comprises frame, inlet, handle, and chamber. It has capacity of tonne per hour (t/h) mill processing. This machine comes handy, and therefore serves as a call to potential potters from developing countries to attempt fabrication of equipment necessary for the ceramic studios. It finally concludes by recommending the equipment to every ceramic studio, pottery homes and to Institutions in developing countries where power supply remains a challenge. It is hope that this effort would enhance the possibilities of substance of ceramic cottage industries.

Key world: Design, Fabrication, Ball mill, Cottage industries and Production.

Introduction

In many developing nations, including Nigeria, where power supply"electricity" is not guaranteed to power ceramics equipment all the time, the quest for the fabrication of local machinery for self-reliance has forced people to engage in the fabrication of some essential and/or necessary equipment. (Uzzi, 2008) and (Etuokwu, 2016). This is confirmed from the numerous workshops, conferences, and seminars, as well as from the final-year student projects in many universities. Every studio potter desires the Ball mill, which is a straightforward piece of equipment. Simple manual Baw mills might only have the cylinder hung on a rigid metal platform with two bearings supporting the cylinder's center rod and operated by hand. The cylinder needs to be hefty in order for the machine to build up enough momentum to move at the desired speed. The wheel in the wards of (Leach, 1976: 67), according to him, "consists of a wheel disk, which revolves with considerable momentum and smooth control of speed and is driven by hand, foot, or by gear." A flywheel or a heavy wheel head is used to generate the momentum.

However, some Ball mills have always been connected to one issue or another. Due grinding the epileptic power supply in our current communities, the electric Baw mill has not been a complete solution to the potter's difficulty in this area. One of the objectives of setting up a manual studio Baw mill is to "ensure that its adaptability shall adequately provide efficiency even in the absence of electricity, making it a reliable source for production of pottery wares" (Agberia 1999:18). The lack of a Ball-mill in the ceramic workshop has therefore presented a significant challenge to the potter and calls for an urgent remedy. Therefore, efforts are made to build manual Studio Ball-mill utilizing materials that are readily available locally in order to ease the potter's problem in looking for a dependable mill that would withstand the test of time for his pottery output. The mill is a crucial and practical instrument for making glazes in the ceramic workshop, and its presence also improves the environment. But in the past, the Ball-mill had been created by previous researchers using a different operating system, which he found to be inconvenient, therefore the new. The original design, shown in Plate 1, was built such that it could be powered by electricity or a motor.

Plate: 1. Electric Glaze Ball Mill.

Plate 2. Hand Turning Glaze Ball Mill.

But in this new design, the hand pedal has been incorporated so that the machine could be operated manually. See plate 2, It is possible to integrate the functionality of the marble stone and the raw materials thanks to the substantial cylinder employed in this innovative design. Because of this, the hand pedal could be turned just enough to register a speed that would allow the mill to pick up speed and start mixing the raw ingredients. (Primmer, 1974: 193-194) asserts that the flywheel's weight (or the wheel head's weight) "provided the necessary momentum and the potter was able to vary the speed with his foot. He continued, "It is difficult to achieve the necessary speed and pressure if the weight of the flywheel is insufficient." As a result, the weight of the wheel head and/or flywheel is crucial to the functionality of the potter's kick wheel. However, in this instance, the weight of the cylinder and the marble stones inside the cylinder provide the necessary speed by hand spinning. The hand turning pedal, which is a novel addition to this design, allows the potter to control the speed at which the mill runs. The effectiveness of the mill and its high speed control enable a potter to appropriately combine their glazes depending on the material's particle size.

Requirements:

Some of the materials required for the construction of the Studio Ball mill are as follows-

1. Cylinder (Stainless steel or galvanized) 16 gauge 56mm
2. Medium size 'H' iron rod (or any other solid metal)
3. 16mm to 20mm thick metal plate – 16 gauge thick flat metal plate
4. 3.8cm angle iron bar
5. 18mm bolts and nuts- (4 pieces)
6. Welding equipment.
7. Marble stones
8. 2 Bearing
9. 6mm iron rod- ½ inch twisted rod to line inside mill (50mm)
10. Pipe (1 length)
11. Rubber washer for covering mill opening

Construction Procedure

A skilled metal fabricator or welder will be essential to help the artist with the fabrication in order to have a friction-free Ball mill.

The Framework

The four-footed assembly's framework is tightly welded in some spots to hold the weight of the cylinder, the marble stones, and the rod inside the cylinder. To achieve the requisite rigidity and stability, the legs are built using solid 5 cm galvanized angle pipes. It is advisable to employ welded metal construction, according to (Primmer, 1974:194), to get the requisite rigidity in the structure. It is possible to use any other solid metal rod (or hard wood), though. A rigid structure for stability and longevity is created by bracing this with angle iron bars. (Plate 3)

The four legs include additional angle bars that are right-angled and riveted to them 31 cm from the top. As a result, the cylinder bearing will have a sitting. (Plate 3) On the uppermost part of the framework, angle bars are also used to create seats for the bearings, which will support the cylinder after it is attached. Also welded to the top of the four foot will be a reasonably thick flat plate or angle bars measuring 25 cm by 25 cm, which will serve as the cylinder's supports. The machine works well at heights between 70 cm and 75 cm.

