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Volume 3, Issue 6

Build Your Own Corning Machine

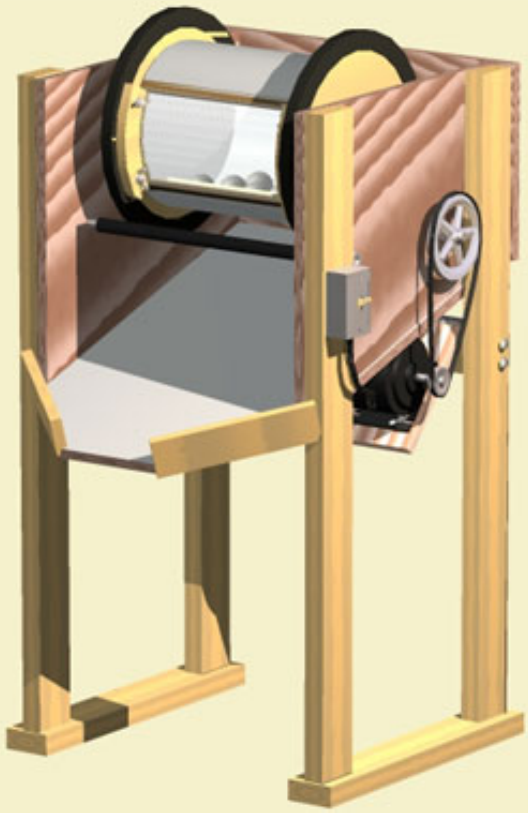

Figure 1: A simple corning machine that screens as it corns.

Materials:

- (4) 48" 2x4s
- (2) 24" 2x4s
- (1) 23" 2x4
- (2) 11-3/8" long 1x4s
- (1) 26" x 14" 3/4" plywood
- (2) 23" x 22" 3/4" plywood
- (1) 32" x 23" 3/4" plywood
- (2) 16" diameter disks 3/4" plywood
- (2) 11" diameter disks 3/4" plywood
- (1) 14" long 1/2" wood dowel
- (4) 14" x 1/4" x 3/4" wood strips
- (1) 10" x 14" screen
- (12) 3-1/2" long 1/4" lag screws
- (12) 1/4" washers
- (1) box 1.5" #8 wood screws
- (1) 8" pulley
- (1) 2" pulley
- (2) 2" swivel casters
- (1) 26-3/4" long 5/8" rod
- (1) 24-1/4" long 5/8" rod
- (4) 5/8" collars
- (4) 5/8" ball bearings
- (2) 21" long 5/8" I.D. heater hose
- (2) 3" hinges
- (1) 14" long 11" I.D. tube or pipe
- (4) 2" long 1/4" stainless bolts
- (4) 1/4" stainless wing nuts
- (1) 32" bike tire innertube
- (1) switch box
- (10) pool balls
- (1) 4L400 40" drive belt

Unmeasured:

staples, formica, contact cement, motor mounting hardware

Introduction:

With the increasing price of commercial black powder, many pyro hobbyists are trying their hand at making their own. The process is pretty straight forward: mill some good quality meal powder, perhaps using some home-made hardwood charcoal, then compress it into hard pucks and break them apart. Screen the crushed particles into the various sizes you want and there you have it.

Most pyros already have a ball mill and various screens. Hydraulic presses are readily available on the market or easily made. However, it is the process of breaking up the pressed chunks of powder, known in the trade as "corning," which results in the most tedious labor when making home brew black powder. The simplest and probably most common method for corning is to take the chunks and break them apart using the end of a wooden bat or some other blunt, non-metallic object. However, this method is time consuming and a little nerve racking for some. Even though black powder is very stable with regard to friction and impact, the corning operation is still the source of most accidents in commercial manufacture.

Corning BP by hand also results in more work, since the grains must be repeatedly screened during the process to

keep from crushing the grains that are already the desired size. Without frequent screening there will be an overly large amount of "corning dust," which is the name given to the fine grains leftover after corning. Corning dust is too fine to be used for any kind of lift or break charge, yet too grainy to be used as meal powder. While corning dust has some good uses such as dusting over prime slurry or freshly made black match, the amount resulting from any corning operation is optimally minimized.

The two most common approaches to corning involve either impact or a grinding action. Some hobbyists feed large chunks into a set of parallel grinding rollers that have pyramid shaped teeth on them. The rollers are geared to roll in opposing directions toward each other, thus grabbing the chunks and pulling them in as they are ground. This method reduces corning dust and time spent screening, but is still a manual operation conducted at close proximity.

