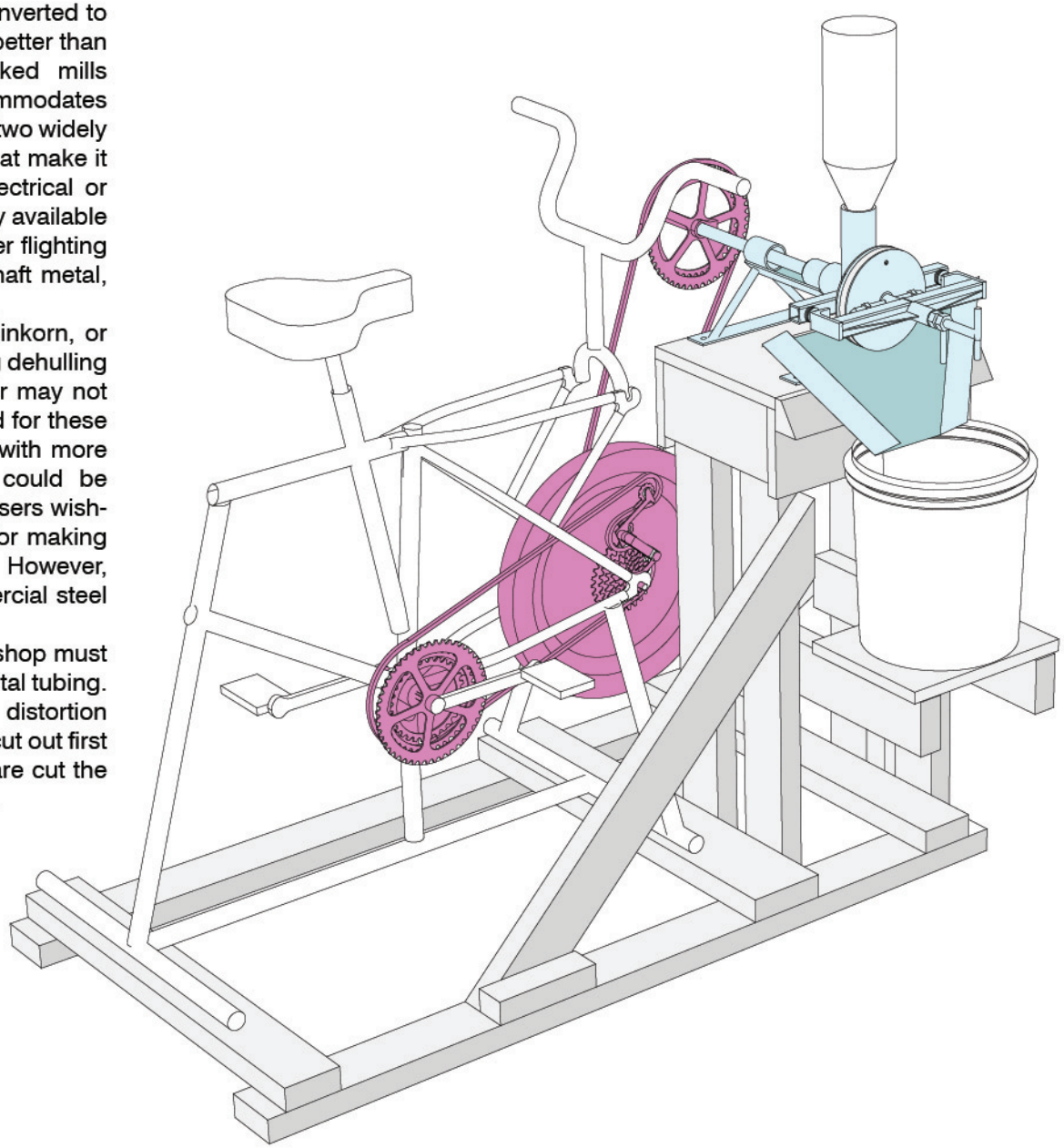
THE DEHULLER | MILL

Here are plans for a horizontal shaft mill intended for dehulling grains. It can be easily converted to a flour grinding mill. This simple mill is better than the available inexpensive hand cranked mills because it uses ball bearings and accommodates a larger dehulling disc. In addition it has two widely spaced bearings and a stable design that make it better for the use of bike power or electrical or mechanical power. The mill uses readily available 1 3/8" x 3/4" sealed bearings. The auger flighting is made from a straight piece of key shaft metal, heated and bent around the auger shell.

For users wishing to dehull rice, einkorn, or emmer, instructions are given for making dehulling pads. For barley and oats this dehuller may not work, as much more scouring is needed for these two crops. However, it is possible that with more aggressive dehulling disks, this mill could be made to work for barley and oats. For users wishing to mill flour, instructions are given for making crude steel burrs with an angle grinder. However, in most cases the user can buy commercial steel or stone burrs and fit them to the mill.

Building the mill is not difficult. The shop must be equipped to make square cuts on metal tubing. Welding techniques that minimize distortion should be used. All of the parts can be cut out first and then fabricated. Once the pieces are cut the actual fabrication time is only five hours.

