

A Fifty-Pound Truck-Tire Rock Tumbler: Specifications and Experiences

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Once upon a time I started collecting rocks. Much, much later I completed designing from scratch, building, and debugging a rock tumbler capable of grinding about 50 pounds of rocks at once. The story of how I got from “there” to “here” is entertaining, but I’ll save it for an appendix... First I’ll describe what I built.

I got some good ideas and parts from other people, but I didn’t look for any design plans to follow. Despite lots of forethought, I encountered many problems to resolve or rebuild. Maybe this document will save you from doing your own prototyping -- or at least amuse you.

1. Basic Design

Visit your local tire shop. Find yourself a worn-out but usable truck tire... The bigger, the better, but be sure:

1. It’s not so big that you can’t physically maneuver it -- empty.
2. It’s not so big or odd that you can’t find a replacement someday.

Next, visit an industrial supply store like Grainger. Buy four pillow block bearings (about \$10 each), sufficient compatible-diameter cold-rolled steel rod, and an adequate motor. (Of course you always might be able to scrounge these from another source.) What size and speed motor is required? I don’t know, but I used 1725 RPM, 4.5 amps (1/3 HP?) and it’s probably overkill.

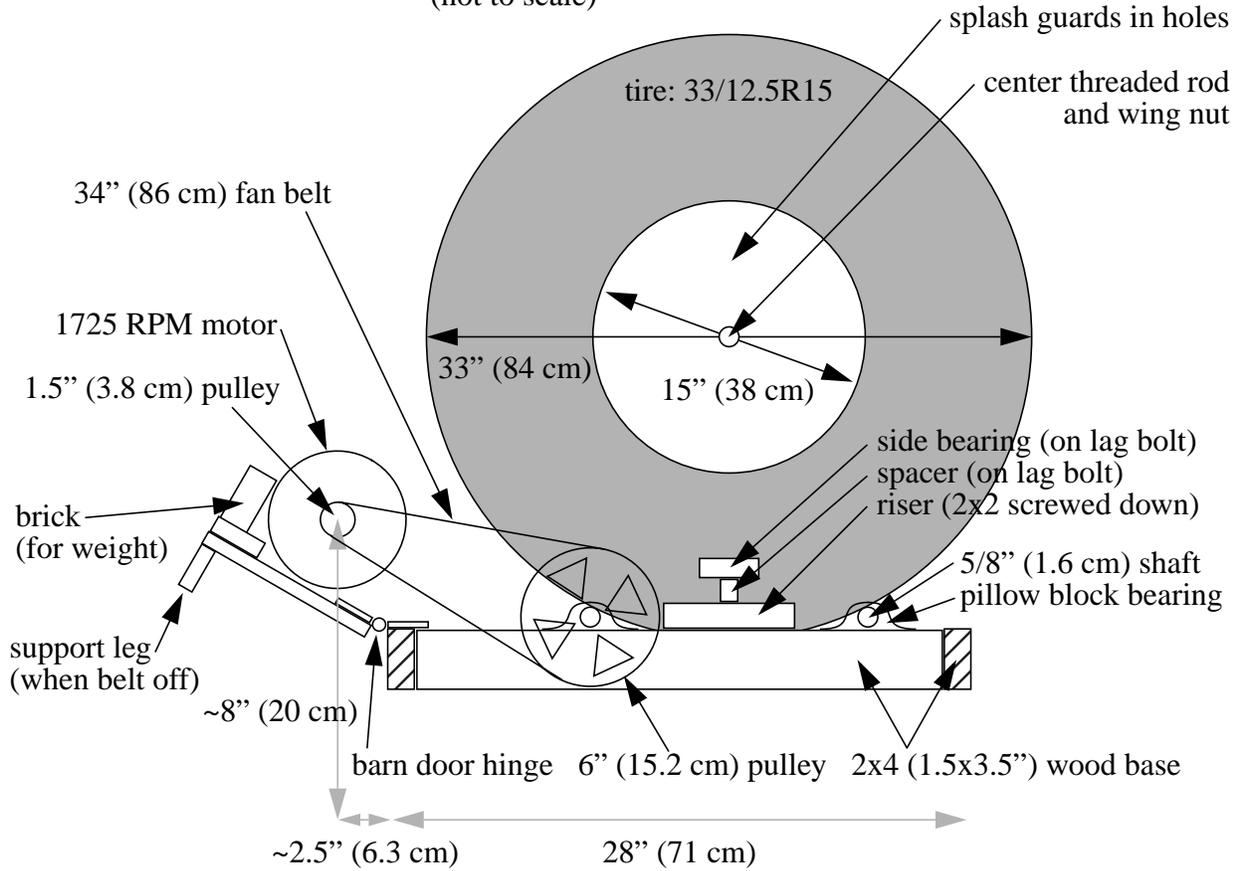
And then obtain:

- a fan belt (see below for size; I used 34” (86 cm))
- two pulleys (see below for sizes; I used 1.5” (3.8 cm) and 6” (15.2 cm), both with correct center sizes)
- a barn door hinge
- at least two good quality roller bearings (such as from roller skates)
- an adequate electrical switch box
- enough power cord, ideally three-wire
- some plywood, a long threaded rod, two washers, a nut, a wingnut, and some waterproof paint
- sufficient lumber, wood screws (about 37 various), lag bolts (about 10 various), and tools to keep you busy in your workshop for many hours
- lots of grit -- at least coarse grit
- buckets, rags and/or sponges, a suitable scoop that fits inside the tire, a big dropcloth...

