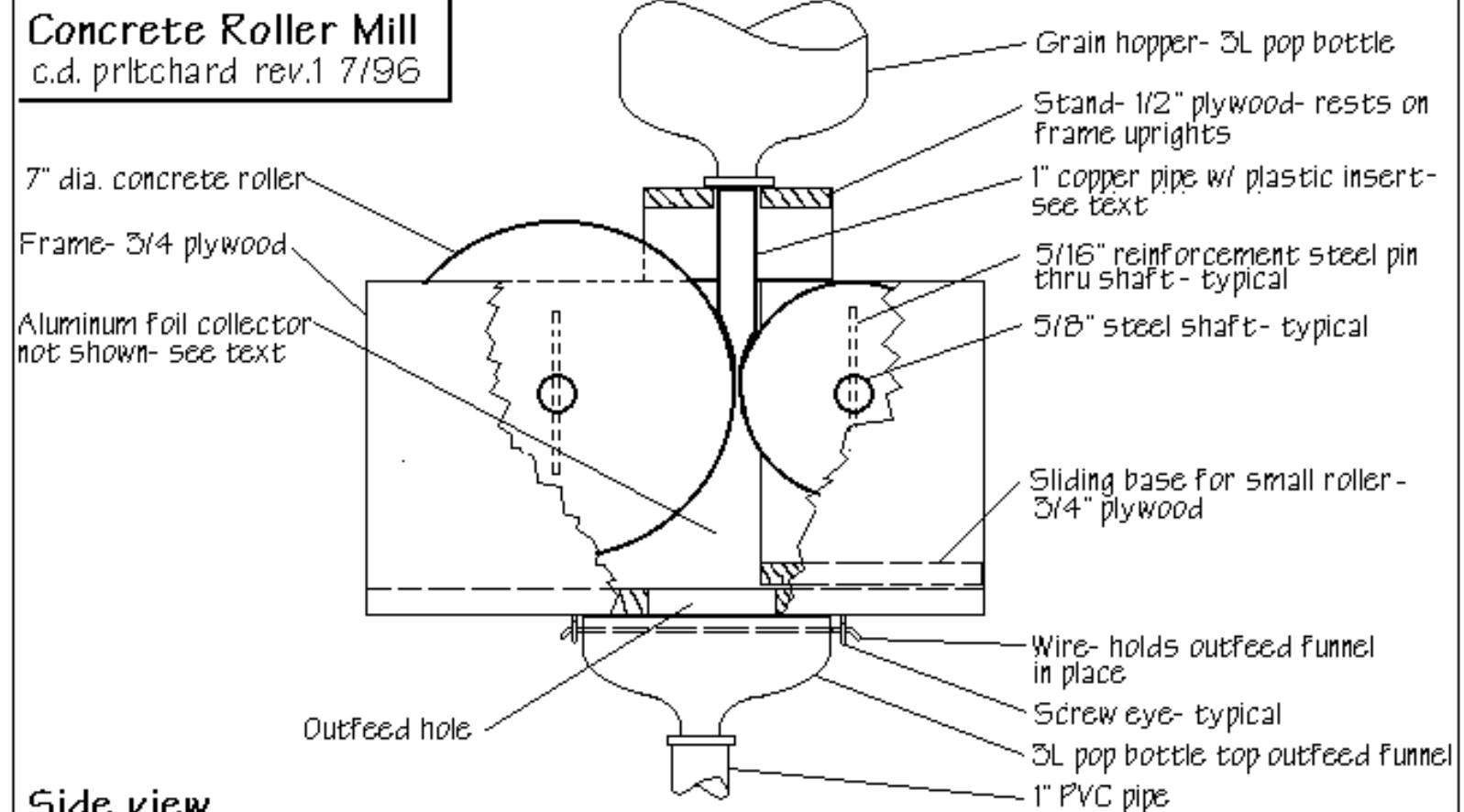


Concrete Roller Malt Mills

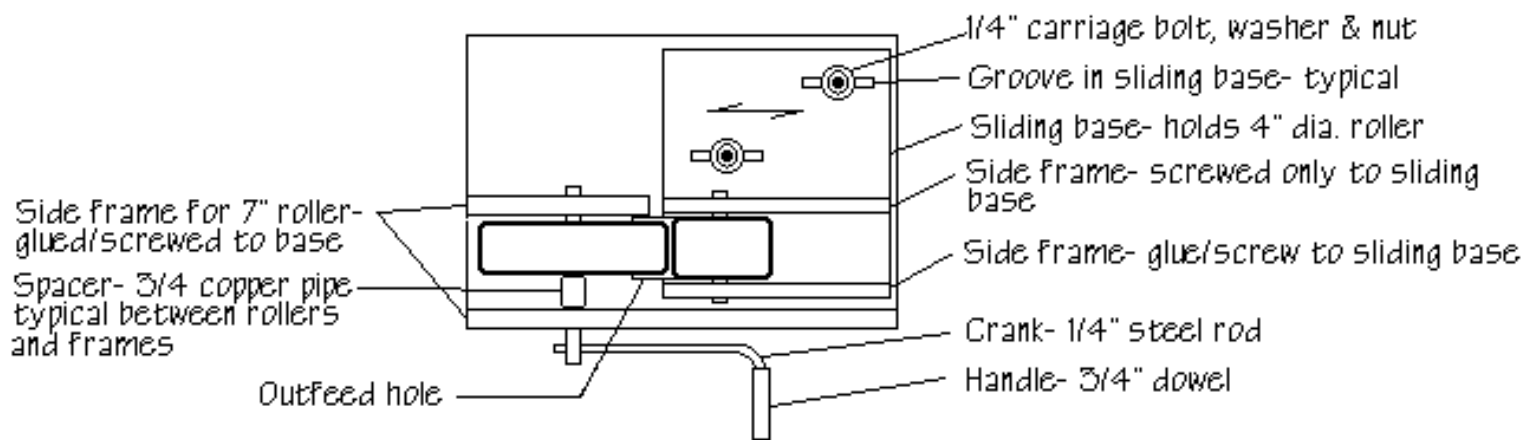
c.d. pritchard - Rev. 2 7/24/05

Most of this page details the third version (rev. 2) of a concrete roller malt mill which was built in '96. I've built two more [mills](#) since then and built two [previously](#). Rather than a whole new page, I've just added update info. If/when I quit experimenting, I'll post details on the "final" mill.

Mill, rev. 2



Side view



Top View

Note: Infeed hopper omitted for clarity

The rollers were cast using fast setting concrete. It is made by QuikCrete and comes in 10 pound plastic

pails and larger bags. It does not contain any gravel. A 4" PVC pipe cap was used as a mold for the smaller roller. A 5/8" hole was drilled in the base of the pipe cap to accept the shaft. A shaft for the roller was made from 5/8" steel rod. A pin made from a short piece of 5/16" steel rod was inserted into a hole drilled in the shaft. This is embedded in the concrete and helps bond the concrete roller to the shaft and ensures torque is transferred well (i.e., without the pin, the roller would likely slip on the shaft). The pin could just as well be made of 1/4" steel rod. The shaft assembly was inserted into the hole in the pipe cap and plumbed. A rather stiff mix of concrete was made (stronger but a bit harder to get all of the air voids out), poured to a depth of about 1.75" in the mold and rodded and tamped well. After the concrete set (about 24 hours), the pipe form was removed by cutting slots along it's periphery with a table saw and then prying off the plastic in chunks.

Construction of the larger 7" diameter roller was similiar except a plastic bucket was used as a mold. It was cut away with a knife rather than using the table saw to cut slots.

The frame consists of two separate pieces- a base and frame for the big roller and a smaller base/frame for the smaller roller. The later frame/base rests on the former and slides back and forth giving one a means for adjusting the gap between the rollers. Two carriage bolts inserted up throught the bottom base and through grooves in the top (small roller) base are capped with washers and nuts. These secure the sliding base/frame in place after the gap has been adjusted. The frame was made from 3/4" plywood (use the strongest and densest stuff you can find!) The rollers were then mounted into wood frames with cheap ball bearings similiar to those used on the little red wagon you had as a kid. The bearings were friction-fitted into holes drilled in the side-wall frame pieces. One of the two side frames for each roller is permently affixed to its base with glue and screws while the other side frame is removable- it's affixed with screws only. The removable side walls are necessary for installation and removal of the rollers.

The handle was fashioned from 1/4" steel rod stock. It is friction-fit to a hole in the shaft to allow for removal for storage and so a pulley can be used for powering the mill. The handle shaft was peened to a rough square shape where it met the mill shaft and the hole in the shaft was made roughly square and slightly tapered.