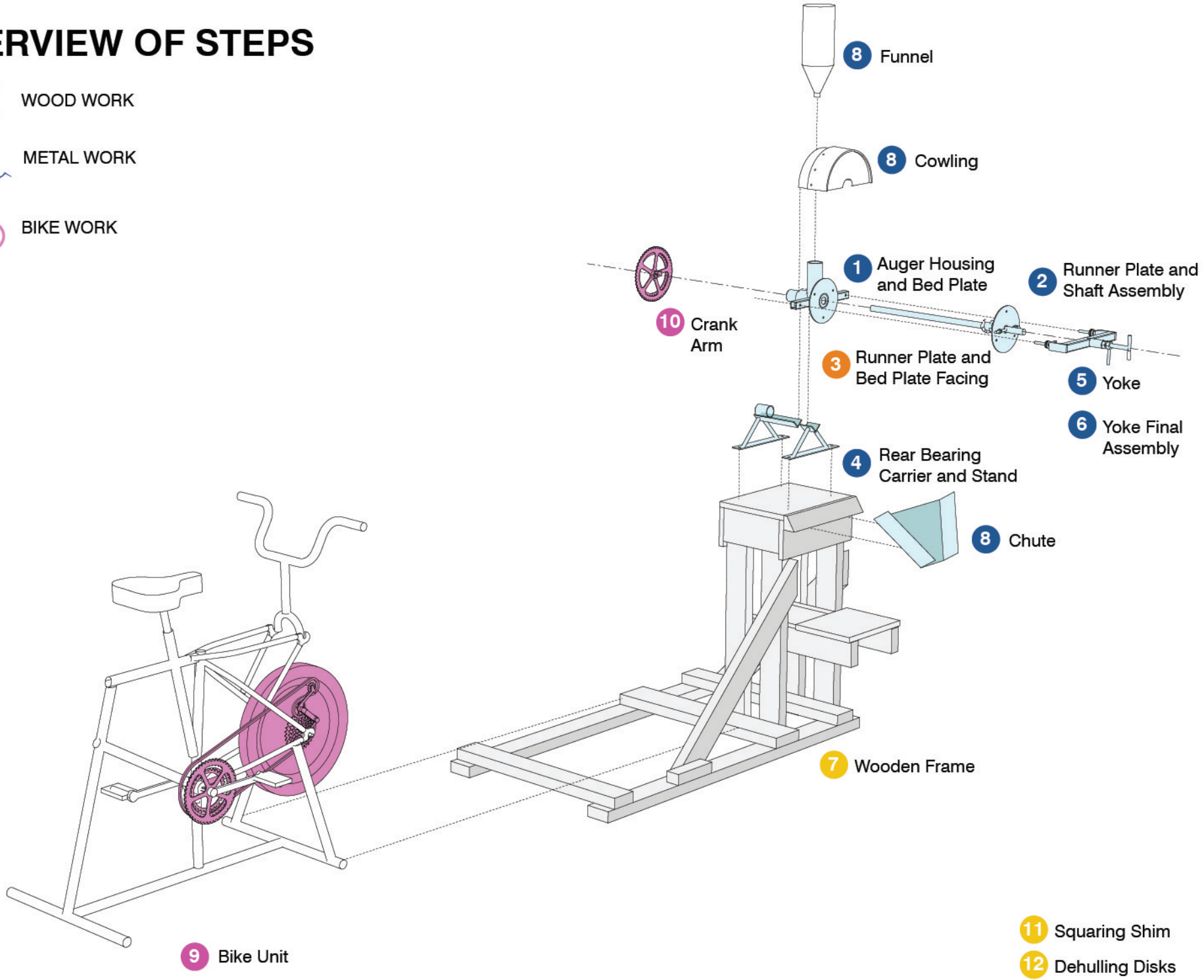


OVERVIEW OF STEPS

WOOD WORK

METAL WORK

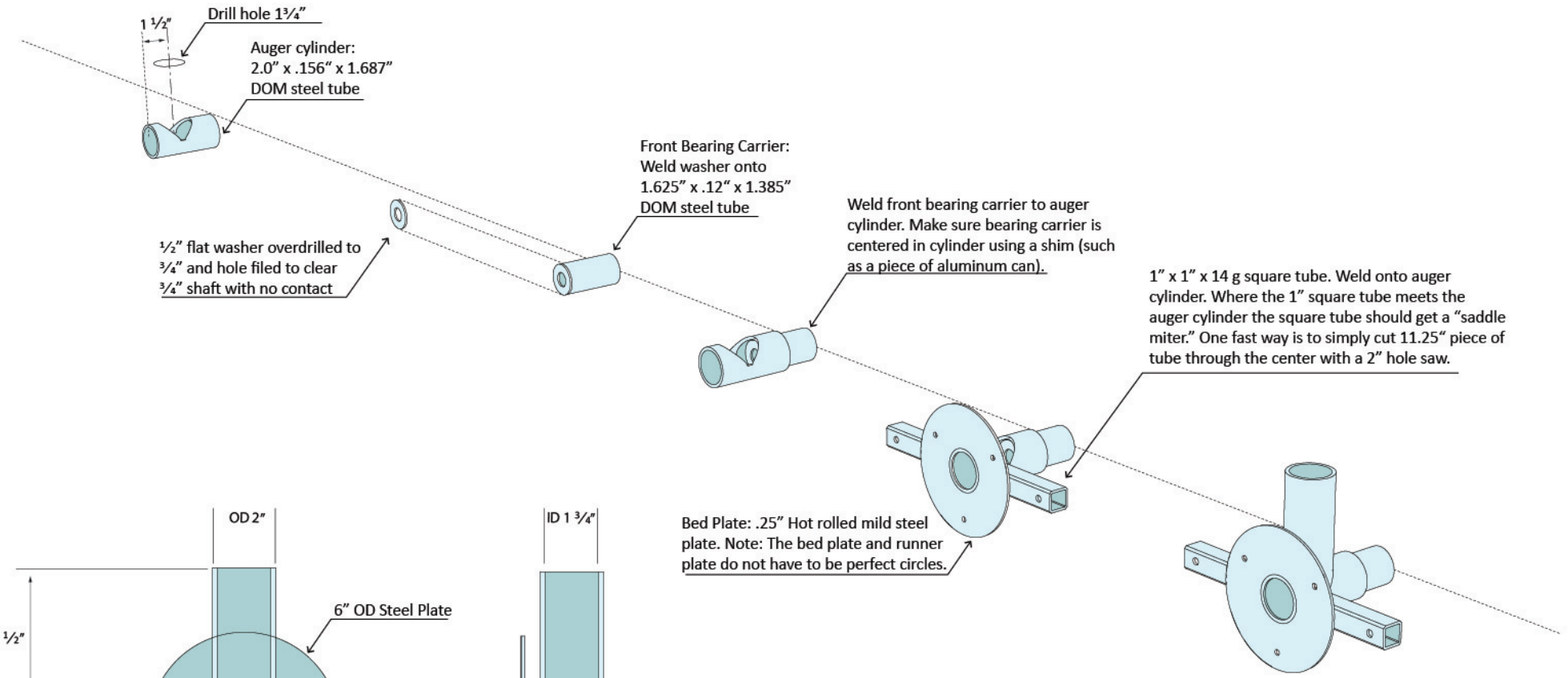
BIKE WORK

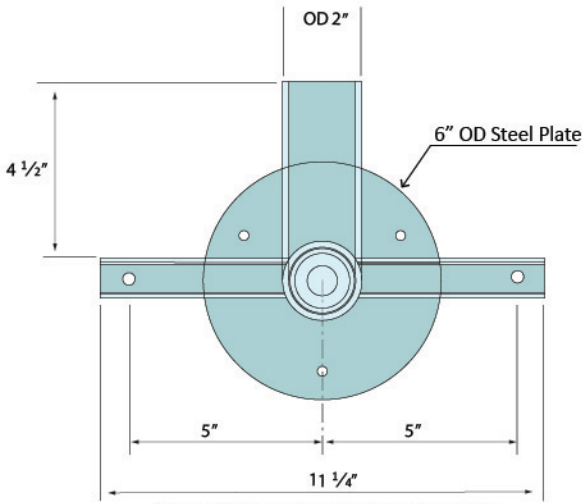


STEP 1

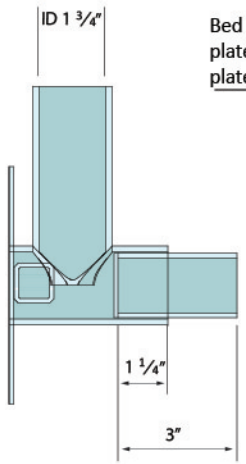
AUGER HOUSING AND BED PLATE

Whether the mill is intended for dehulling, flour, or both, the runner plate and the bed plate will need to be true and square to each other so that as the runner plate rotates the gap between the two plates remains constant. This requires making square cuts in the metal parts and welding the parts together square with a minimum of weld distortion.





The mounting hole pattern in the plates should match the mounting hole pattern of the disks or burrs the mill will use.



Hopper Standpipe:
2" x .12" x 1.78" DOM steel tube or something similar. Where the standpipe meets the auger housing there will be a "saddle miter" the standpipe may be cut with a 2" hole saw or you can use a tubing notcher website such as http://www.cycle-frames.com/bicycle-frame-tubing/Tabbed-Tube-Notcher.html