Take a deep breath... Do you really want to go through with this? OK, here’s what you are trying to build:

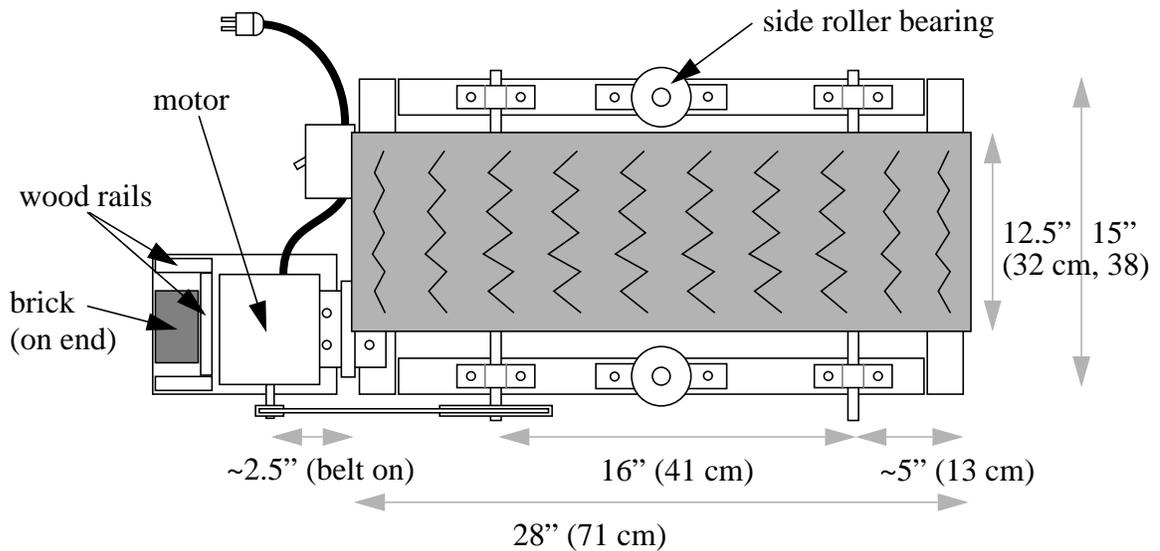
Side view of tumbler

(not to scale)



Top view of tumbler

(not to scale)



Miscellaneous construction suggestions:

- Use wood screws, not nails or glue, for just about everything, so you can back them out and revise your tumbler base as necessary. Avoid gluing anything you might need to disassemble.
- Attach the motor any way you like, just so it's solid. I screwed a wooden rail to the motor platform, drilled holes in the rail for the motor body bolt ends to go through (which was tricky), and secured another rail behind the motor to hold it in place.
- Mount the side-guide roller bearings such that the spinning part of each bearing is not in contact with the spacer on the lag bolt.
- Use a riser block if/as necessary to put the bearing at the widest part of the tire while giving the lag bolt enough bite into wood. With a longer lag bolt and spacer, the riser block would not be necessary. See also "Side Guide Roller Bearings" on page 12.
- Mount side bearings so they stick out over the riser block and base, so the tire doesn't rub against the latter.
- After getting the roller shafts as absolutely parallel as you can, and tightening down the lag bolts that hold the pillow block bearings, put a small nail on each side of each bearing base, not all the way down (so it's removable), to keep the bearing from slipping over time and ruining the shaft alignment.

That's essentially what you need to know to build (though not necessarily to operate) a tire tumbler like mine. The rest of this document is background information on the design, including the splashguards.

2. Tire Size and Volume

I've seen tire sizes represented two ways:

- wmm/a R Win, such as 165/70R13, or,
- Tin/win R Win, such as 33/12.5R15, a variation seen on big tires,

where the meanings of the values are as follows.

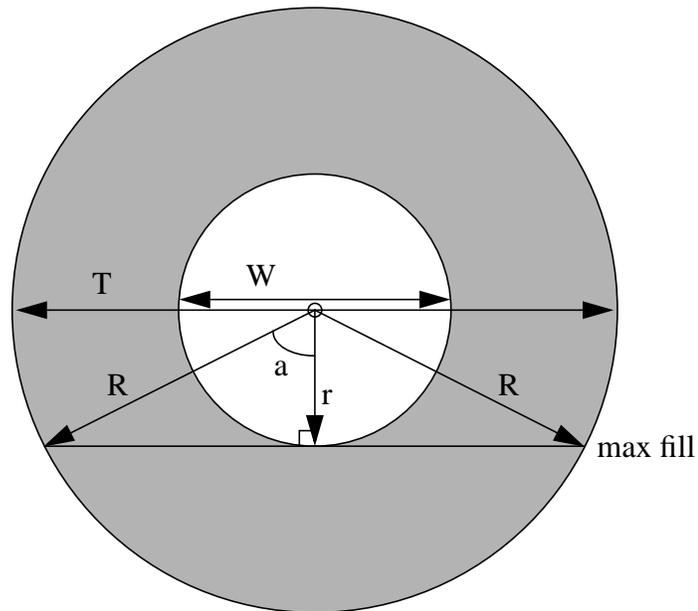
Table 1: Tire size measurements

w	section width, maximum width of tire; depends on rim width
a	section height, aspect ratio %, sidewall to width
W	wheel diameter
T	tire diameter
mm	millimeters
in	inches
R	stands for "radial"; other values possible too

From the first representation T can be computed as follows.

$$Tin = Win + \left(2 \cdot win \cdot \left(\frac{a}{100} \right) \right)$$

Imagine a tire as a torus of rectangular cross-section with these dimensions in side-view:



The tire can be filled with rocks, grit, and water no higher than the rim -- the horizontal line above labeled “max fill”. Given a tire diameter T, rim (wheel) diameter W, and tire width w (not shown above) -- in my case 33”¹, 15”, and 12.5” -- and angle “a” expressed in radians, the cross-

1. Based on a circumference of 101”, my tire is closer to actually being 32.15” in diameter, but I didn’t use this correct number in this document, and I’m too lazy to go restate it all now.

sectional area of maximum fill is a wedge of a circle (of angle $2*a$), less the area of a rectangle (two triangles, each with side r and hypotenuse R) in the wedge above the fill line.

$$R = \frac{T}{2}$$

$$r = \frac{W}{2}$$

$$fluidarea = \pi R^2 \frac{a}{\pi} - r \sqrt{R^2 - r^2}$$

$$a = \arccos \frac{r}{R}$$

$$fluidarea = R^2 \arccos \frac{r}{R} - r \sqrt{R^2 - r^2}$$

$$fluidvolume = fluidarea \cdot w$$

Using a 33/12.5R15 tire, that works out to **2362 cubic inches** (ci) (38,700 cc).

