Ball Mill

A ball mill is device that can be used to grind chemicals much more easily and to a finer consistency than can possibly be done by hand with a mortar and pestle. It is often usefull to grind chemicals in order to increase their surface area. This will generally increase the rate at which they react in a pyrotechnic composition and make mixtures more homogenous which results in a steady burn rate. For making good quality black powder at home a ball mill is essential, and black powder is needed in very many pyrotechnic devices.

Note: ball milling inevitably causes friction and shocks and possibly leads to static electricity buildup as well depending on the design. Ball milling of mixtures should only be attempted when an appropiate place is available to operate the mill (ie one where it causes no damage or injury in case of explosion) and it must be turned on and off remotely. Most chemicals can be milled more safely but several sets of balls and containers must be available to prevent contamination and milling of metal powders can be dangerous as they may become pyrophoric.

Materials

I used whatever I could get cheaply to construct my mill, so you will probably not be able to get the exact same materials and have to improvice somewhat.

Motor: I used to use a electrically powered drill to drive my mill, but several people have advised against it as these are not designed to operate for extended periods of time. They tend to get excessively hot and eventually fail. Old motors can be found in many places for little or no money. Washing machines for example contain durable motors and are often plentifull at scrap yards. Mine came from a pump from an old coffee machine.

Container: A piece of PVC sewer tubing works well. I use a 34 cm long 11 cm diameter piece, with two fitting end caps. PVC is hard and will not suffer from erosion as much as most other materials I've tried. This container has lasted about 150 hours of operation thus far and shows no visible signs of wear. One point of discussion is that PVC may accumulate significant amounts of static electricity during operation. I've tested if the container is able to attract small chips of polyethylene right after use, which it doesn't. I'm not entirely convinced PVC is harmless though. For some more ideas on this matter, check out this page on the charging of powders in a rotating drum. Strips of rubber from a bicycle tire are glued around the casing with hot melt glue to improve its grip on the roller.

Roller: The roller is conveniently made of PVC tubing as well. I used 2.5 cm outer diameter sewer tubing, but the diameter may be chosen depending on the speed of the motor availalable. The ratio of 2.5 cm (roller) to 11 cm (container) yields a factor 4.4. reduction in speed. As the motor operates at about 250 rpm, the container would theoratically rotate at a rate of about 60 rpm. In practice it reaches 50 rpm due to slipping. Somewhat faster would be more efficient. It used to operate at 80 rpm when

I was still using the drill, and black powder would be ready in 3 hours. Now, it takes 5 hours to obtain a similar quality, but the time gain is not worth an expensive tool. The roller is coated with rubber to improve grip on the container. I did this by sliding the ends of cut inner tube from a bike tire on the ends of a piece of 2.5 cm PVC tubing. Inflating the tube allows it to slide over the PVC as the air escapes.

Media: Most of the money was spend on media. I bought 150 lead balls of 1.78 cm diameter in a hunting supplies store. They are used for reloading rifles. Lead and brass media are preferred as they don't spark. Sparks could accidentially ignite the mixture you are milling, with disastreous results. Other media such as glass, steel or ceramic can be used for pure chemicals and non explosive mixtures but not for ignitable substances. How much media will you need? I recall that it is most efficient to fill exactly half of your container with balls. My container is 11 cm diameter and 34 cm length, which took 150 lead balls of 1.78 cm diameter.

Assembling

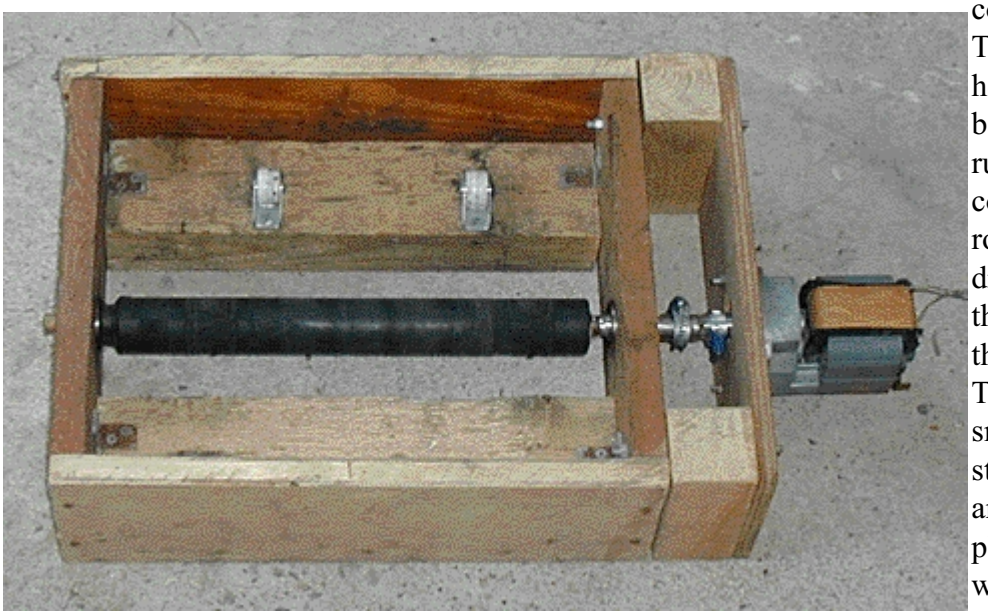
Constructing the mill is fairly simple. The pictures below illustrate the principle. The container rests on the roller and two small wheels. A copper rod lengthwise through the roller is driven by the motor on the right.

Using the mill

Ball milling can be dangerous. It inevitably causes friction and shocks that could ignite a mixture. Depending on your container and media material and the substance you are milling the process can generate static electricity as well. Milling metals can make them pyroforic. When a mixture ignites inside the mill the results can obviously be disastrous. The explosion will produce large amounts of shrapnell from the media and the milling container that can be hurled away hundreds of meters. Under no circumstances should you attemp to mill explosive mixtures such as black powder inside or near a building. Operate it on a piece of open terrain and turn the ball mill on and off remotely. Barricade it with sand bags. You can often safely mill pure compounds, but be aware that metals (which can be milled with steel media) can become pyroforic and ignite when you open the milling container (thereby letting oxygen in). Pyroforic metal powders can be very treacherous. They do not necessarily ignite immediately (although it could happen), but after some time when you think they are safe since there has been no reaction upon contact with air. When ignition occurs expect a large, extremely hot ball of flame, the burns of which can easily cause a painfull death. Use your common sense when ball milling and be prepared for the worst.

I do not know wheter the materials I chose for my ball mill (PVC and lead) generate static electricity. I have prepared many batches of black powder in my mill (using a wet process) and have not had any accidents so far. Any comments on the above design are very welcome (wfvisser@dds.nl).

Pictures



This shows the basic construction. The black horizontal bar is the rubber-covered roller, driven by the motor on the right. The two small white structures are small plastic wheels, such as are used under furniture.

The container consists of a section of PVC tubing with fitting end caps. The picture shows some of the lead media (1.78 cm diameter lead balls), and a few chunks of charcoal. These will be broken up in the mill in a matter of minutes. Strips of rubber are glued around the container as

shown to improve its grip on the roller.

The container where it belongs.

Back to main page