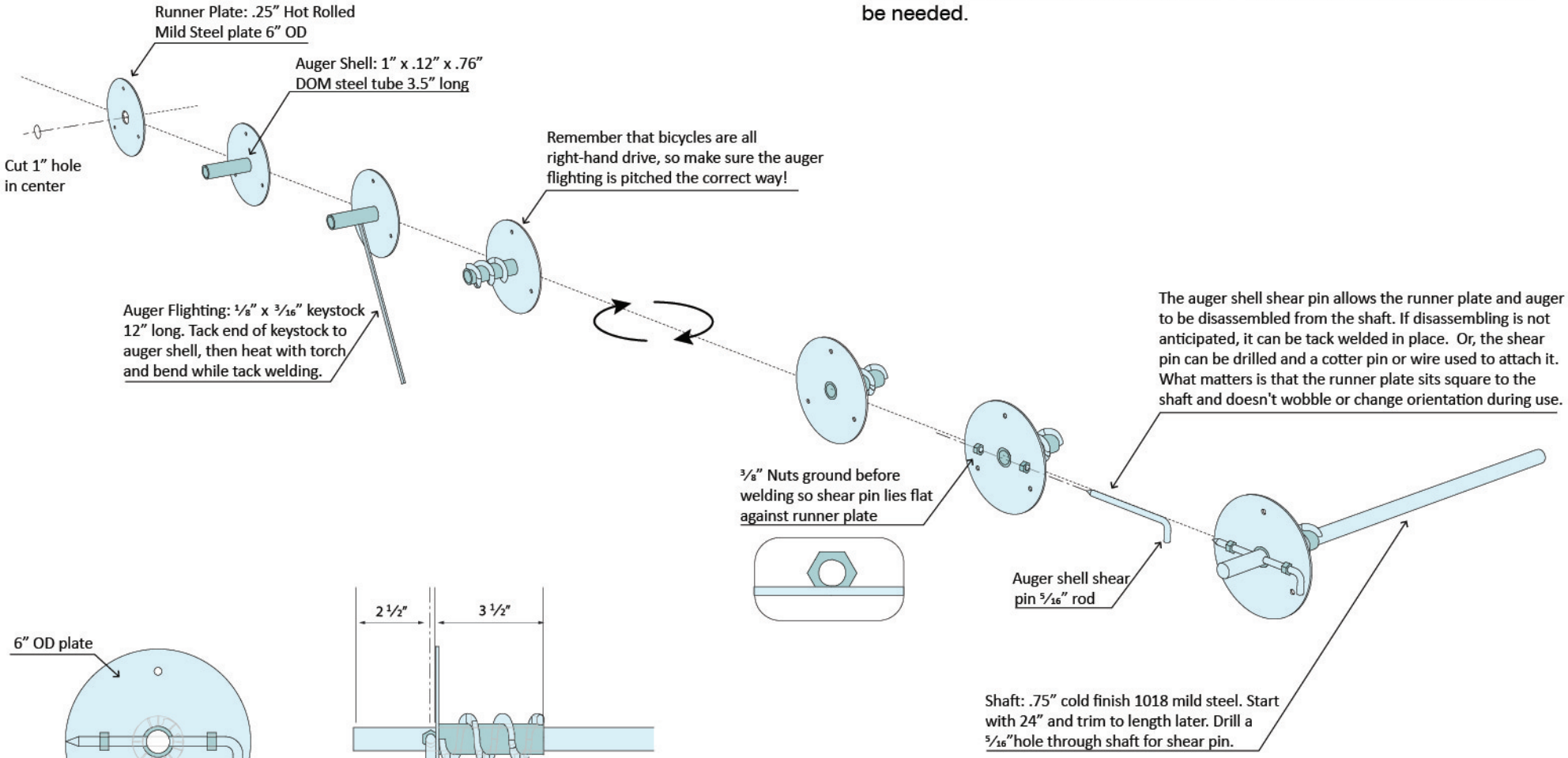
STEP 2

RUNNER PLATE AND SHAFT ASSEMBLY

Wrapping the auger flighting around the auger shell is easily done with a welding or brazing torch and a pair of pliers. The straight flighting-stock (key-stock or a small piece of sheet metal) is tacked to the shell and then heated and bent. Every half turn or so it is tacked to the auger shell and the process continues until all the flighting is attached.

Important!: Remember that as the shaft turns the auger must move grain toward the runner plate! The bicycle power unit will always turn one way (right-hand drive), so the orientation of the mill to the bike must be designed before the auger is made.

Also, the correct length of the auger shell and its flighting will depend on the width of whatever disks (dehulling disks, steel flour burrs, stone burrs) are sandwiched between the plates. If you anticipate using burrs or disks with a total width of greater than 1", then a longer auger shell may be needed.

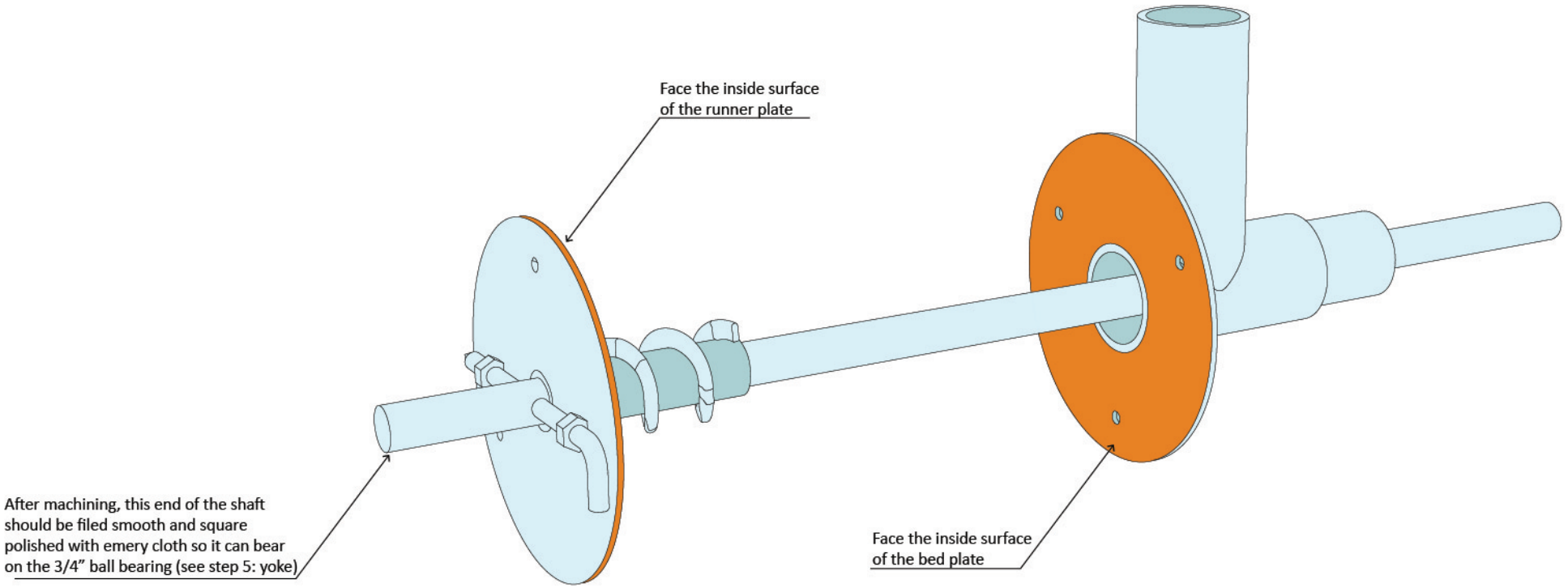


The mounting hole pattern in the plates should match the mounting hole pattern of the disks or burrs the mill will use.

STEP 3

RUNNER PLATE AND BED PLATE FACING

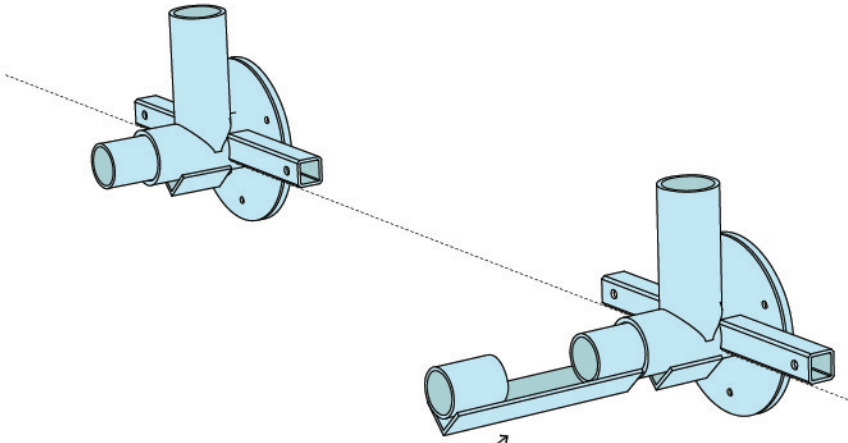
At this stage, the shaft assembly with the runner plate, and the auger cylinder assembly with the bed plate, can be taken to a machine shop and the working faces of the two plates can be faced on a lathe. The facing pass will make them true and square to the shaft center and the bearing carriers. Later, when the whole mill is assembled, a shim can be "run in" to remove any remaining lack of square (step 9: Shim).



STEP 4

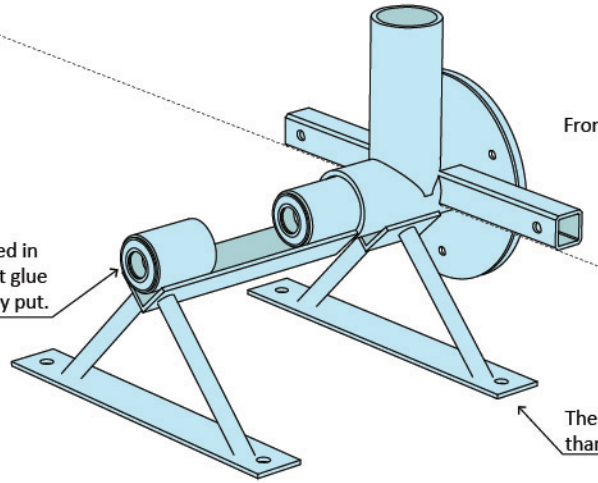
REAR BEARING CARRIER AND STAND

Now all that remains to build the auger cylinder housing is the rear bearing carrier and the stand. To attach the rear bearing carrier so that it is co-axial with the front bearing carrier, a piece of straight, clean, angle iron is used.

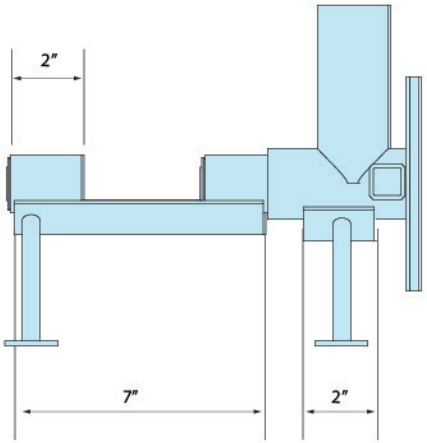


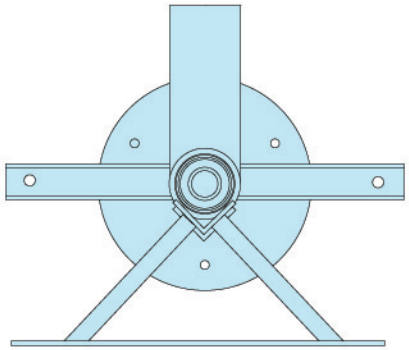
It is important that the angle iron used and the bearing carriers be straight, clean, de-burred, and free of welding spatter so that the bearing carriers remain aligned when clamped to the angle iron. The welds in this step should be small so as to minimize distortion.