2.1 Complications

Three real-life factors complicate this calculation:

1. You can't fill the tire up to the rim. Significant "head room" is needed so the slurry doesn't spend much time above rim height while tumbling -- it just splashes.
2. Tire width (sidewall to sidewall) is not a constant. Tire ratings are for the maximum external width.
3. Tire treads and sidewalls have non-zero thickness, which significantly reduces the internal volume.

The effect of issue 1 above could only be resolved by experimenting. For issues 2 and 3, I measured the actual volume of my big tire by dumping 12-pound tumbler barrels full of water into it. Based on this I derived a derating factor of **0.585** from theoretical to-the-rim tire volume (external, maximum-width, rectangular cross-section) to approximate real volume (internal, complex cross-section, still up-to-rim).

This derating factor -- by volume rather than by each linear dimension -- seems to agree with actual measurements on both small (165/70R13) and large (33/12.5R15) tires, based on filling them with water. It appears that wall thickness might scale with the cube root of volume?

2.2 Tumbler Barrel Ratio

While thinking about this problem I developed a concept I call "tumbler barrel ratio" (TBR). My 12-pound Lortone tumbler barrel, filled 3/4 full of rocks, grit, and water, offers about 3464 cc or **212 ci** of usable volume, which I defined as a TBR of 1.0. (Various numbers here are not exact due

to intermediate round-offs.) Any larger tumbler's capacity can then be stated in TBR, which is more meaningful than cc or ci.

The derated (theoretical internal) maximum capacity of my 33/12.5R15 tire is 1382 ci or **6.53 TBR**, which would be $12 * 6.53$ or ~ 78 pounds of payload (rocks). In actual use I've loaded it with 50 pounds of rock (weighed on a scale) with good results, which is an effective TBR of $50 / 12 = 4.17$.

2.3 Tire Choices

I did some informal research on standard and large tire sizes and calculated internal volumes and TBRs for various tire sizes. First I discovered the following.

Goodyear says their largest standard tire (31/10.50R15) is stocked by dealers (though they're moving more to metrics), and also available aftermarket; 32" and 33" tires are sold "one a month" or must be gotten from "4-by" dealers. The largest metric tire I've seen advertised, 265/75R16, is equal to 31.65/10.43R16. Estimated TBRs for these tires of 4.37-4.48 are substantially smaller than the 6.53-6.90 (depending on standard derating or actual internal measurements) for the 33/12.50R15 tire I have now, probably due to the significant added width of the larger tire. See also the website <<http://www.off-road.com/4x4web/faqs/tiresfaq.html>>.

The following table shows a variety of typical tire sizes I've heard about or seen advertised, the estimated (derated) internal volume to the rim, and the resulting TBR. It's constructed using a UNIX script I wrote. The table is sorted by TBR. You can see how rapidly this measure of capacity rises for especially large tire sizes. In other words, if you're going to build a tire tumbler for capacity, you might as well make it good-sized, which means an unusually large tire. The tire I found and used is marked "--->".

Table 2: Relative capacities of various common tire sizes

w (mm)	aspect (%)	T (in)	w(in)	W(in)	vol (ci)	TBR
165	70	22.09	6.50	13.0	216	1.02
155	80	22.76	6.10	13.0	229	1.08
175	65	22.96	6.89	14.0	229	1.08
175	70	22.65	6.89	13.0	253	1.20
195	60	23.21	7.68	14.0	268	1.27
195	60	24.21	7.68	15.0	274	1.30
205	55	24.88	8.07	16.0	277	1.31
185	70	23.20	7.28	13.0	293	1.39
185	70	24.20	7.28	14.0	301	1.42
205	60	24.69	8.07	15.0	313	1.48
185	75	24.93	7.28	14.0	337	1.59
195	70	24.75	7.68	14.0	346	1.64
205	65	25.49	8.07	15.0	357	1.69
195	75	25.52	7.68	14.0	388	1.84
205	70	25.30	8.07	14.0	395	1.87
205	70	26.30	8.07	15.0	404	1.91
225	60	26.63	8.86	16.0	410	1.94
205	75	26.11	8.07	14.0	444	2.10
205	75	27.11	8.07	15.0	454	2.15
215	70	26.85	8.46	15.0	459	2.17
225	70	26.40	8.86	14.0	508	2.40
215	75	27.70	8.46	15.0	516	2.44
225	70	27.40	8.86	15.0	519	2.45
235	70	27.95	9.25	15.0	583	2.76
235	70	28.95	9.25	16.0	595	2.81
245	70	28.50	9.65	15.0	652	3.08
235	75	28.88	9.25	15.0	655	3.10
245	70	29.50	9.65	16.0	666	3.15
235	85	31.73	9.25	16.0	827	3.91
265	70	31.61	10.43	17.0	838	3.96
265	75	31.65	10.43	16.0	924	4.37
.	.	31.00	10.50	15.0	948	4.48
.	.	31.50	12.00	16.5	998	4.72
.	.	39.00	9.00	20.0	1185	5.60
--->	.	33.00	12.50	15.0	1382	6.53
.	.	35.00	12.50	15.0	1659	7.84
.	.	35.00	14.50	16.5	1725	8.16
.	.	35.00	14.50	16.5	1725	8.16
.	.	36.00	12.50	15.0	1806	8.54
.	.	38.00	15.50	15.0	2626	12.42

2.4 Other Capacity Issues

A typical rock spends 3 weeks in fine, prepolish, and polish runs. Coarse grinding varies from 1 week for soft and/or already river-tumbled rocks, to 5 weeks or more for hard, tough agates. (I like my rocks well-rounded.) Assume:

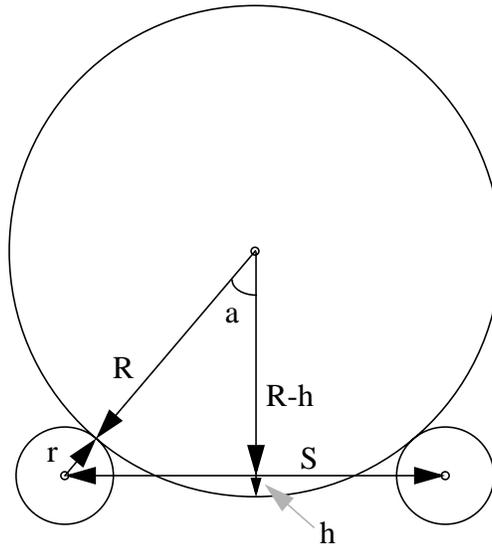
- an average of 4 weeks per rock on coarse grind; actually 24 days at 6 days per load, because that's about how long it takes to consume the 60-weight grit;
- my two small tumblers (3-pound and 12-pound) are only used for finishing runs, at $7 + 8 + 8 = 23$ days per load; and
- the tire tumbler is only used for coarse grinding -- no need to ever clean it out!

Then to match capacities and run all tumblers all the time, I would need a coarse grinding capacity of $(0.25 + 1.0) \text{ TBR} * 24/23 = \mathbf{1.30 \text{ TBR}}$. At an actual capacity of 4.17, in theory I can run the tire tumbler only $1.30 / 4.17 = 31\%$ of the time and still keep the little tumblers busy polishing. In practice, this probably means only running the tire tumbler when I'm home overnight so I can keep an ear on it! I trust the little tumblers unattended, but I'm not so sure about the big one.

Especially for this calculation, your circumstances might vary, but this gives you an idea of how you might think about the issue.

3. Roller Shaft Dimensions and Spacing

When a tire (or barrel) sits on two shafts (or a set of wheels), you can model it like this.



The goal is to find S , the roller center spacing; and also to ensure that h , the distance the bottom of the tire projects below the roller centers, is not far enough to hit anything, like the floor under the tumbler base.

$$a = \arcsin\left(\frac{\frac{S}{2}}{(R+r)}\right)$$

$$S = 2(R+r)\sin a$$

And:

$$a = \arccos\left(\frac{R-h}{R}\right)$$

$$h = R(1 - \cos a)$$

I measured my 3-pound and 12-pound tumbler bases to determine their angle “ a ”, and then explored the value of S and h for various values of “ a ” for the tire tumbler, as shown in the following table. (Please do your own metric conversions, sorry...)

Table 3: Roller spacing parameters

tumbler	R (in)	r (in)	S/2 (in)	implies	a (deg)	h (in)
3-pound	2.19	0.16	1.66	----->	44.9	0.64
12-pound	3.88	0.38	2.50	----->	35.9	0.74
31" tire	15.5	0.3125	7.91	<-----	30	2.08
			9.07	<-----	35	2.80
33" tire	16.5	0.3125	8.00	----->	28.4	1.99
			8.41	<-----	30	2.21
			9.64	<-----	35	2.98

As you can see, the 12-pound tumbler uses a smaller angle “ a ” than the 3-pound tumbler; that is, the shafts are proportionally closer. I don’t know if this is intentional or significant, but I decided to go with a yet smaller angle for my big tumbler base, partly to allow for perhaps someday needing to operate with a smaller (31”) tire.

The only risk I could see was that the tire might jump or roll right off the base. But with 2” or more of tire, full of rocks, projecting below the drive shaft centers, this didn’t seem likely, and in fact it isn’t likely in actual operation. Even if you freeze the passive (idler) shaft, the driven shaft slips against the tire rather than lifting it out of the base.

So it appeared that $S/2 = 8$ ”, or $S = 16$ ” (**41 cm**), was a pretty good number, and that’s what I used.

3.1 Complications

- Curiously, the 5/8” steel roller shafts I used, while plenty strong enough, are smaller in total diameter than the rubber-coated portion of the shafts on the 12-pound tumbler. This means the

effective ratio (RPM reduction) is even greater, as described in “Motor/Tire RPM, Pulley Sizes, Edge Speed” on page 10.

- Also, the need for good friction between the driven shaft and “barrel” (tire) is greater too than it would be with larger-diameter shafts. I found that the tire would start up a bit slowly, and the driven roller would squeak and get warm, until everything “warmed up”. Duct tape wrapped around the driven roller to increase friction seemed like a good idea, and it worked for a while, but eventually it wore off, balled up, got on the tire, transferred to the other shaft, etc.

Later I opted to instead roughen up the driven shaft. I found a cute way to do this. I held a hand-operated engraving pencil tip against the shaft and ran it back and forth between the pillow block bearings while the motor turned the shaft. After several minutes the shaft was coated with thousands of tiny impact dots and felt much rougher.

- With the motor on the base but the tire off, the base is almost ready to tip over toward the motor. Picking up the base requires lifting it by the driven shaft and pushing down on the idler shaft to counterbalance the weight of the motor. This is awkward but doable. Shaft spacing and distance to the motor might make some difference, but probably not enough to worry about.

4. Motor/Tire RPM, Pulley Sizes, Edge Speed

A/C induction motor speeds are synched in some mysterious way to the wall power cycles per second. As a result, two popular speeds are 1725 RPM and twice that, 3450 RPM. I don’t know why. I did find a used **1725 RPM** motor pretty cheap, with some small pulleys already on its shaft.

Note that induction motor power consumption rises with load, which means it’s not terribly inefficient to use too big of a motor for the job. Plus that way it runs cooler.

You must step down the necessarily high motor speed to drive the tire at a reasonable speed. What’s reasonable? It turns out there’s some physics behind rock tumbling, but I’ll spare you the details. The goal is to spin the barrel fast enough to carry rocks up the walls, but not so fast that they are held in place by centrifugal force. Based on email in 1995 from Raymond Rodebaugh (ray@therad.rpslmc.edu), the relevant formulas for optimal rotation speed are as follows.

$$RPM_{round} = \frac{132.8}{\sqrt{D_{in}}}$$

$$RPM_{hex} = \frac{79.7}{\sqrt{D_{in}}}$$

D_{in} is the barrel diameter in inches. I’m not sure why faceted barrels should turn slower, but anyway...