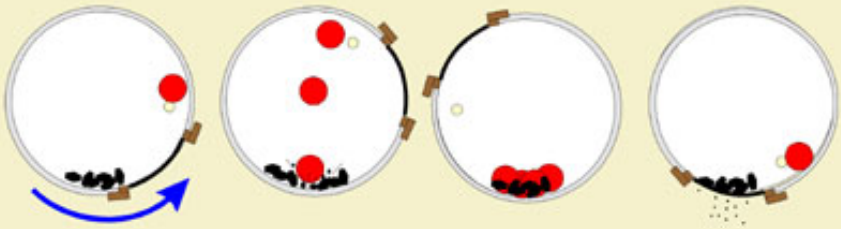

Figure 2: Corning and screening cycle for one full revolution.

The ideal corning machine should operate unattended, produce a minimal amount of corning dust and output a variety of grains that need no further grinding. The machine I have designed here does just this, and can process about a pound every fifteen minutes. The machine, shown in Figure 1, operates like a large ball mill with a screen built into the side. Each revolution of the large drum results in an impact stroke and a screening stroke.

As seen in Figure 2, the low RPM corning drum contains a single lift bar and a half dozen or so grinding balls such as billiard balls or something similar in size and weight. The lift bar catches the balls and carries them to the top of the drum, at which time they free fall to the bottom and strike the powder grains that remain at the bottom of the drum. The lift bar then comes back around and collects the balls while letting the powder grains pass between them. The powder then passes over the screen port, which removes any grains that have been reduced to the correct size. Because small grains are removed as they are produced, only the larger grains that still need to be reduced are subject to further impacts.

This impact/screen cycle results in faster corning with less corning dust while also freeing up the operator to do something else with his time. I find that this machine can corn powder at about the same rate that I can press it, so I will let the machine work on one 1000 gram batch of pressed chunks while I prepare the next 1000 gram batch.

The catch box built around the rollers also make an excellent area for screening the finished product, since there is plenty of room to vigorously shake the screens and the chute makes collecting the results easy. I place a table under the mouth of the chute so that the grains can be swept out onto a sheet of poster board for easy transfer into screens, containers or wherever it needs to go.

The remainder of this article describes how to build the machine shown above. A future article will describe the entire process for using this machine in conjunction with a ball mill and a press for making commercial quality black powder.

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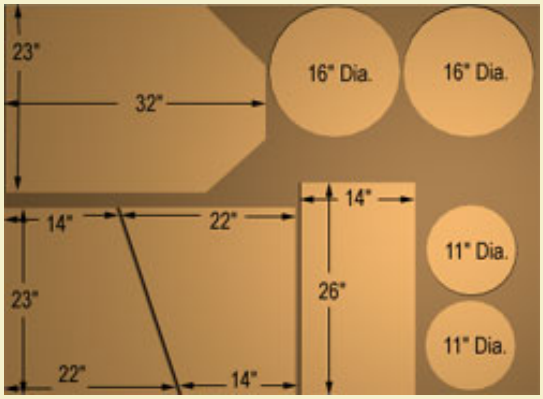

Figure 3: Cutsheet for 3/4" plywood pieces.


Figure 4: Components for building the corning drum.


Figure 5: Single 1/2" lift bar located 2" from

The Corning Drum:

The corning machine consists of two major components: the corning drum and the roller stand (similar to a milling jar and the mill). Figure 3 shows the dimensions for the plywood pieces required for both the drum and the stand, which are cut from 3/4" thick plywood. The two 11" diameter disks need to be laminated on one side with sheets of Formica to protect the wood and provide a wear resistant surface. The large 32x23 piece, which will be the bottom of the chute that guides the powder away as it is corned, also needs to be laminated on one side with Formica so that the powder can slide easily across it.

The most difficult part to locate when building this project is a suitable piece of pipe to use for the rolling drum. The dimension of the drum will determine a lot of other dimensions, so what you wind up using may change many of the dimensions shown here. The dimensions shown here are for an 11" diameter drum that is 14" long with 1/4" thick walls. The stand will work for a range of diameters up to about 16" diameter, but the width is set specifically for a drum that is 14" long plus an extra 1.5" added by the end disks, giving a total drum width capacity of 15.5".

The corning drum must be pretty large in diameter in order to give the pool balls plenty of distance to pick up speed when they are falling. The drum must also be resistant to wear and provide a sturdy surface to pound against. The ideal material would be a segment of 16" diameter thick walled PVC, which I just happen to have recently obtained from a fellow pyro to use for this purpose. The thicker the tube wall is, the less it will absorb impact and the more effective the corning action will be.