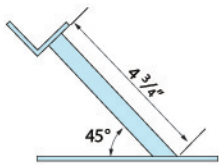
Bearings: 1 3/8" x 3/4" flanged sealed bearings. When the bearings are pushed in to the bearing carriers use some gasket glue or aluminum foil to make sure they stay put.



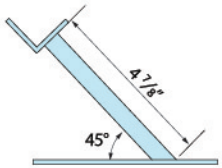
The front two legs are shorter than the rear two legs.







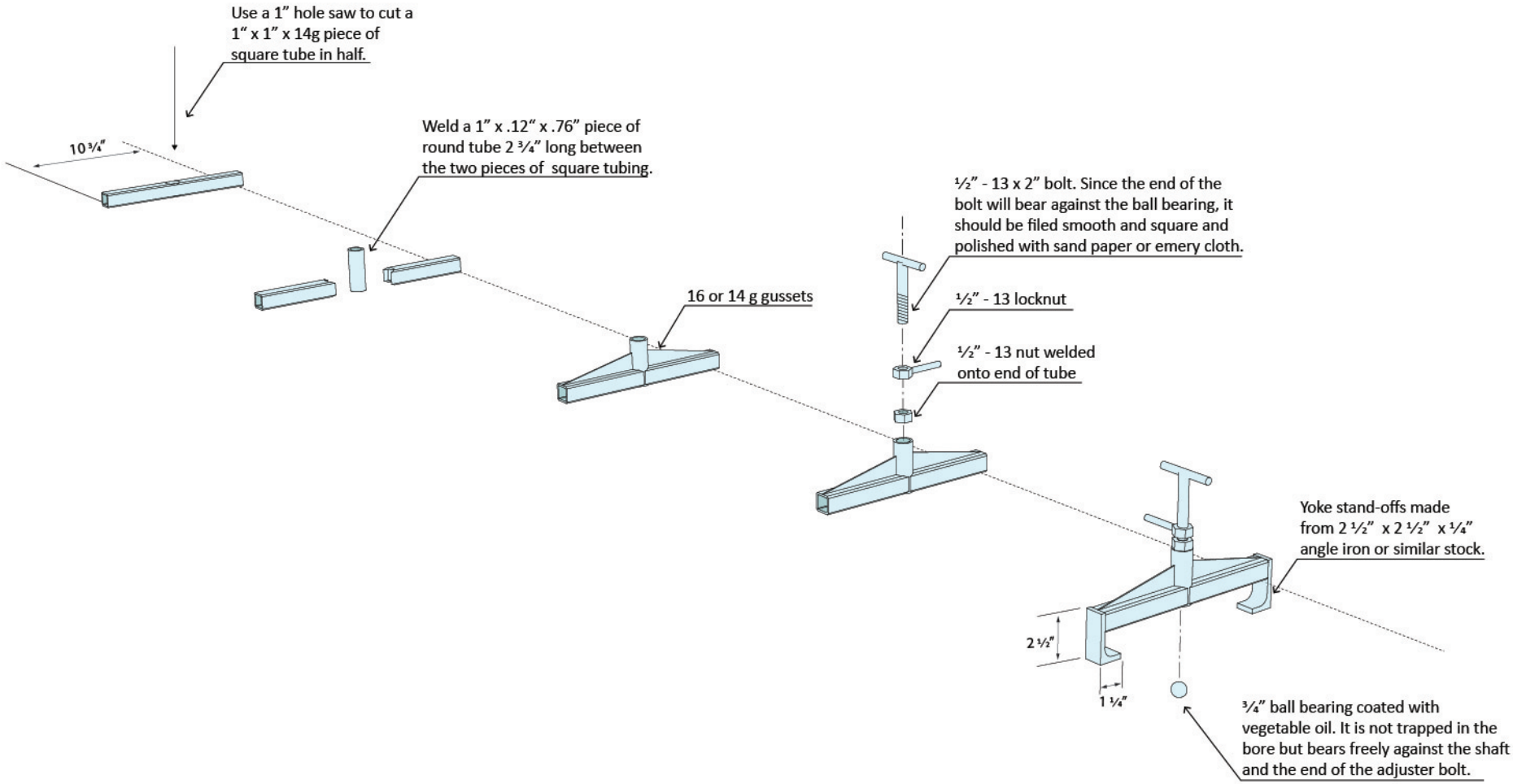
FRONT LEGS



REAR LEGS

STEP 5

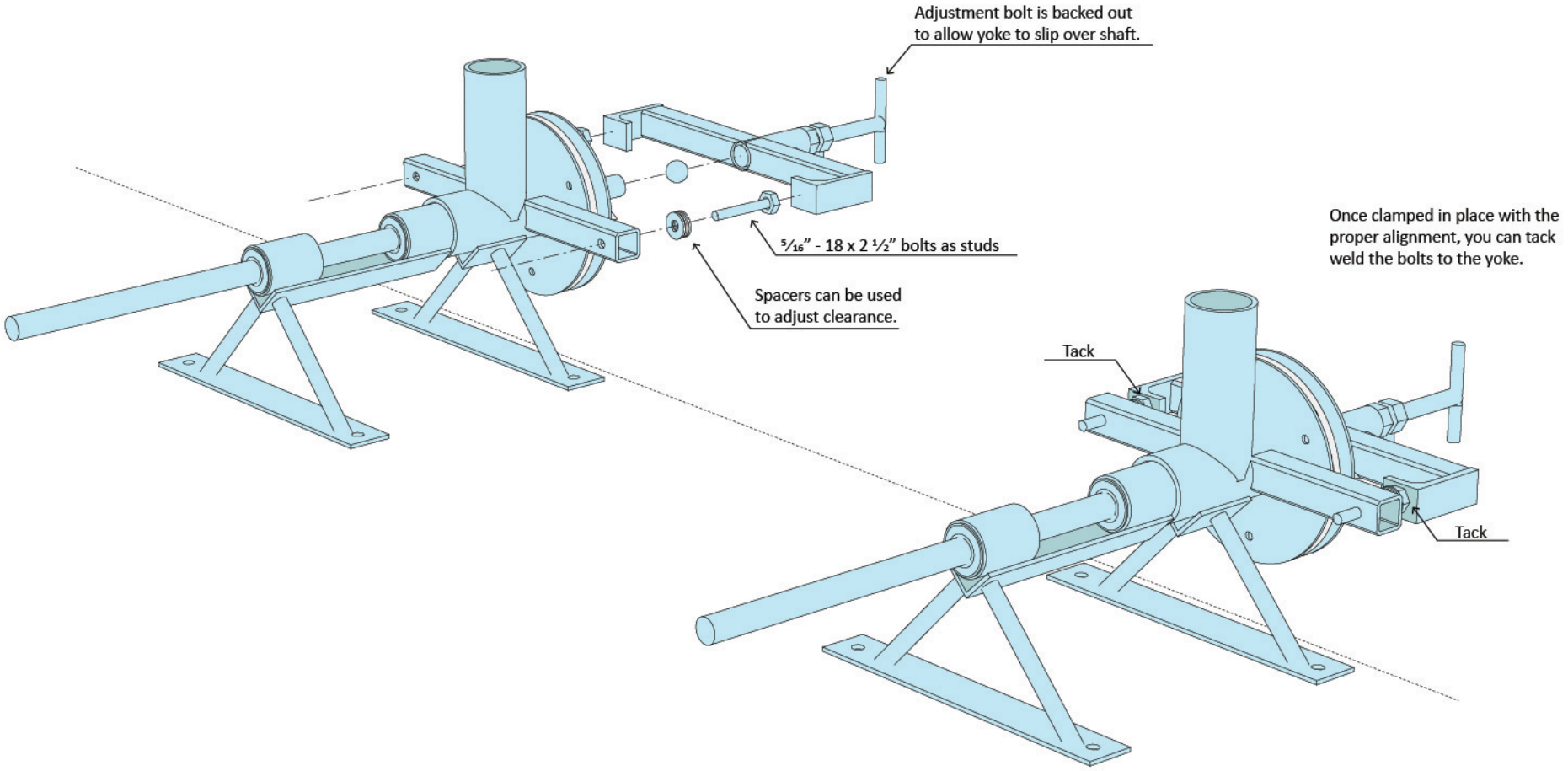
YOKE


Use a 1" hole saw to cut a 1" x 1" x 14g piece of square tube in half.
10 ¾"
Weld a 1" x .12" x .76" piece of round tube 2 ¾" long between the two pieces of square tubing.
16 or 14 g gussets
½" - 13 x 2" bolt. Since the end of the bolt will bear against the ball bearing, it should be filed smooth and square and polished with sand paper or emery cloth.
½" - 13 locknut
½" - 13 nut welded onto end of tube
Yoke stand-offs made from 2 ½" x 2 ½" x ¼" angle iron or similar stock.
2 ½"
1 ¼"
¾" ball bearing coated with vegetable oil. It is not trapped in the bore but bears freely against the shaft and the end of the adjuster bolt.