I ended up with a **1725 RPM motor** turning a **1.5” pulley**, driving a 34” fan belt, driving a **6” pulley** connected to a **5/8” driven shaft**, driving a **33” tire**:

$$1725 \cdot \frac{1.5}{6} \cdot \frac{\left(\frac{5}{8}\right)}{33} = 8.17\text{RPM}$$

Of course the fan belt size doesn’t really matter in this calculation, as described below in “Fan Belt Size and Motor Mount” on page 11.

Here’s what I calculated or observed. (Again, please do your own metric conversions, sorry...)

Table 4: Tumbler rotation speeds

tumbler	type	D (in)	nominal RPM	observed RPM	observed /nominal	observed edge speed (in/min)
Lortone 3-pound	smooth	4.38	63.5	52	0.82	716
Lortone 12-pound	faceted	7.76	28.6	28	0.98	683
Thumler 12-pound	faceted	~7.76	28.6	22	0.77	536
tire	smooth	33	23	8.2	0.36	850

You can see that three different commercial tumblers all run slower than the nominal formula. Rotation speed must not be very critical. If it was, there would probably be a way to adjust it for different types of rocks and polishing steps, as is suggested in old booklets on tumbling.

Originally I was going to have the tire tumbler run at about 20 RPM, and for a while I did, but it was unnecessarily fast. When I had to go to a larger fan belt (see “Appendix B: How Not to Build a Big Tumbler” on page 17), I also changed from a smaller pulley on the driven shaft to a larger pulley, resulting in a stately but effective 8.2 RPM.

To my surprise, the observed rotation speed is within 0.5% of the calculated speed, which is within measurement errors, meaning there’s virtually no slippage. Sure enough, the driven shaft does not get warm -- unless you coat the tire with something slippery by accident -- see the above reference.

Later I computed the edge speeds and discovered, to my surprise that even at its relatively slow speed, the big tire “moves rock” 19% faster than the 3-pound tumbler and 24% faster than the Lortone 12-pound tumbler. No wonder it grinds pretty fast.

Also, I put the unit on a “smart” power meter that understood power factor, and discovered that it draws about 250 W on average with a low power factor of about 0.41. This means the motor is not working near its capacity, which is good because it won’t overheat (I hope).

5. Fan Belt Size and Motor Mount

The fan belt size is surprisingly non-critical. I picked a size I had handy (34" (86.4 cm), labeled 15330) and built the base to fit. I hope it won't be hard to buy an exact replacement someday, or if it is, to get something close enough and then adjust the motor position to accommodate the new belt.

- The belt must be large enough to go around both pulleys and allow the motor to sit out of conflict with the tire, even when the motor is up at an angle on the barn door hinge.
- The belt shouldn't be so large that the motor sits ridiculously far from the tire. To keep a good angle on the barn door hinge, with a longer belt the motor would have to sit higher. Also the base would get tipper with the tire off, etc.

I mounted the motor in a way that makes it relatively easy to move it to one of four different "stops" on the hinged base. This is a crude adjustment in case it's necessary. Mounting varies a lot depending on the motor type and size, so I'll leave unspecified how you do this, and just raise the issue so you are aware of it. You might do something I did not, and put some sort of heat shield between the motor and the wood to reduce fire hazard, since a motor can operate at 70 degrees C.

By the way, Tom Pettit says pulleys are rated by "pitch diameter", for the actual linear belt speed, which is very nearly halfway between OD and ID.

6. Side Guide Roller Bearings

If you put a reasonably wide tire on a pair of perfectly parallel and level drive shafts and load the tire with rocks, it's bottom-heavy and not very prone to tip over. However, the shafts are never perfectly parallel and the base is never perfectly level, so while the tire still isn't very tippy, it drifts to one side or the other while being driven. For this reason you need side-guide roller bearings mounted horizontally.

After building my base I saw a picture of one design that had the bearings mounted up high, at the top of the tire. Initially I thought I would have to do that too, but later I realized they could be at the bottom and the tire would not tip over -- it's pretty stable when loaded with rocks. This is somewhat simpler, more compact, and possibly less dangerous to the tumbler and to people messing with it.

It's important to mount the roller bearings:

- reasonably horizontal,
- positioned vertically at the widest point of the tire,
- positioned horizontally equidistant between the drive shafts (at the centerline of the tire),
- projecting far enough inward from the base and riser blocks so the tire doesn't rub against them, and
- far enough apart so it's not too hard to get the tire in and out -- which means the base itself must be wide enough to accommodate the tire and the side guide bearings.

This allows the tire to ride up against one bearing or the other with little force or harm. You never know which side it will be, it doesn't matter, and it varies with time and circumstances. If the tire runs "tippy" and hard against one bearing, try shimming the base in the other direction.

Note that you should **not** aim to have the tire contact both side bearings at once; there's no need, and it would be difficult to ensure anyway.

