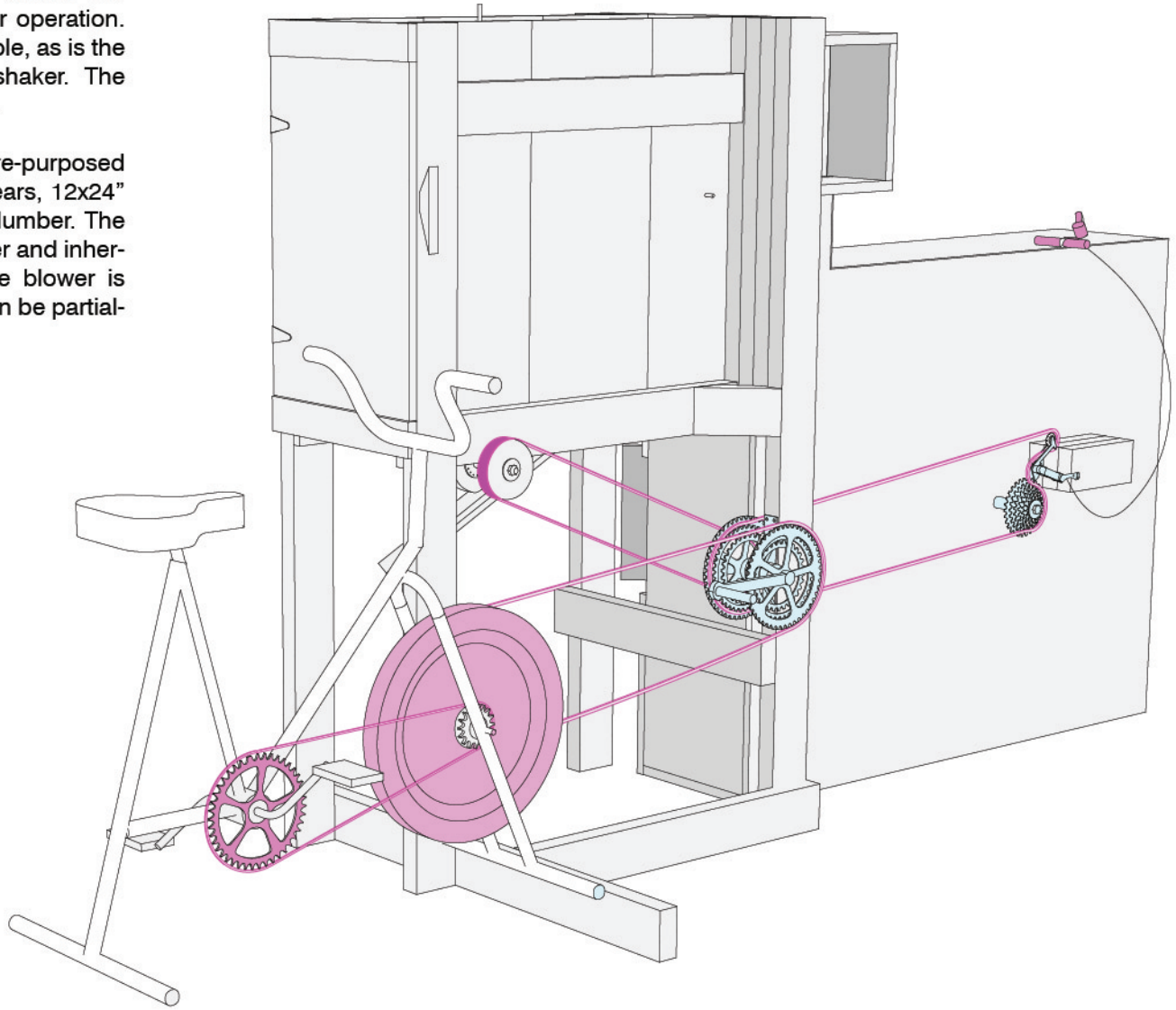