STEP 6

FINAL ASSEMBLY

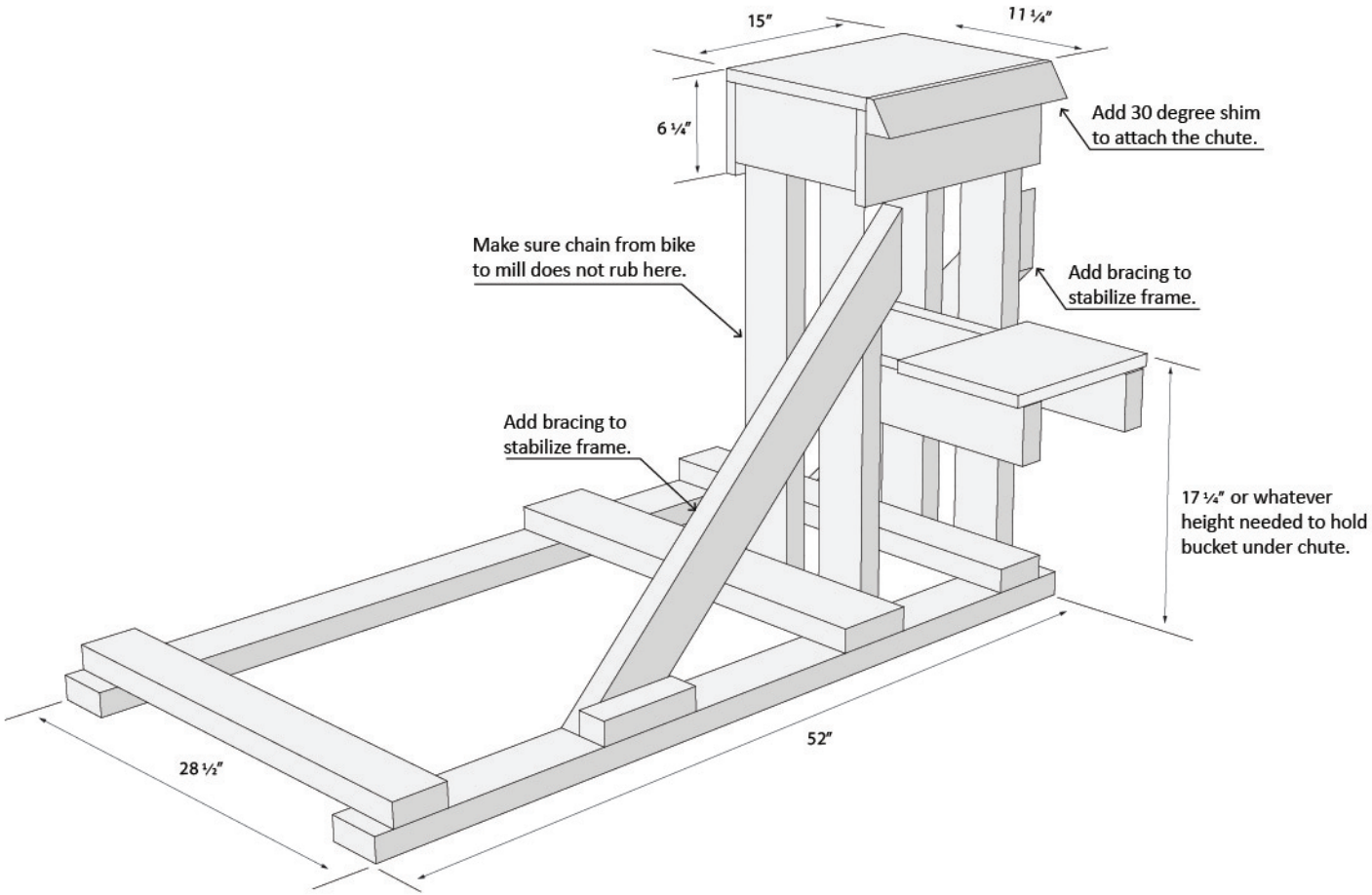
Assemble the auger housing, bearings, and shaft (use flat plywood disks or metal shims to space the runner and bed plates apart so that the auger shell inserts all the way into the auger cylinder but doesn't rub). Assemble the yoke on the end of the shaft (with 3/4" ball bearing inserted) with the two studs. Clamp the assembly in place and tack the studs to the yoke as shown below. Mark the left and right sides of the yoke with a center punch (so it can be re-assembled the same way every time). Disassemble and weld the studs to the yoke.



STEP 7

WOODEN FRAME

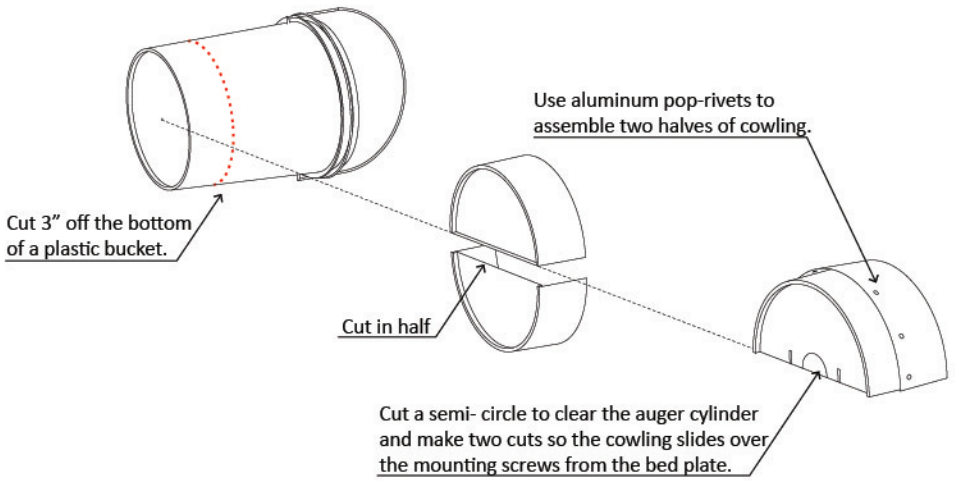
The frame below makes a steady platform to mount both the bike and the mill. The rider faces the mill and can use their hands to pour grain into the hopper or poke the hopper with a stick to keep the grain feeding evenly. The wooden frame can be built from standard 2x4 and 1x12 lumber, palette wood, or any lumber scraps available. The dimensions given worked for the particular exercycle we were using. You may need to vary the dimensions to suit your exercycle.