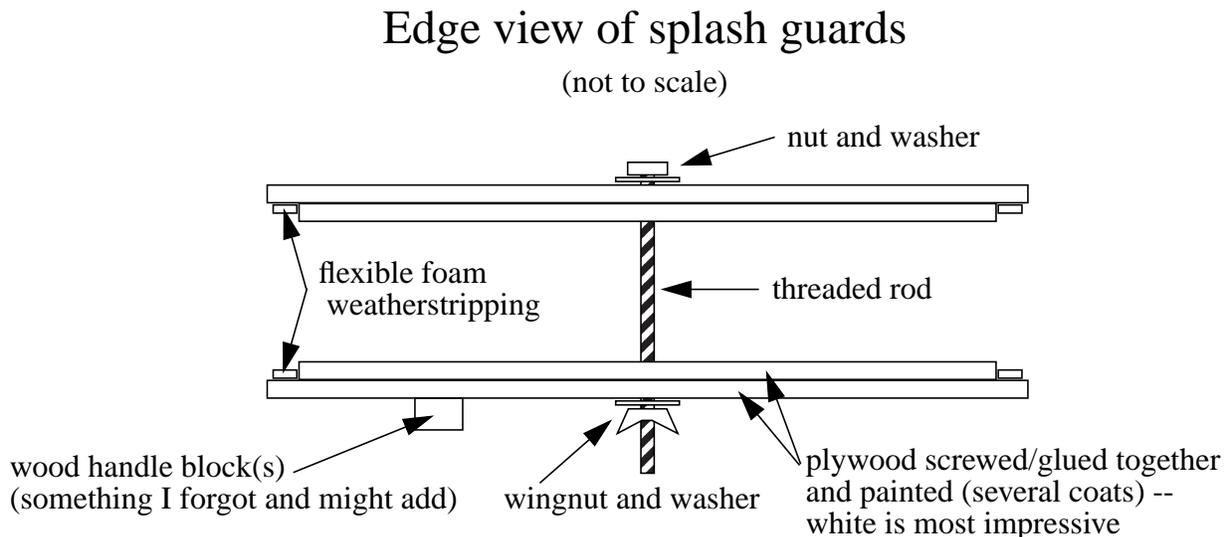
I happened to obtain four identical bearings rather than two, so I mounted two on each side, stacked vertically. This means the vertical position is not so critical and/or the tire can change size (diameter) a little.

Once when the base was significantly off level, the tire tended to ride up sideways and threatened to tip over. I debated putting two side guide bearings on each side of the base, horizontally separated. However, they would have to be carefully aligned somehow to match the angle of the tire at the contact point, to avoid slippage, and are really not necessary if the base is level.

7. Splash Guards and Weatherstripping

If you don't use splash guards of some type, rock chips and slurry drops fly out of the tire pretty quickly. However, it's impressive to watch briefly and clean up the mess later... And this unusual tumbler design allows you to do that. It's an interesting demo.

For normal operation, if you use splash guards but don't put weatherstripping on them, water leaks out, making a mess all around the tire. If you add weatherstripping but you put too much water in the tire, slurry still leaks out and makes a mess, although much more slowly.



It takes less water than you think to run the tumbler without leaking; about 1-2" (3-5 cm) deep in the tire. If you do everything right, thick slurry forms fast and very little leaks out.

Measure and cut splash guard diameters carefully. The smaller one should just fit inside the rim of the tire. The outer one should fit inside the bead on the rim. Drill center rod holes fairly close in size too, to minimize leaks.

I thought it might matter which side of the tire the wingnut faced, versus tire rotation, but it really doesn't seem to matter. Curiously, when I remove the wingnut and washer, the opposite splash guard seems to be the easier one to pull out, along with the threaded rod.

If I'm careful removing and reinstalling the splash guards there's not much of a mess made. It's easy to wipe up with a large sponge. Wiping the bead of the tire's rim and the weatherstripping on the splashguard is reminiscent of cleaning the rim on the smaller tumbler barrels.

After I built my splashguards, someone cleverly suggested instead inflating a wheelbarrow inner tube in the center hole of the tire. I haven't tried this, so I don't know how well it would stop leaks, how long it would last without wearing out, and how much trouble it would be to inflate and deflate.

8. Care and Feeding of Your Monster Tumbler

After many hours of operation, I've learned a few things I can pass along that might save you some time rediscovering.

- The tumbler is deafeningly loud with even one splashguard off. With both on it's merely loud. Choose a location in which to operate it where the noise will be tolerable.
- Keep in mind summer heat -- to be nice to the motor -- and winter cold -- so you don't freeze the slurry, and also so working on the tumbler is pleasant. I operated mine in the garage, but now that I have it figured out I moved it to the basement, near a power outlet, water tap (hose connection), and floor drain. I set it up on top of a dropcloth.
- Be sure you have a sturdy, level place to park the tumbler. You might want to put the base up on a couple of junk 2x4s laying flat so if it does leak, the standing water soaks into the 2x4s and not into the tumbler base.
- Put the tumbler where no one is going to hurt themselves by getting anything caught in the fan belt and pulleys, or between the tire and shafts. I didn't build a belt cover 'cause I don't have any pets or little kids at home, but you might want one (a belt cover, not a pet or a kid, trust me, a big rock tumbler is much less work to maintain).
- I only use the tire tumbler for coarse grinding (60 grit). Thus I don't need to clean out the tire, which would be messy and tricky.
- I only run the tumbler when I'm home, so I can keep an ear on it. It is audible upstairs, say in my bedroom, without being annoyingly loud.
- Something I learned experientially: You do not lift the tire except when it's empty, and even then that's asking for a hernia. When the tire is loaded, you **roll** it onto the tumbler base. And, you do not pull or lift it over the edge of the base and idler shaft, you **push** it up and over!

However, in practice it's seldom necessary to take the tire off the base at all.

- I found that to keep the tire from leaking much, I can't fill it with much water compared to a sealed barrel tumbler. Hence I can't add the usual proportion of grit, about 1 cup for 12 pounds of rocks, either. I use about half the nominal amount of grit (2 cups) and run the tumbler for about 20% of the usual time, say 30 hours over three nights rather than 144 hours over 6 nights. This devours the grit, grinds the rocks pretty well -- about equivalent to half a week in a smaller tumbler -- and produces a thick slurry.

My experience is that the tumbler always leaks at least a little. Slurry seeps out and forms dried mud blobs. I just scrape/sponge them off and let the crud collect on the dropcloth under the machine. I bought a cheap whisk broom to more easily brush dry mud flecks under the base for later vacuuming. All in all it's not a big deal.

After about 30 hours I open the tumbler, add another two cups of grit and 2-4 cups of water, and run it for another three nights. Then I spend an hour or more to dump it and sort the rocks. This seems to work pretty well. I've pulled out 11 pounds one time, and 14 pounds another time, of rocks ready to polish.