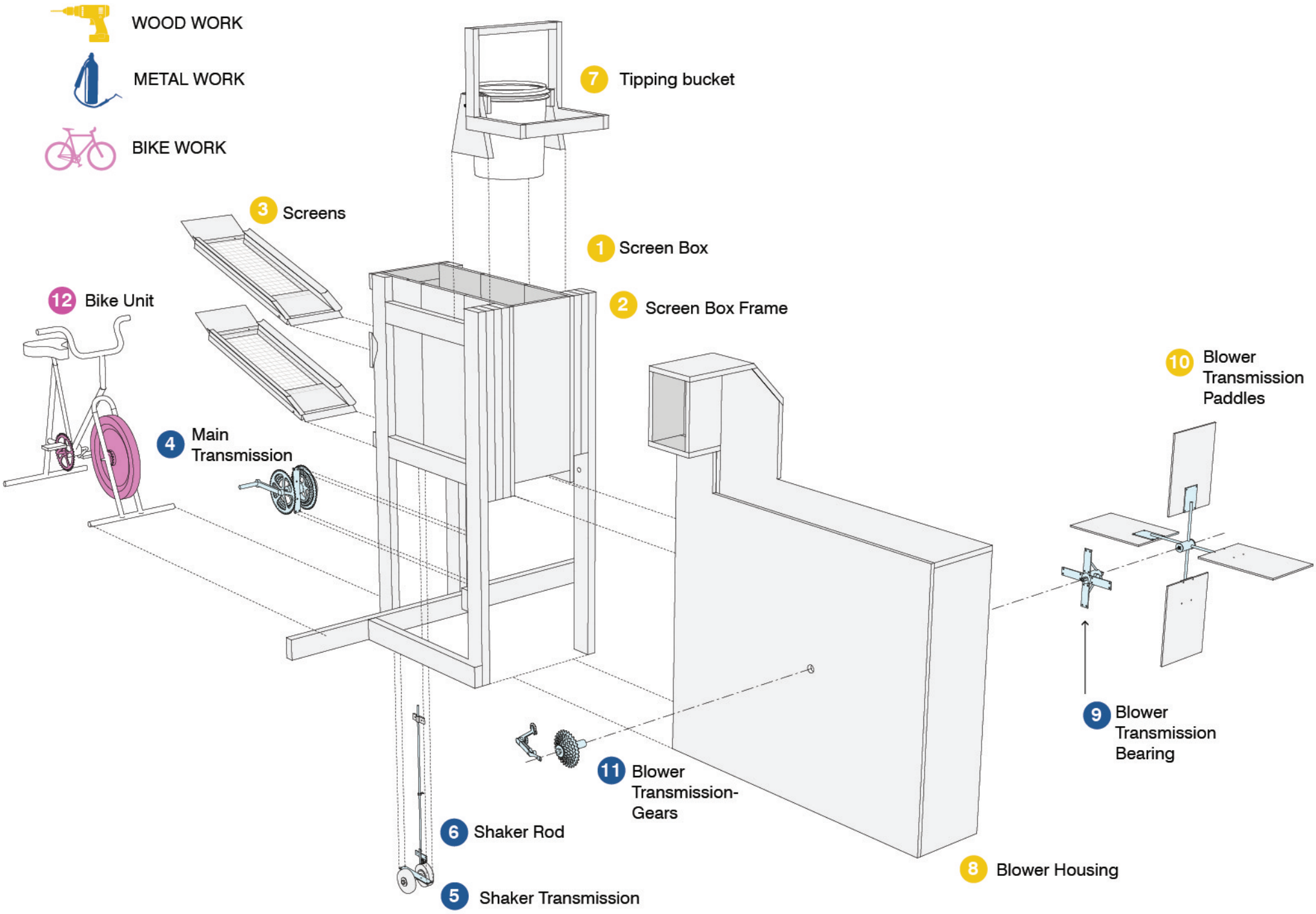
FANNING MILL