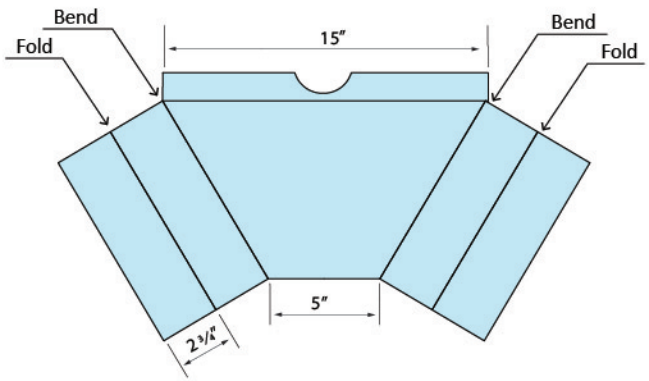
STEP 8

CHUTE + COWLING + FUNNEL

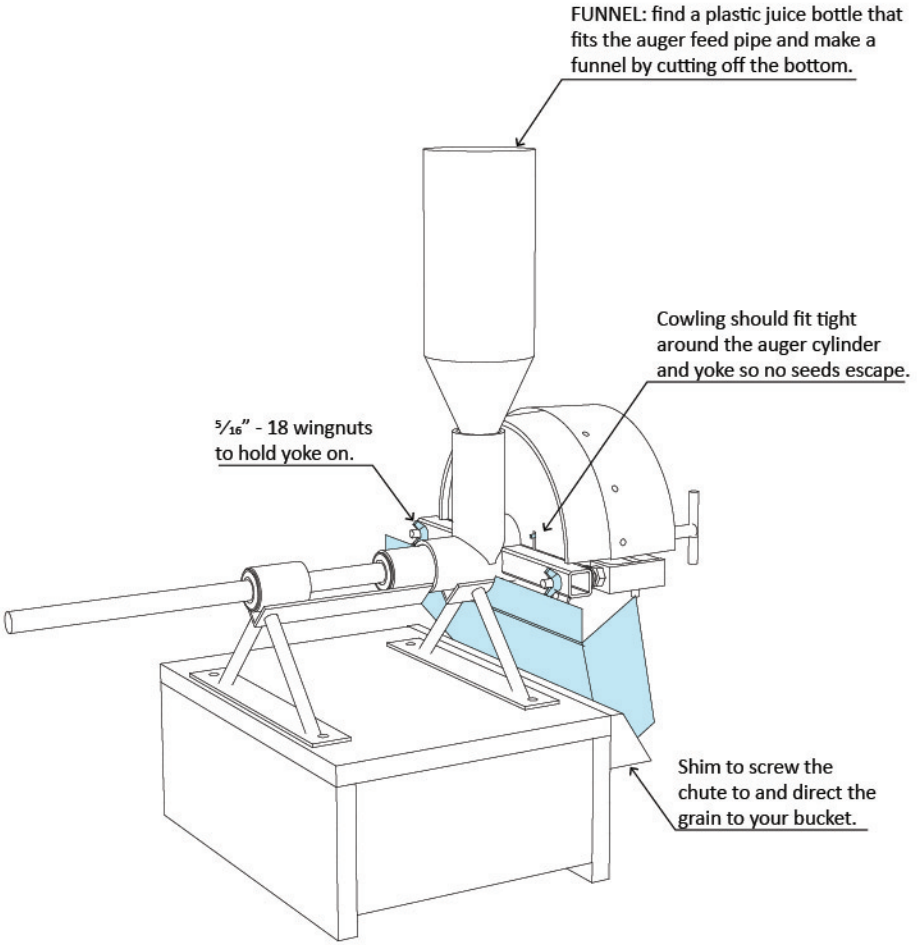
COWLING



CHUTE



ASSEMBLY



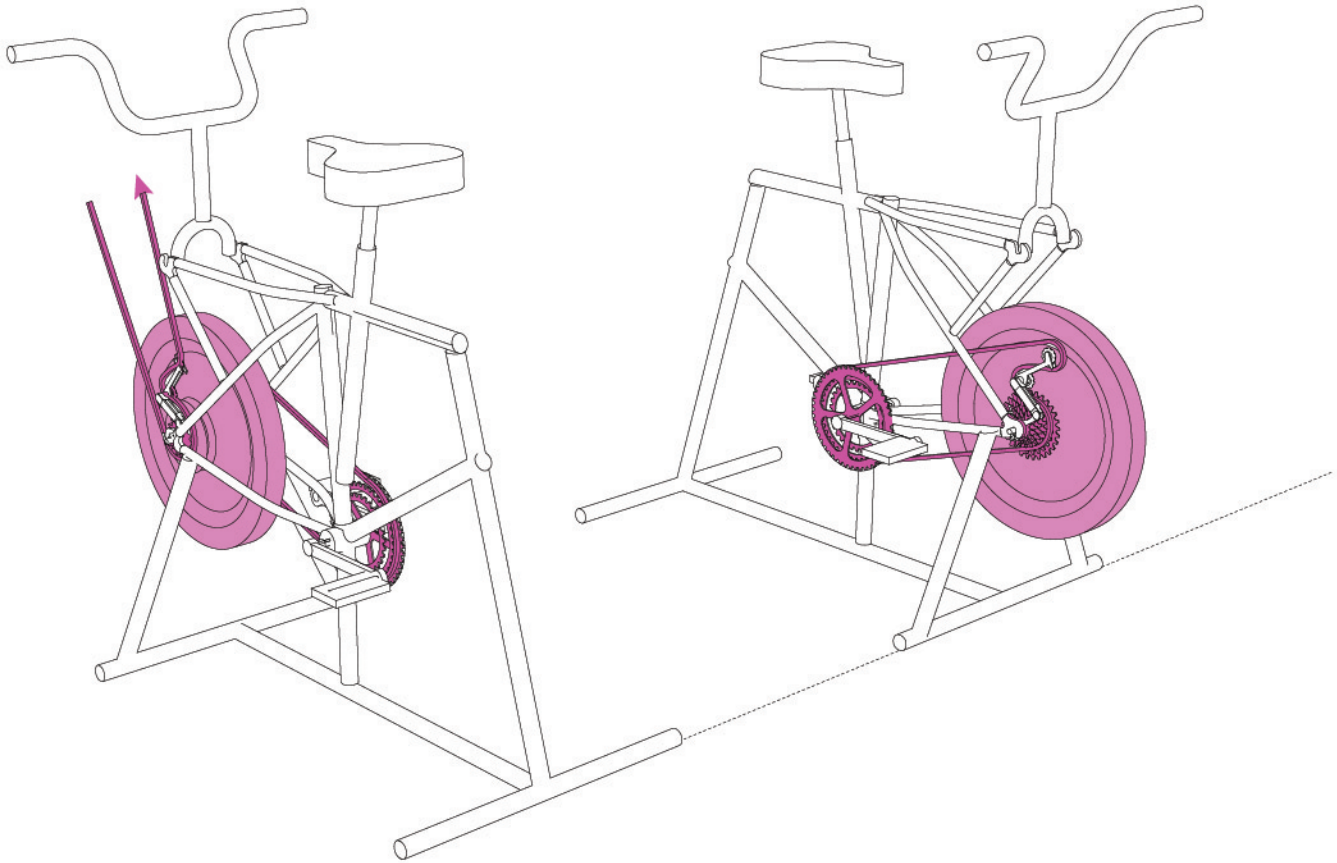
STEP 9

BIKE

Pictured is a method for taking two discarded bicycle frames and making a single stationary bicycle PTO with a flywheel (from an exercycle) and gears. Notice that the drive and non-drive side are reversed. This means some cold setting of the rear triangle may be necessary to accommodate the rear gear cluster. This PTO has the advantage that good components, gears, and a good rider position (power position) can be used. For grinding flour this is great because it takes a lot of power to make flour. Also, dehulling requires less power and a higher rpm, so gears are helpful if the plan is to switch back and forth between dehulling and flour milling.