- “You know you're serious about a hobby when you buy supplies in 50 pound lots and congratulate yourself for saving money.”
- I've noticed that sometimes to get the tumbler to roll the rocks well, I must add **more** rocks.
- I found a cute trick for emptying rocks and slurry from the tire. Find a one or two quart soft plastic pitcher or stein, with a handle, that fits inside the tire. Hold it against the inside wall of the tire with the opening down, and flip on the power switch briefly. The tire rotates, the rocks and slurry slide right into the pitcher, and you can bring them out to dump them into a bucket or a big collander. Repeat until the inside of the tire is sufficiently empty.

This leads to some drips, but with care it's not too messy.

- To make rock washing easier, it's also helpful to take off one splash guard, turn on the tumbler, and spray the rocks with a garden hose sprayer, before removing the rocks and slurry from the tumbler.
- Of course now you have a heavy bucket full of rocks and slurry. What do you do with it? I spray it full of water, find a comfortable seat, and sort the rocks into four other buckets: more coarse grinding needed (can stay dirty), ready for polish (hard rocks), ready for polish (soft, need pellets), and junk (rejects) headed for the rock garden. Each bucket can now be filled with water, the rocks allowed to soak if needed, carried elsewhere, drained off, etc.

Later I switched to a large collander over a catch bucket.

- Ultimately the result is one big “spooge” bucket full of slurry that's too thick to go down the drain. I decided to press a 23 gallon (87 liter) tub into service. This I allow to settle, then I pour, or actually rack (siphon), off the clear water. I use a cheap plastic siphon with a squeeze valve. When there's too much mud in the bottom of the bucket, scoop it into a smaller bucket, let it dry out, and dump it in the trash before adding more slurry.
- Avoid the temptation to coat the tire rubber with Armorall or equivalent. After scrubbing off slurry leakage I did this to make the tire look nicer, but it really slicked up the tread. The tire wouldn't turn reliably on the base. Read more about this in “Appendix B: How Not to Build a Big Tumbler” on page 17.
- “What do you do with all those rocks?” -- I decided long ago to avoid ever going commercial with this hobby. I collect and polish rocks for fun, and I give most of them away.

8.1 Summary of Infrastructure Required to Operate the Tumbler

- Electrical outlet of course.
- Rocks go in and come out. Fifty pounds is a lot to carry in one bucket, so you might want to use two smaller ones.
- Grit goes in, and should be stored nearby.
- Water goes in, and is used for cleanups. It's handy to have nearby a hose with a spray head, a sponge, a sponge- and hand-washing bucket, and a floor drain, possibly with a funnel.
- You'll need several other buckets, as described above, to wash and sort rocks. If a collander of some type fits in the top of one of the buckets (the slurry bucket) so you can run water over the rocks to rinse them, that's a plus.

9. Appendix A: How Not to Work Your Way Up to Needing a Big Tumbler

Once upon a time I was a little kid who occasionally picked up an interesting rock. In high school I had access to a lapidary shop and learned how to make cabochons.

Many years later I collected a handful of agates at Moonstone Beach, California. I put them in a jar to admire them. Over the years I repeatedly thought, "Someday I should build a tumbler and polish those."

One day I collected some scrap parts and built a big, ugly tumbler base. It sort of worked. I put the "moonstones" in a glass jar with beach sand and commenced to tumbling. Several days later I found the jar broken and the contents spilled all over. I cleaned up the mess and put away the base.

Years later I discovered the Lortone 3-pound tumbler. I called a lapidary supply company and ordered just a barrel (no base), along with some grit. This barrel operated fine on my homemade base. Yay! I was off and tumbling. I learned where to buy grit in small, expensive quantities around town.

After several months my homemade base got flakier and more frustrating to maintain. Finally I decided it was time to shell out some \$\$ and do it right. So I called a lapidary supply company and asked them to send me just a Lortone 3-pound tumbler base -- no barrels.

What arrived was a base and **two** barrels. I got that straightened out and went on my merry way tumbling "for real".

Some years later I joined the local rockhounds club. Also I got older. On a nice summer day I was now as likely to go rockhunting as peak-bagging. I hiked less, collected more, and soon overran my little tumbler's capacity. Still enjoying the hobby, I decided to spend (gulp) \$130 or so more to buy a 12-pound Lortone tumbler.

With two tumblers cooking I was in great shape! I could process rocks faster than I could find them, for the rest of my life... I thought.

The next sign of trouble was when I found myself needing to sort my raw materials into low and high priority piles for tumbling. I started to fantasize increasing my capacity again. But I didn't want to spend \$400 or more for a large professional tumbler.

Eventually around the beginning of 1999 I decided to dabble with building a big tumbler myself, as much for the fun of the engineering as for the result.

10. Appendix B: How Not to Build a Big Tumbler

The tire tumbler described in this document is actually my "Mark IV" model.

- My first design was to use a 5-gallon plastic paint/pickle bucket rolling horizontally. I happened to have some old mower wheels with real roller bearings in them, and also several buckets, but they were kind of old and beat up.

I started looking for some buckets with rubber lined lids in good condition. Buckets were easy to come by at bakeries and some fast-food restaurants, but rubber-lined lids were not.

- Meanwhile, I thought through, designed, and built my Mark I base except for the motor. I wrote up a long list of expected issues and possible solutions, about 16 in all, such as, "What if the bucket isn't cylindrical?" "Use mower wheels instead of solid shafts so the wheels can turn independently..."

Eventually I was able to roll a bucket on the base. I found a lid in decent condition. I tried filling a bucket with water and putting it on the base with the lid attached as securely as possible. It leaked a little. Nothing I did seemed to prevent it from leaking. This was disappointing.