Since 16" diameter PVC is not an easy thing to come by, the machine shown here was made using a segment of 11" diameter cardboard tube which can be purchased in some home improvement stores. These are used as forms when pouring concrete columns and are available in a variety of different sizes, although they are surprisingly expensive. They are spiral wound with about a 1/4" thick wall.

First make the two ends of the drum, which are created by gluing the 11" disk centered over the 16" diameter disk. Since it is hard to clamp these together, it is best to use screws in addition to the wood glue. If you wait to laminate the smaller inside disk after the two have been glued together, you can use the laminate to hide the screw heads.

drum wall.

Figure 6: Edge view of screen frame assembly.

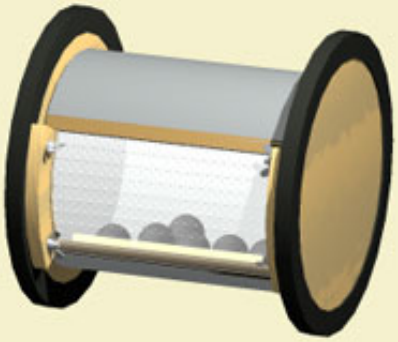

Figure 7: Completed corning drum.

Figure 8: A corning drum after several years usage.

After the end disks are glued together, line the outside edges with rubber strips cut from a bicycle innertube. This rubber edge will serve to reduce wear on the rollers and produce better traction. The innertube is split down the side and then stapled from both sides while pulling it tight around the edge of the 16" disks. Figure 4 shows the two end disks completed. Before installing these, you will need to drill a 1/2" diameter hole measured 2" from the edge of the inner disk to the center of the hole. These holes are used to hold the lift rod and should be 3/4" deep.

Note that the location of the lift bar is critical to proper operation of this machine. The lift bar must be positioned so that the balls are released prior to reaching the peak height of rotation. This is because the optimal landing point of the balls is dead center on the bottom of the drum, but the forward velocity of the balls resulting from the speed of rotation means that they must be dropped early in order to account for their forward arc. Thus the lift bar location is subject to change based on the size of your corning balls and the speed of drum rotation. The 2" mark given here is specifically for billiard balls used in a drum rotating at 16 RPMs.

Since the cardboard tube used here is not as rigid as PVC or other materials, a corning machine made with this type of drum will not be able to break fully dried powder chunks. But it will work just fine if you corn your chunks right after pressing them when they are still slightly damp but dry enough to snap with a crisp crack when broke apart by hand. If your pressed pucks do not break with crisp sharp edges after pressing, you are not pressing them hard enough or long enough.

Because the cardboard will not hold up well to friction and does not provide a solid surface to pound against, the inside of the tube must be lined with Formica. This can be a bit of a challenge, but it is easiest to do if you remove the segment of wall where the screen will be installed first. Mark two points on the rim of the tube such that a straight line between them measures 7-1/2", then draw guide lines down the side of the tube for cutting with a hand saw or utility knife.

Once the screen slot is cut from the tube wall, fasten the tube to one of the end disks using screws around the edges. This will help hold the tube in place while applying the Formica inside. Make sure the hole in the end disk is located just behind one edge of the screen slot as shown in Figure 5.

The Formica is cut to size and trial fitted before applying any contact cement, then the inside of the tube and back side of the Formica are coated with contact cement. After about 15 minutes when the cement is dry, the Formica piece is carefully rolled up and placed into the center of the tube without touching any part of it. Make contact with the tube wall at one point and then uncoil the Formica slowly from that point outward on both sides. Any excess around the screen slot should be trimmed.

The 14" long lift bar is now inserted into the hole and the other end disk is put in place. The lift bar need not be glued, which will allow you to replace parts easily later on.

The screen that slides over the side port is made by clamping two

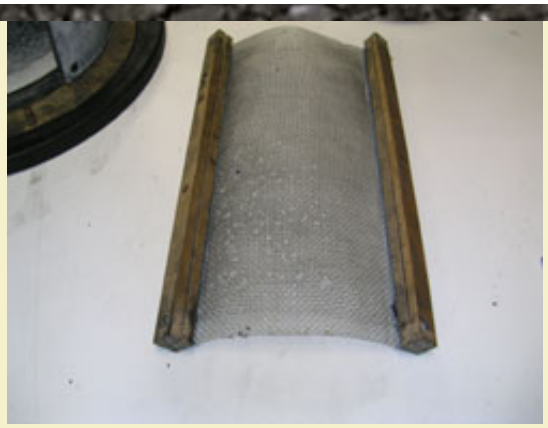

Figure 9: Interchangable screen design.