Plate 3: Ball mill Framework and cylinder Stand

Plate 4: The side view of the Cylinder Seating

The hand turner

A 1.3cm galvanized pipe could be effectively used in the construction of the hand turner. The center of the cylinder rod that passes through the bearing sitting has this formed into a 60 cm long "Z" shape, and a bolt and nut are used to attach it there. Having a hinge-like system welded to it 20 cm from the top, this is situated on the frame in an upward position. The bearing on the cylinder's right side is attached with the same-sized pipe by welding, with a 10 cm projection. On the opposite end of this pipe projecting, a flat plate measuring 5 cm long is welded. To enable unrestricted movement without resistance, these two constructs are coupled and loosely attached together with a bolt and nut. This device allows the user to freely turn the machine by hand by employing metal washers at the place where the bolt and nut make contact with the machine. (Plate 5)

Plate 5 A. The Assembly of the Hand Pedal.

Plate 5 B. Showing Hand Pedal key

The Cylinder

The cylinder is constructed from thick metal pipe that is 56mm in length and 30mm in diameter, with a 16mm opening in the center. A lid serves as the tender point. The pipe's one end is a metal flat pan with a 5mm metal permanently block. With ten holes spaced evenly along its end above the pipe, a metal ring with a diameter of 15 mm has been soldered around the other opened end. A 51mm-diameter, 5mm-thick metal pan with ten holes is manufactured to ensure that the second opened end is covered. Ten bolts and nuts of the proper size are used to firmly screw the pan to the pipe's entrance side. Through the two side caps or lids of the cylinder, a 25mm stainless steel rod (Shaft) is welded that runs through the middle of the cylinder. The shaft has a cube-shaped, keyed threaded termination on one end.

Plate 6. The cylinder

Plate 7: The cylindrical tank with the flat pans welded
To cover the sides and the shaft passing through the center

As shown in Plate 8, cut three lengths of the twisted rod to exactly 50mm long, the length of the cylindrical tank. These three twisted rod lengths are welded to the inside wall that runs from one end of the cylinder to the other, with equal spacing between each length. The main drawback of using a regular still pipe is that it may cause the glaze or other milling raw materials to discolor. This drawback may be overlooked or tolerated, but it may be desired by an artist potter who wants to add unique effects to his glazes or pots.

Cutting the cylinder opening

The metal cylinder is made from a 10 mm thick plate and has a 30 cm diameter. An acetylene gas torch is used to carve the circle to perfection after measuring its size with a compass. The metal plate's center is then welded with a 20mm nut so that it may be fitted onto the 20mm shaft bolt sticking out of the top of the axel. The metal plate must be heavy enough and sufficiently thick. This will make it easier to build up the necessary momentum for turning the cylinder quickly and easily. With a sharp tool, concentric circles are also drawn on the plate's opposite side. (Plate 6)

The cut cylinder has a small 27mm flat bay welded on top of it with holes at both ends that allow 10mm bolts to pass through to lock the cylinder opening during rotation.

Plate 8: The cylinder tank with 16mm opening at the center

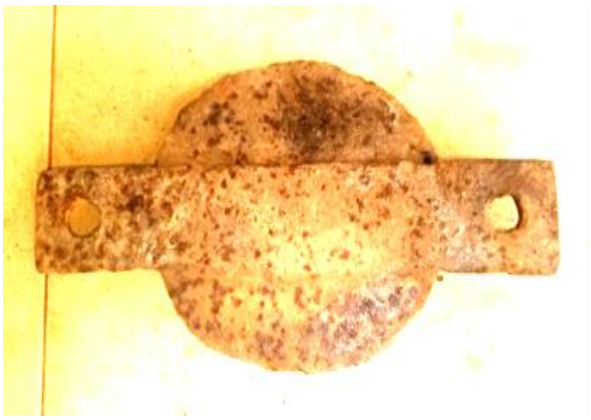

Plate 9: The cylinder cover with welded 27 mm flat bay for locking

Plate 10: The cylinder bearing

Plate 11: The cylinder bearing bolt and nut

Plate 12: Mable stones used as grander (various sizes)

Coupling the Ball mill

After the framework has been completed, the cylinder is put on the space allocated for it and securely bolted down using a bolt and nut. The coupling of the hand turning handle comes next. The bearing is then fastened on both sides so that the cylinder's shaft clearly protrudes from the aperture that has been made at the base (center) of the cylinder. After being screwed to the platform, the mill bearing is next put onto the shaft that projects outward from the cylinder. With this the ball mill is completed, assembled and ready for use. The assembled machine could be coated with high quality enamel paint for an ideal presentation. (See Plates: 13.