The rollers were a tad out of round and each had a slight taper so I used a right angle grinder with a masonry disk to true them up- did it by rotating the roller while applying the grinder to the periphery of the roller. Using a drill to spin the rollers speeds the job and gives a better result.

The infeed hopper was made from the top 3/4 of a plastic pop bottle. The infeed tube (between the hopper and the rollers' gap) was made from 1" diameter copper pipe. It's very difficult to get the bottom, business end of the pipe shaped to match the surface of the two rollers. If it doesn't fit well, grain will escape without being milled. Taking the easy way around the problem, I roughed the copper tube somewhat to shape, leaving it with a 1/8" or so clearance from the rollers, then inserted a rolled-up piece of thin (.05 or so) semi-flexible plastic into the infeed tube. Friction alone holds the thing in place. The resulting plastic inner tube was allowed it to extend a bit past the shaped end of the copper tube. The edge of the plastic tube was then shaped to conform to the rollers' surface by applying the tube to the rollers as they were turned thereby grinding away the plastic. I chucked a drill to the roller shafts to do the grinding- alternately spinning one wheel and then the other until the end of the plastic inner tube conformed well to the rollers.

The infeed tube/hopper assembly is mounted through a small "U" shaped frame made from 3 pieces of 1/2" plywood. This assemby the rests on the top of the roller side frames. A pin in the top the top of each of the two fixed frames marries with holes in the bottom of the assembly to ensure it's properly located.

The drawing does not show the aluminum foil "collector" used for collecting the milled grain and channeling it through a square hole in the lower base to the outfeed. It's made from a double layer of heavy gauge aluminum foil. I toyed with the idea of making this thing from plastic or aluminum flashing but the complex shape which is necessary dissuaded me. The foil is easily shaped and is held in place with staples. The outfeed is fitted with a funnel made from the top 1/4 of a 3 liter plastic pop bottle. A length of 1" PVC pipe is fitted to the neck of the funnel. The pipe carries the milled grain to the collection container (a garbage bag wire-wrapped to the pipe). The bottle is held to the frame with wire inserted through holes in the thing and through two screw eyes on the underside of the frame. This admittedly ain't elegant, but it works and allows the thing to be removed for more compact storage.

For powering the mill, I tried using a direct-coupled 1/2", 350 RPM drill. It was too fast- a lot of grain was thrown from the mill due to the high surface speed of the large roller and the grind contained a lot of flour. I then tried a 1-1/2" pulley on the drill and a 6" pulley on the shaft of the large roller. Much better! Turning the mill by hand results in a through-put of about 1 lb./min.- plenty fast for me, so, I seldom use the drill to power it.

To use the mill, I clamp it to the top of my workbench- it projects over the edge which allows the outfeed funnel thing to be affixed.

Performance

I've put over 50 pounds of pale ale, cara-pils, crystal and other speciality malt through the mill so far (7/96). It is holding up well and does a very good job of milling. Very little if any glazing has occurred on the rollers as happened with the first mill versions. Even with the rough surfaces and the fact that the smaller wheel is not powered, the malt husks come out largely intact- certainly an improvement on the performance of the prior single-roller mills which used a tangential steel plate. The required turning torque is (a guess!) about 8 ft-lb to start the milling and about 4-6 ft-lb after it's started.

Minor problems I've encountered

When the mill is started, about 1/2 the time you have to give the small roller a flick to get it started. Powering both rollers would solve this problem but, doing so adds a lot of complication to the mill's design. I'm leaning toward mounting a pulley on each shaft with a round cross-section belt connecting them. (BTW, if anyone knows where I can buy order such belting (about 1' long or so), I'd *really* appreciate hearing about it!) I figure I'll twist the belt into a figure "8" so that the rollers counter-rotate. If this doesn't work, some idler pulleys will be necessary. At least one will be necessary even with the figure 8 belting to allow the belt to be mounted. With different size rollers, the right diameter pulleys are critical to ensuring the surface velocity of the two rollers is the same. OTHO, maybe a slight difference in velocity would yield a better grind???. *(Update: see below for more info on driving both rollers)*

The infeed hopper assembly infrequently raises itself slightly for some reason (vibration?). This allows some grain to pass through unmilled. Not enough of a problem for me to do anything about it yet- I just push it back on. *(Update: Simply adding weight to the hopper assembly virtually eliminated this.)*

When milling some slightly sticky crystal malt, about 10% of the milled grain particles followed the rollers around instead of dropping into the collection hopper. Not enough of a problem to fix at this point. Perhaps a piece of foil (ala the collector) acting as a roller scraper would work...