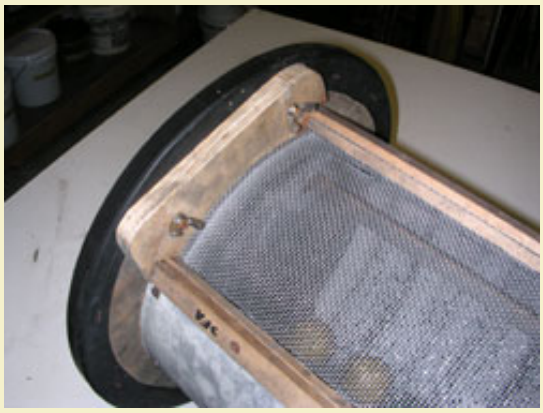

Figure 10: Closeup of screen clamp block.

Figure 11: 16" diameter PVC with 1" thick walls for ideal corning drum.

edges of a 10" x 14" long piece of strong screen between two 1/4" hardwood slats on both sides, as seen in Figure 6. The slats are screwed together so that the overhang faces inward from the edges of the screen, then they are folded over so that the screen passes over the bottom of each piece as seen in Figure 6. This allows the screen to sit flush with the inside of the drum and prevent powder from getting hung up at the junction between the drum wall and the screen.

The screen is held in place by two wooden blocks at each end. These blocks are cut with an 11" radius where they will bind the screen against the end disks of the drum as seen in Figure 10. They are held in place by two bolts that are countersunk from the outside edge of the support disks and held on with wing nuts for easy removal. The bolts should be positioned so that the screen frame pieces can slide under them without the need for removing the bolts, since the screen will need to be slid open every time the drum is loaded. Note that all metal hardware should be stainless steel, not only to eliminate spark risks but also to avoid corrosion caused by nitrates or damp outdoor air.

More...

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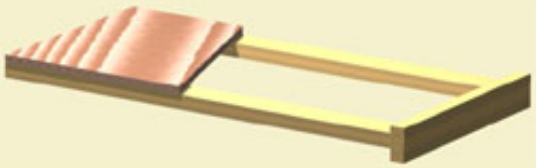

Figure 12: Assembling side panels flat on the ground.

Figure 13: Side panels fastened together with the back panel.

The Rolling Stand:
The roller stand shown here is simply a box built around a set of rollers where the corning drum will spin. The bottom of the box is angled downward so that the grains that fall from the corning drum can be carried away from the under the drum.

Start by cutting out all the plywood pieces, then locate the two side pieces and mark where the holes for the rollers will be drilled. These will be 12" down from the top and 5" from the edge of each side. Start by drilling a countersunk hole half way through the plywood on the outside of each panel. The diameter of this hole should be equal to the outside diameter of the ball bearings you have. You will most likely need to use an adjustable hole cutter to make this hole a snug fit with your bearings, then use a chisel to carve out the center that the hole cutter leaves behind.

Stamped bearings are ideal for press fitting into this hole, since the outer flange around the edge of the bearing will keep it from getting pulled through the hole. If using this type of bearing, you can actually drill the large hole all the way through the plywood. Otherwise you can drill the remainder of the hole with a 1" dia. bit, which should produce a hole large enough for the rubber heater hose to fit through.

Once the side panels are cut and drilled, cut four 4 foot long 2x4s to use as the leg supports for the stand. Align two legs at each edge of the side panels and screw through the side panel into the legs while the assembly is flat on the floor as seen in Figure 12. Be sure that you don't create two left or right sides, as one should mirror the other.

A 2 foot long 2x4 foot is now fastened to the bottom of the legs on each side assembly, as seen in Figure 12. This is done using the 1/4" lag screws, which must be countersunk so that the wood sits flat on the floor.

The side pieces are now stood upright and the back panel is clamped in place and screwed into the 2x4s as shown in Figure 13. Note that the back panel should extend all the way to the outside edges of the 2x4 legs.

Once the back panel is secure, flip the unit upside down and align the bottom panel. This panel should be laminated on one side with Formica prior to assembly. The Formica will provide a smooth surface for the powder to slide across, as well as make the surface easier to clean. It may be easier to cut the angled front corners after the panel is test fitted in place so that you can mark the exact point where the overhang meets the side walls.

Figure 14: Inverting the corning stand to fasten the bottom panel.

Once the bottom panel is fully fabricated, attach it to the bottom by screwing around the perimeter into the edge of the plywood side pieces.