The Fanning Mill sorts and clean seeds. It first grades material by size with two (high pass and low pass) screens, and then winnows the remaining material in a vertical winnowing tower. The screen size is selected for the crop or operation. The tilt angle of the screens is adjustable, as is the rate and amplitude of the screen shaker. The speed of the blower is also adjustable.

The design is based around using re-purposed bike parts for the transmission and gears, 12x24" screens, and common 1x12 and 2x4 lumber. The blower is designed for maximum power and inherent turbulence. If finer tuning of the blower is needed (for small seed) the air inlet can be partially blocked (choked).



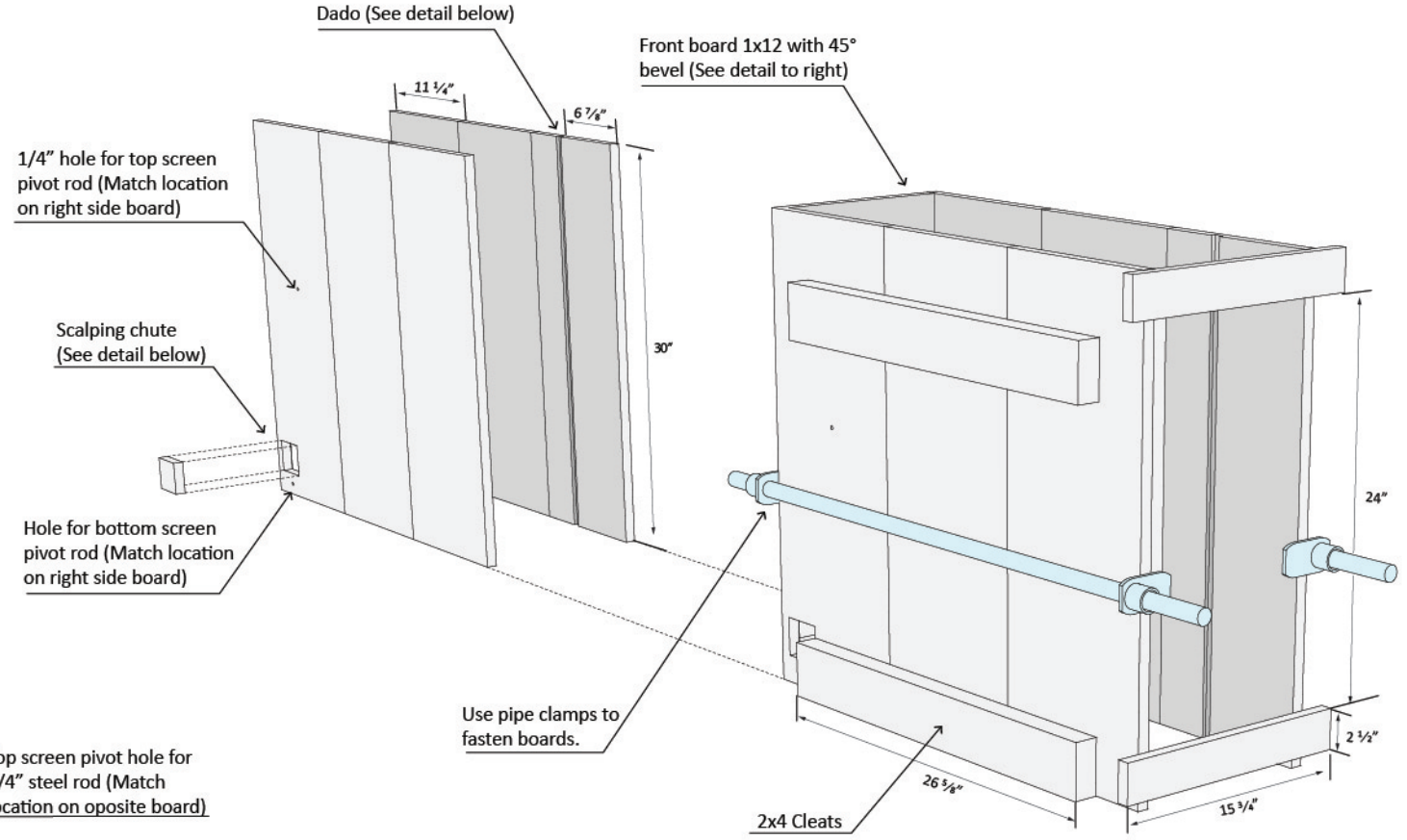
OVERVIEW OF STEPS

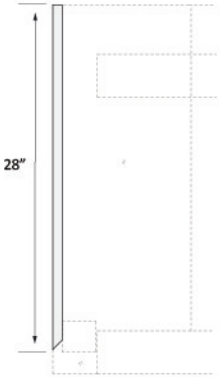


STEP 1

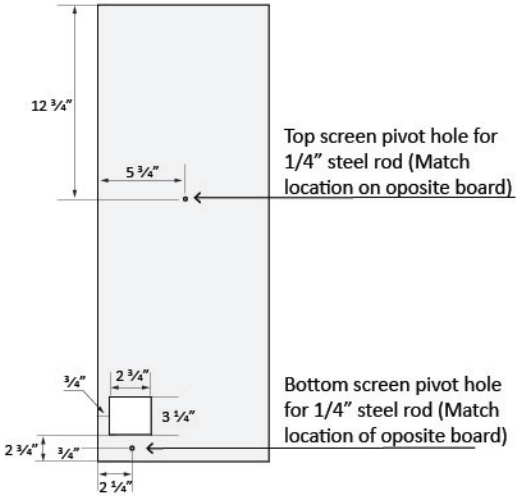
SCREEN BOX

The 1x12 sides of the screen box get cut to 30". Then the dado, the window for the scalping chute, and the holes for the pivot rod are added as shown. The sides are jointed together with the 2x4 cleats. It is a good idea to use pipe clamps to squeeze the edges of the 1x12 together so that no little gaps are left where seeds could get stuck or escape. Once the two sides are made, the front board can be made and attached, as well as the two back frame pieces.