Plate 13: Coupling the Baw mill:

Plates 14: The Completed and Assembled ball mil

Results And Discussion

Plates 15: Glaze milling

Plates 16: milled Glaze

Plates 17: Collection of slurry Glaze

The result shows that the work was built with 100 percent metal welded in order to make it strong and durable. The materials are strong enough to mix glaze to the desired state. The glaze material must be poured into the storage mill. Then a certain amount of water is poured inside depending on the amount of the glaze to be mixed. After the glaze is mixed to a desired slurry state, the top cover

can then be opened for the glaze to rush through into a basin.

Discussion Of Findings

Form the pictures presented above; ball mill machine was built in stages welding each material to the other. Each stage of the construction was successfully and the machine is capable of mixing a considerable amount of glaze to a slurry state, pictures of the result has been presented above.(Plates 15 to 17)

Features

The following characteristics were given special attention as this ball mill was being developed and built, placing a high importance on effectiveness and economy:

1. Robustness; the iron bars and rods used to finish the framework are made of high gauge metal.
2. Very minimal effort is required in turning with hand pedal to attain the required speed for turning.
3. The flame is constructed in such a way that space for bucket or container to collect the mixed glaze materials to eliminate messy working environment.
4. The maintenance cost is very minimal.
5. The Baw mill is well engineered for rapid and reliable mass production of ceramic glaze materials.
6. The operating mechanism is reversible. It operates both clockwise or counters clockwise for both left hand and right hand throwers.
7. Easy to install
8. Minimum space requirement. You only need just a very small space in the studio or workshop to install the equipment.
9. Apart from milling the glaze, the equipment could also be used in the milling of all other ceramics raw materials into very fine particle sizes.

Analysis, Conclusion and Recommendation

It has become necessary for potters to individually fabricate different types of equipment, including the potter's Manual Ball mill, locally to equip their various studios in order to facilitate pottery production in a developing nation like Nigeria where there is this advocacy for self-reliance and self-sufficiency in the development of machinery and equipment. Building and operating a homemade ball mill is a difficult task, but most potters eventually manage to create one for them. In addition to the financial benefits of building your own tools, like the manual Ball mill, there is also the delight and satisfaction of building and utilizing a successful mill. There is nothing like getting started and doing it yourself; resolving issues as you go truly increases your understanding of the equipment, its design, operation, and maintenance.

However, a lot of consideration, math, and study went into creating this extremely effective apparatus, and I'm hoping it will significantly lessen some of the difficulties most potters have. Due to the fact that operating this glazing Ball mill requires relatively little time and energy, it can easily be compared to the performance of an electric mill. However, because it pays, it is crucial to build new equipment with the greatest materials available.

The workmanship and component parts are of the highest caliber, and the machine is powerful enough to mix up to 25 kg of glazes. Anyone, from the beginner (armature) to the professional, can use it because it is made for intensive use in the studio. Any local environment can be used to purchase the materials needed to build this mill. As a result, it is possible to create high-quality mill locally for the creation of pottery in ceramic workshops.

The ball mill is designed to solve the most recent generation of production glazing equipment, which is focused on addressing a number of crucial needs, such as higher productivity, control, and lower energy usage. It was created to satisfy the rising demand for ceramic goods to be produced in large quantities. This device will be crucial for anyone operating a small pottery or cottage ceramics business. A good professional potter could glaze a respectable number of pots in a very short period of time utilizing the grinder or ball mill, and products can be manufactured easily in a few minutes.

Without mentioning or knowing about glazed goods, a discussion of pottery is scarcely comprehensive. A pottery studio or workshop that doesn't have a grinder or ball mill for blending grains is only a half-finished one. Potters' familiarity with the mill has made it simple for skilled potters to glaze products for mass manufacturing of ceramic goods. Etuokwu defended the aforementioned assertion by pointing out that all ceramic studios, pottery homes, and potters use this easily installed, inexpensive equipment because it works so well for making glazes in particular. It is basic and straightforward to use. Just weigh out your basic components for the glaze and put them in the mill along with just enough water to create a glaze slip. In the event of a power outage, operate by turning the handle or firmly screwing back the cover with the rubber washer. All that is required to create your own finely ground glaze or raw materials is to run the ball mill for one to two hours at a relatively low speed of 50 to 70 rpm.

This study should therefore serve as a challenge and an appeal to interested studio potters to develop an interest in making essential tools for their own usage in the studio rather than turning to expensively priced market purchases. It is envisaged that this Ball mill will help researchers in various study areas of equipment manufacturing and acquisition gain a new perspective on the practical and functional knowledge of ceramics. For those who enjoy ceramics, it will also encourage an effective learning program.

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