The unit is now turned upright again and the hardware components are installed. The 5/8" ID heater hose pieces are slipped over the steel roller bars, then the bars are passed through the holes in the side walls. The bearings are slipped over the ends and then press fit into the side panels. The bars are now kept from sliding out of place by securing shaft collars on both ends. Note that the longer bar goes in the back set of holes, and the extra length is applied to the right side where the drive pulley will be attached. The 8" drive pulley should be installed to make sure it does not rub against the support legs at this point.

A single 2" dia. swivel caster is fastened at the center point between the two roller bars at the top edge of each side. These are used to prevent the drum from traveling to either side and rubbing against the side walls during operation.

The angled edges of the chute are faced off with pieces of wood as seen in Figure 15. These are screwed into the edge of the chute panel and serve to guide the powder out the front of the unit.

Lastly you are ready to attach the drive motor to the unit. A cross bar is first screwed into place 8" down from the bottom edge of the back panel using two 1/4" lag screws on each side, as seen in Figure 16. The motor is bolted onto a plywood plate that is then mounted to this cross piece using hinges as shown. A 2" pulley is fastened to the drive shaft and aligned with the 8" pulley above it.

The motor used here is a 1/2 H.P. AC motor with built in starting capacitor and runs at 1145 RPMs. The rotation speed of the drum is not real critical as is the case with ball mills. If built exactly as shown here, the drum will rotate at about 16 RPMs. The speed could be increase a little, but rotating the drum too quickly will tend to throw the balls too far forward and they will miss their target at the bottom of the drum. There are no problems with lower speeds other than less efficient milling times.

Usage Notes:
The drum should be placed on the roller so that the lift bar always rolls ahead of the screen panel. If the drum rolls clockwise looking from the right side, then the lift bar should be to the back of the machine when the screen is in the loading position, otherwise the lift bar should be at the front. The basic idea is to make sure that the grinding balls do not roll over the screen during operation.

Note that the screens can be easily changed to produce different sized powder grains. The screen represents the largest size grain that is desired, since there will always be many grains smaller than the screen size that will be produced. However, using smaller screens such as 40 mesh in an attempt to produce only 4Fg size powder will result in a higher percentage of corning dust.

With a 15 mesh screen, this machine will yield about 40% 3FA, 35%

Figure 15: Installing roller bars and casters.

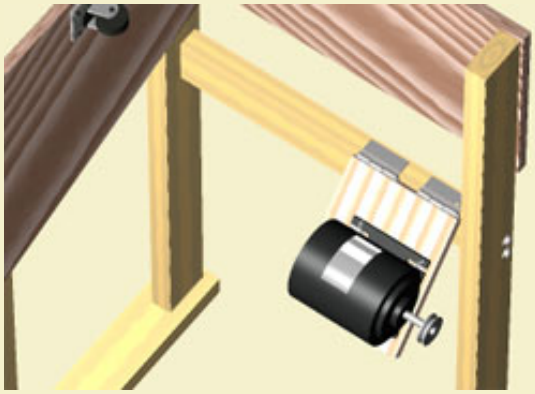

Figure 16: Installing the motor using a hinged plate.

4Fg and 25% corning dust. These percentages will vary depending on how well you pressed your powder cakes before putting them into the machine. Overly damp or crumbly cakes will naturally result in a higher percentage of corning dust.

I like to break the pressed powder cakes into large pieces by hand before placing them into the machine, otherwise they may get stuck or ride the lift bar up with the drop balls. Much of the powder gets carried up and dropped with the pool balls anyway, so pre-cracking the cakes may not really be necessary. From the sound of the machine, it appears that the powder that gets carried up is the first to fall from the top of the drum, then the pool balls come crashing down shortly after.

Figure 17 shows an attempt to automate the screening process so that it occurs during milling. A second pulley was added to the side and powered from the drive roller. An off-center arm is connected from this wheel to a box of stacked screens mounted on a swivel cradle such that each rotation of the wheel rocks the cradle back and forth. The idea was for the powder to fall down into this continuously rocking box of screens, which were stacked in order from most coarse to least, and the grains would be shaken down to settle on the various screens. However, much of the powder tends to collect on the chute into a big clump that slowly slides down into the screen all at once. The rocking action provided by this setup was not adequate for getting the powder to settle out, so it tended to just collect in a big pile on the first screen. A much more aggressive shaking motion would be required for something like this to work, so I eliminated this part of the design and just do the screening by hand.

This machine is really no more difficult to build than a ball mill, and the work it will save you is well worth the work required to build it.

Figure 17: Variation using rocking screen stack to sort grains while corning.