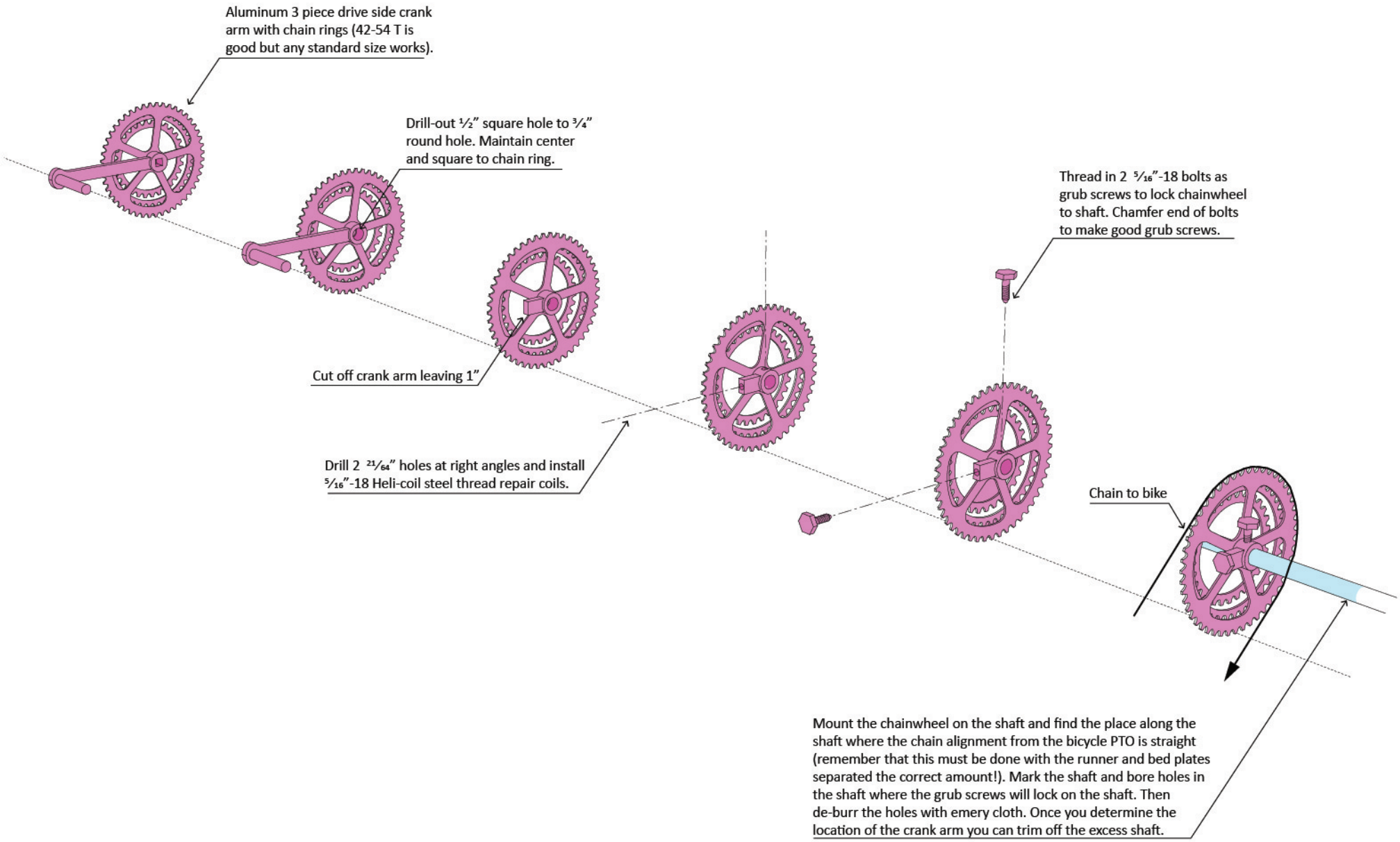
Originally we toyed with the idea of having one bicycle PTO that could be moved from machine to machine. This ended up not working well, as too much set-up time is lost between processes. Obviously this bicycle PTO takes much longer to build than the simple modifications to an exercycle detailed in the previous Grain Bike plans (Thresher, Fanning Mill). It is included because exercycles are sometimes harder to find than bicycles, and some bicyclists will insist on higher performance components and a better riding position than offered by old exercycles.

The choice to use a standard (upright) bicycle position rather than a recumbent position is because the upright position allows the rider/operator to use their hands to feed or adjust the machine being used.



STEP 10

CRANK ARM

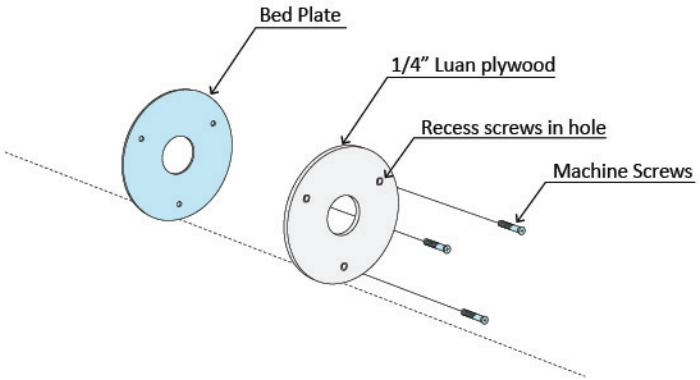


STEP 11

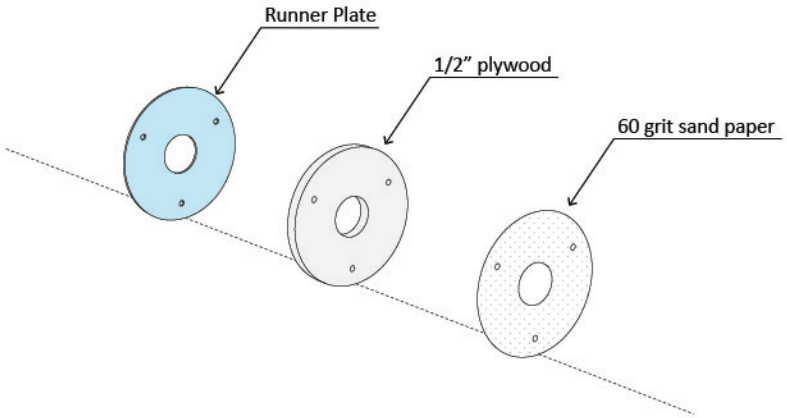
SQUARING SHIM

With the mill assembled and mounted on the frame with the bicycle, one last step can be performed to square up the two plates for precision operation. A 1/4" plywood (such as luan) disk (6" OD) is bolted to the bed plate with machine screws that are recessed in the plywood 3/16". A runner disk of 1/2" plywood is prepared with 60 grit sandpaper glued to it, nice and flat. The mill is assembled and operated so that the sandpaper "runs in" the shim. It usually takes a few minutes of sanding and blowing out the dust until the sanding disk touches the shim over its whole surface. Now the two faces are exactly square. The shim will live on the bed plate sandwiched between the bed plate and what ever bed disk (dehulling or flour burr) is in use. In order to record the shim's orientation make a "timing mark" on the shim and the bed plate.

SHIM



RUNNER DISK



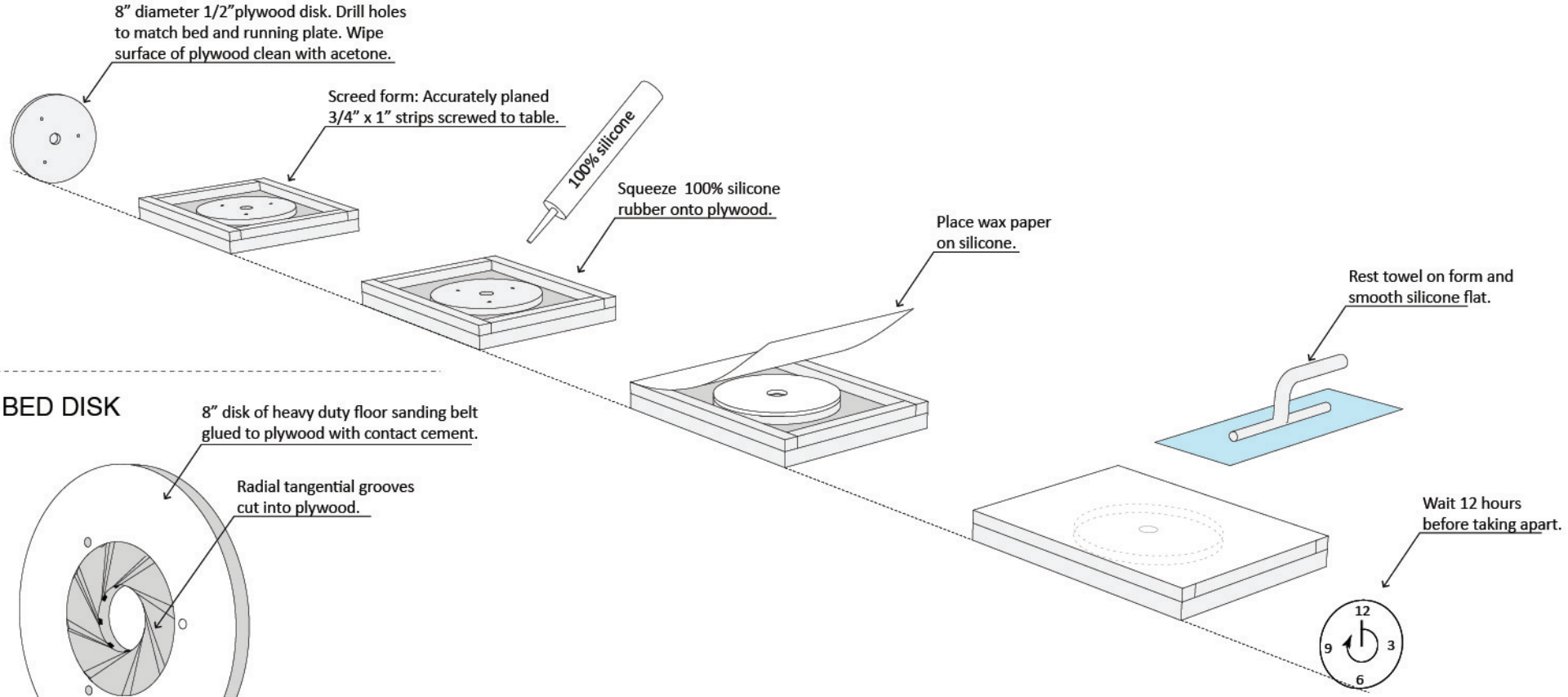
STEP 12

DEHULLING RUNNER DISK AND BED DISK

The runner disk for the dehuller is made by casting a 1/4" thick layer of silicone rubber (use 100% silicone with no additives) on to a flat disk of 1/2" plywood. To cast the silicone rubber nice and flat a screed form is set up around the plywood disk. The silicone is squeezed on to the disk and then a piece of wax paper is laid on top of the silicone and it is towelled flat through the wax paper with the trowel always touching the screed form as a guide for flatness. A good trick to know when tooling silicone is that a wet surface or an ice cube will tool the material without sticking to it. The water left behind does not damage the cure (it actually helps it cure faster). It is reasonable to anticipate that a couple of tries will be required before a good silicone casting is produced. Luckily the cost of making several tries is small.