(Update: This is much less of a problem with the rev. 3 mill. I think I was pre-wetting the malt with too

much water way back in '96)

There seems to be a bit of give in the system- probably due to the sloppy fit of the bearings in the frame. I've noticed that very hard grain (cara-pils) doesn't get ground well without narrowing the gap between the rollers. Methinks it's due to the sloppy bearing mounting hole (I free-hand routed the holes rather than drilling them. Next time, I'll use a forester bit and I'll strenghten the wood around the hole by soaking it in instant glue. *(Update: This was due to the base and roller supports not being strong enough to withstand the lateral force from the rollers. See lessons learned below for more info. Although the wood around the bearing held up well, I did use instant glue on later mills.)*

I use a powered leaf blower to clean the mill after use. If I'm not careful, it severely deforms the aluminum foil collector. I'm more careful now and live with this. BTW, always clean your mill after use. I store mine in the shop and found lots of bugs and spider webs on it after not cleaning it before storage. Storage in a plastic bag would help if your anal about cleanliness. *(Update: I've ditched the bogus collector thing. Store mill in plasitc Rubbermaid bin. Put soft foam tape on lid to better seal it. Becuase it's convient/easy for me to do, I still blow out the mill with a leaf blower before storing.)*

Update:

Over 150# of malt were milled with good results with this mill but I wanted better performance so I made some more mills.

Later Mills

These were constructed much like the rev. 2 mill detailed [above](#). Big differences were:

Rev 3.

This one had two ~6" dia. x ~3" wide adjustable rollers with only one driven. I also used brozen oil-filled bushings instead of cheap ball bearings used on prior mills. The larger diameter (and maybe also the large mass) caused the undriven roller to stop turning a bit too often for me- maybe every third time when starting milling after stopping with no grain in the gap. That was not a big problem since I just had to give the undriven roller a flick to start it. I gave up on the mill after a drop to the concrete floor broke a roller. Due to the high torque required to hand-crank it, I didn't want to recast another one.

Rev 4. (current mill)

This mill has two ~3" wide adjustable rollers which were cast in 4" PVC DWV pipe so they are just under 4" in dia. Only one is driven. I'd initally worried the smaller diameter rollers wouldn't pull the grain through so I used a bit coarser sand (masonry sand) than with previous rollers. The surface texture of the rollers is about like that of used 120 to 150 grit sandpaper. The smaller diameter of the rollers reduces the cranking torque required. The current feed chute is 3/4" copper pipe instead of 1" as on rev. 2 since I ran out of 1" tubing. I recently started driving it with a 350 RPM drill (Millwalkee 1/2" Hole Hog). I've not yet calculated the milling rate, but it's really fast- especially when compared to hand cranking! My guesstimate is that it puts out at least 5 lbs/min. It's crude in appearance but I'm happy with it after milling a bit over 50# of malt.

See [lessons learned](#) below for other changes.

The Next Mill

The next mill I hope to build some day will have 2" or 3" dia. x ~8" long rollers. The rollers will be fixed, i.e. a nonadjustable gap in the usual sense. Instead, the axis of the rollers will be nonparallel so the gap will vary across the length of the rollers. The grain bin and/or its feed chute into the gap will be adjustable laterally so the grain can be admitted at a varying location across the length of the rollers. The crush could perhaps approximate that of 3 roller mill by varying the width of the feed chute, having multiple feed points or by varying throat width of the feed chute. It will have a better means of collecting the milled grain than the pop bottle/PVC pipe affair which is sort of flimsy.

Earlier Mills

Original Version (rev 0)

This used the 4" concrete roller which is detailed above and a tangential steel plate which tilted thereby allowing for an adjustable gap width. The surface of the roller glazed over with a brownish material after about 5 pounds of malt was run through it. Wire brushing the surface removed the glaze and restored its ability to feed. Judging by the color of the dust from the milling and the pH of the mash, I don't think I got much, if any, concrete in the malt. No big problem, just a nuisance.