- Talking with someone else who'd built bucket tumblers successfully, I decided to try tipping it up at a 45 degree angle so leakage wouldn't happen. I rebuilt the base accordingly to yield my Mark II tumbler. I didn't like it. The bucket was tippy, and I didn't believe it would tumble the rocks evenly and well. Also, this reduced the calculated capacity to only about 2.2 TBR even if all went well.
- I'd heard about tire-based tumblers that used two large split-rim truck tires attached to a truck axle and differential. I knew I didn't want to go that large, but I did want to continue with the project. Hence the tumbler described in this document. I started researching tire sizes. When I bought new tires for my car (little 165/70R13s), I kept one old tire around for a while. I brought home from the dealer's recycle pile a 33" tire with a surprising amount of tread left on it. I also thought through about nine more issues and possible solutions.
- I took apart my Mark II base and started building on my Mark III. I had a 24" fan belt and some smaller than 6" pulleys in my scrap pile, so I designed for that. With fatalistic determination I visited Grainger and shelled out about \$40 for four pillow block bearings -- \$8.96 each with real roller bearings inside, but not sealed types. I obtained a dirty old used motor of overkill capacity very cheap from a rockhound friend. I recalculated everything and started cutting lumber.
- The motor and pulleys vibrated like crazy. After several false starts I yanked off the pulley with the too-large center hole I'd tried to shim and pin to the driven shaft. I replaced it with a smaller pulley that had the right size center hole. This worked better but the tire ran even faster.

- Next I tried wrapping the groove in the too-small driven pulley with strips of duct tape to make it effectively larger, to slow down the tire. This sort of worked, but it also got the fan belt sticky with tape goo. When the tape shifted around to become uneven, I tried again by wrapping some weatherstripping foam with a little tape. That was better, but still dissatisfying.
- Around mid-September 1999 I had a base that seemed like it would work. I put the tire on it... And it rubbed against the motor unless I pushed the motor platform down hard with my foot. Drat! Also, the tire ran pretty fast, about as I'd designed, but it seemed too fast. Also, water leaked out of the splash guards like mad, and the motor mount slipped cockeyed a little as some screws punched through to some abandoned nearby screw holes.
- After a while I gave up and decided to rebuild the base to support a longer fan belt; get the motor out further; rebuild the motor platform; and put in a bigger driven pulley while I was at it. The Mark IV was born! About 37 screws or lag bolts were involved...

Fortunately I had a 6" pulley with the right size (5/8") center hole. It worked great, though I wasn't sure the tire would spin fast enough to do the job. It wasn't until later that I calculated the edge speed and realized it was, if anything, a bit **too** fast compared to the smaller Lortone tumblers.

I made the new motor platform large enough to hold a brick or two on the end. The extra weight seemed necessary when the tire was full; otherwise the fan belt slipped at the motor pulley.

I bought and added weatherstripping to the splashguards, and learned to operate the tumbler with proportionally less water than a sealed barrel tumbler.

- The tire drifted sideways. I realigned the shafts several times to be parallel. It was hard to get them to stay that way, for various reasons. Dull drill bits? Slippery mounting holes?
- I decided to clean up the tire for presenting the tumbler at my local rockhounds club meeting. (I didn't have it ready in September or October, but by November, by God...) I hosed and scrubbed the tire, then treated the rubber with Armorall. Big mistake, now the tire slipped on the driven shaft, or when it ran, it tipped sideways!

Fixing this required: Cleaning off the tire treads with window cleaner and heating them up with a propane torch; ensuring the drive shafts were quite parallel again and nailing them in position; shimming up the base to be more level; and cleaning all the tape gunk off the driven shaft and roughing it up as described elsewhere.

- I noticed the tire was rubbing on the side guide roller bearing riser blocks. In a fit of annoyance I trimmed the inside edges off the risers with a hammer and chisel. It worked.
- At last the tumbler operated OK and it didn't leak badly. But it still leaked a little... Through the sidewall. Hmm, that's why the tire is marked "glass" and still has most of its tread! I found and epoxied several glass cuts. This seems to have (mostly) worked OK.
- I never did paint the base lumber with waterproof white paint to make it easier to keep clean after inevitable drips. Now I wish I had, but I probably won't bother because it would take several hours to remove all the hardware from it, paint it, and reassemble it.

- While scooping rocks and slurry out of the tire I had a brilliant idea. What if I put a closable drain plug of some kind in the tire? Then I could flush the rocks with water right in the tire, and catch the slurry in a pan under the base.

But, where would the plug go? It can't stick out the edge of the tire far enough to interfere with the rollers. It can't stick into the tire very far either or it will get ground off. It would have to be in the sidewall, but as far out as possible.

Thinking about the mess it would make if it leaked, I decided to forego this notion!

Well there you have it -- my specifications and experiences. All the usual disclaimers apply if you decide to build your own tire tumbler... I hope you have fun, but you do so at your own risk! If you burn down your house and sue me, I'll drag out this document to prove you are insane...

11. Appendix C: Exploratorium

From some email received from a person who read an earlier draft of this document:

"I am also planning on making the tumbler wide enough to tumble 2 or 3 tires at once."

I see no reason that wouldn't work, with some possible issues:

- Shaft flexing -- You might want bigger than 5/8" diameter shafts for a longer run between bearings?
- Pillow block bearings -- Although the ones I bought are rated for several thousand pounds, maybe a non-issue.
- Tires rubbing -- They can't be identical circumferences, so they must drift a little with respect to each other as they spin. Will this cause significant destructive rubbing between the tires or against the shafts?
- Access to tires for dumping -- I open one side of my one tire. The back splash guard is basically "glued in" by the slurry and I seldom remove it. Also, the tire hardly ever comes off the base, there's no need. How will you dump two or more tires?
- Leakage -- Harder to monitor and clean between the tires. A don't-care?

12. Appendix D: Change History

A record of significant changes to this document.

991217:

- Added to "Tire Size and Volume" on page 3 an explanation of how tire sizes are expressed, and a footnote that my tire is actually 32.15", not 33", in diameter.
- Added to "Care and Feeding of Your Monster Tumbler" on page 14 a warning about the fan belt and pulleys being dangerous. Also revise it to reflect more experience.
- Added metric equivalents to many measurements.