The bed disk for the dehulling disks is a flat plywood disk with a piece of heavy duty floor sanding cloth (80 grit) glued to it. A series of "radial-tangential" grooves are cut in the plywood to create flumes that admit more grain between the disks. These flumes are made with an angle grinder, wood carving dremel, or chisel and mallet. The flumes have a vertical side and a tapered side. The vertical side is the trailing edge in the direction of travel. The tapered side is the leading edge in the direction of travel ("relative to the spinning runner disk, the bed plate "travels" the other way), and the tangential incline of the flumes is away from the direction of travel. Since plywood wears quickly, eventually the user will want to make a steel bed disk from 1/4" or 3/8" steel plate. Then, instead of sanding cloth, the surface of the bed disk can be made rough by grinding, scoring, etching or blasting.

RUNNER DISK



BED DISK

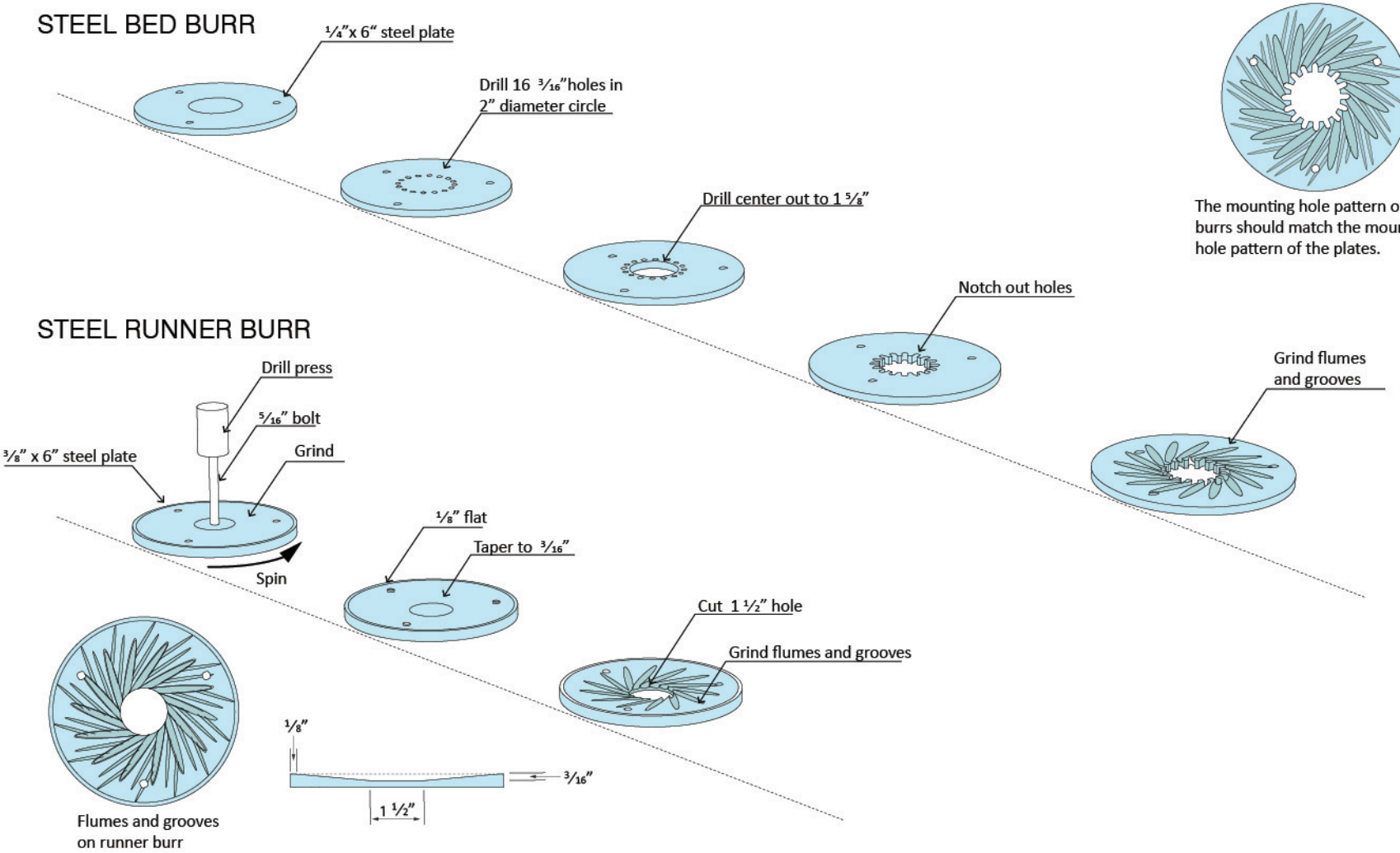
STEP 13

FLOUR BURRS

Steel or stone flour grinding burrs can be bought and mounted on the bed plate and runner plate. Or, steel burrs can be fabricated. The trick to fabricating steel burrs is that one of them, in this case the runner, is dished so that the two burrs only interfere (touch) at the outside edge. To dish the runner burr, cut out a 6" disk from 3/8" steel plate. Make a 5/16" hole in the center of the plate and use a 5/16" bolt with the head removed to mount the plate in a drill press or drill (clamped in a vise). Spin the disk and grind it with an angle grinder until the center (where the diameter equals 1 1/2") is 3/16" lower than the outside edge. Then drill a 1 1/2" hole in the center so the runner burr can mount around the auger shell. The bed burr is a 1/4" steel disk with the center drilled out to 1 5/8". Then a circle of sixteen 3/16" holes is drilled around the center hole of the disk and each hole is turned in to a notch with a jig saw. These notches let more grain between the plates.

Finally, on both burrs a series of flumes and grooves are ground with an angle grinder. The pattern of the flumes and grooves is "radial-tangential" and the flumes grooves should be deeper and wider toward the center and taper toward the outside edge with no groove at all in the outside 1/8" of diameter.

The shop made burrs are easy and cheap to make, however, they don't work as well as high quality commercial burrs.



OPERATIONS

When dehulling, the mill is sensitive to the adjustment of the gap between the runner disk and the bed disk. To properly tune this gap for a batch of grain, start with the gap too wide (1/8"-3/16", depending on the size of the grains). Operate the mill until grain starts falling out from between the disks. Tighten the adjustment bolt on the yoke in small increments until the grain falling out of the mill is dehulled. The hulls should be rubbed off in flakes; if the hulls are falling out as fine powder, then the gap is already too small. If some of the grain is not being dehulled, then the gap is too wide. Note that there is a time lag between when the gap is adjusted and when the grain exiting the mill shows the effects of the adjustment. Therefore, it is necessary to make a small incremental adjustment and wait to see its effect. Once the proper adjustment is obtained, the locknut on the yoke is tightened to hold the adjustment bolt in place. Then any grain in the collection bucket can be added back in to the mill for re-processing. Sometimes a batch of grain contains kernels of widely varying size, making it impossible to properly adjust the gap. Then it is necessary to either make 2 passes through the dehuller, with a smaller gap on the second pass, or to grade the batch of seeds in to two batches of more uniform kernels. For rice, 99% dehulled is ok for eating. However, 95% dehulled is unacceptable for eating and 90% dehulled is a nuisance to eat.

Questions + Comments + Donations -
Contact Lu Yoder - bravelittleship@gmail.com

This project was supported in part by the Northeast Sustainable Agriculture Research and Education (SARE) program (www.nesare.org). SARE is a program of the National Institute of Food and Agriculture, U.S. Department of Agriculture.