Second Version (rev 1)

I recalled an old post to HBD which stated that large rollers don't require texturing so, I casted a 7" roller using a plastic bucket for a mold and mounted it to another frame with the same tangential steel plate. It also glazed over also so I added texturing with a cold chisel- 1/16" deep grooves every 1/2" or so. It worked fairly well; however, it took (a guess) 7-10 ft-lbs to turn it. The concrete takes a groove better if done within a day of casting.

Lessons Learned:

Some things I've learned from building, using and otherwise playing around with mills:

1. Use relatively coarse sand to enhance the ability of the rollers to pull grain thru the nip. Rev. 4 used masonry sand which is fairly easy to get and (literaly) about as cheap as dirt. It doesn't mangle the malt husks into dust as much as I'd feared- even when I don't pre-wet the malt.
2. Trying to homebrew a way of driving both rollers was difficult. I've given up the effort based on the good performance of rev. 4. Gears are an obvious choice but are very expensive and difficult to obtain in the diameters I want. Then there's the hassle of fastening them securely and accurately to the roller shafts. On mill rev. 4, I played with a 1.5" dia V pulley on each roller shaft coupled with "belts" arranged in a figure 8. The first "belt" was a very quick and dirty affair consisting of a bunch of rubber bands which broke fairly quickly as they rubbed together at the middle of the "8". Next try was a "belt" made of vinyl tubing spliced using smaller dia. tubing and glue. It was a bitch to install (had to demount one roller) and the splice broke during testing. It had the same rubbing problem as the one using rubber bands. BTW, to test without milling, I created some drag on the undriven roller's shaft using a wood block with a hole and a saw kerf with a clamp across it. Using a belt ore maybe a chain/sprockets in a serpentine configuration to avoid the rubbing might work but would require more pulleys or sprockets and make the mill much larger, much more costly and more of a PITA to design and build.
3. High strength and/or high early strength portland cement is a good idea- not to reduce wear of the rollers but to avoid breaking the rollers if you are impatient or sometimes clumsily like me. I cast one ~3" wide roller made

with normal strength cement using 4" dia. PVC pipe as a mold. Rather than removing the roller by sawing kerfs axially into the pipe and prying away the chunks as I usually do to remove the cast roller, I wanted to try using release oil on the inside of the pipe for easy removal of the cast roller. I tried to remove the roller after only a week and ended up breaking a chunk out of the roller. As noted above, rev. 3 of the mill met its end due to my dropping it and breaking a roller.

4. 7-ply, 3/4" birch faced plywood is easy to get and cheap but is a bit weak for the application. The base of the current mill has a relatively large opening to allow the milled malt grain to exit the mill and not enough wood on either side. This coupled with a relatively weak method of fastening the vertical pieces which hold the roller to the base allowed the gap to widen during milling. This turned out to be a good thing in a way. I added a clamp type affair which drew the tops of the vertical roller supports together. It affords a very easy and quick way to fine-tune the gap between the rollers. Even better, adjustment can be made while milling. The next mill will be constructed using stronger plywood, oak or maple.
5. Wetting the malt the night before before milling helps keep the husks intact. This allows for a higher flow through the bed during mashing. Since I use a RIMS, a high flow is very important. Add too much water and the malt will tend to stick to the rollers. This doesn't interfere with milling but does either waste malt if one just blows it out after milling the grain or requires spending some time trying to collect the malt from the innards of the mill.
6. I tried milling several rounds of malt twice with a wider than normal gap the first time. I could tell very little difference in the grind.
7. Voids in the surface of the roller from bubbles in the concrete are much less of a problem now that I vibrate molds with an oscillating sander just after pouring. A vacuum bag approach would work even better.
8. Use PVC DWV pipe as molds and the thin temporary PVC pipe caps as the bottoms of the mold. They fit inside the pipe and are intended as temporary caps to keep foreign materials out. It's easy to accurately determine the center of them so the roller shaft is well centered and the need to grind the milling surface is greatly lessened. I secure the caps with several layers of electrical tape wound on very tight.

Some tips on milling are [here](#).

Page Revisions:

- r1, 7/96- ?
 - r2, 7/24/05- Added info on later mills, updates on problems with rev. 2 mill and work-arounds, and added other updates here and there.
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