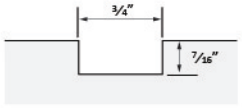




Front Board Detail



Scalping Chute and pivot rod hole detail

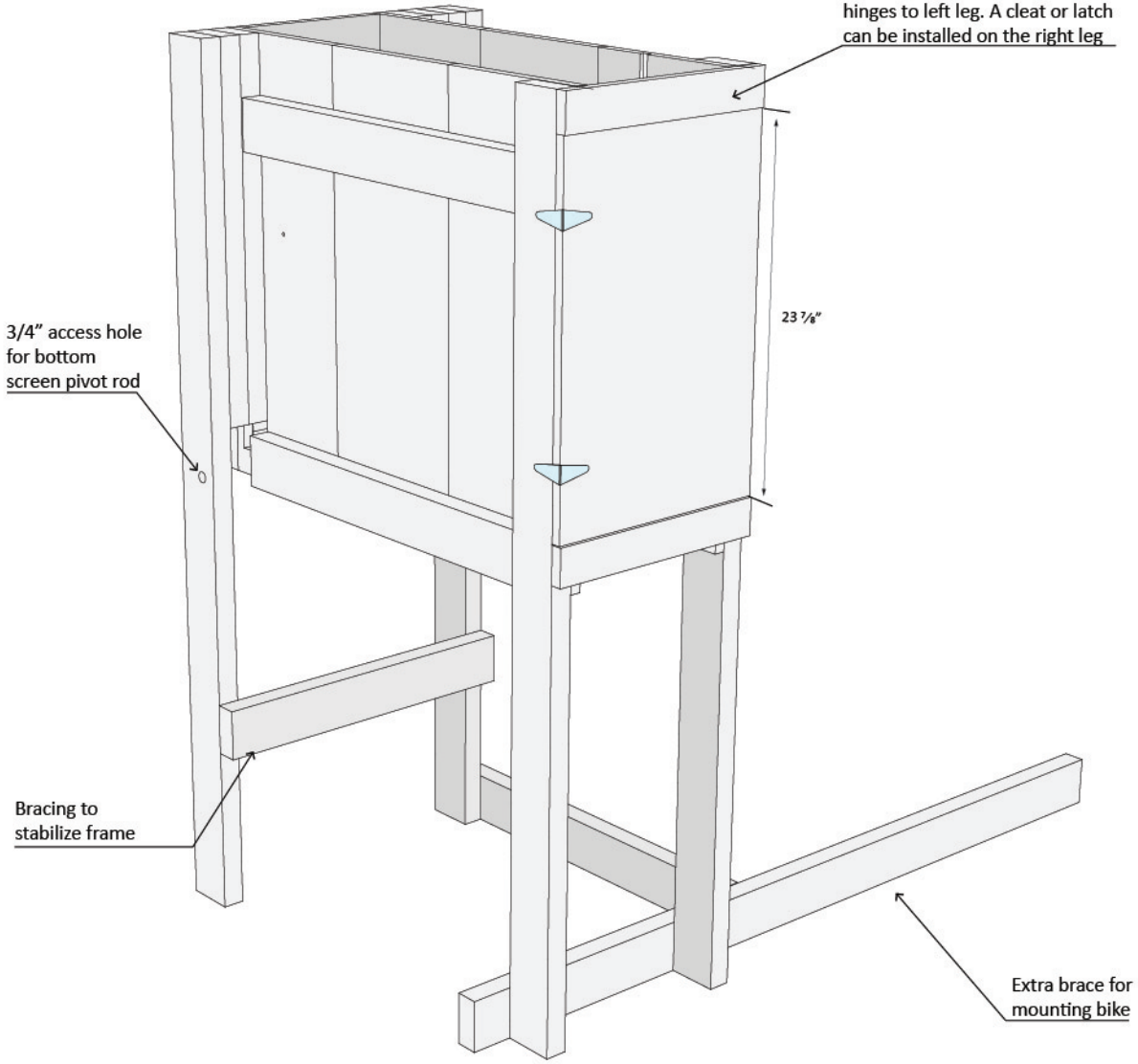


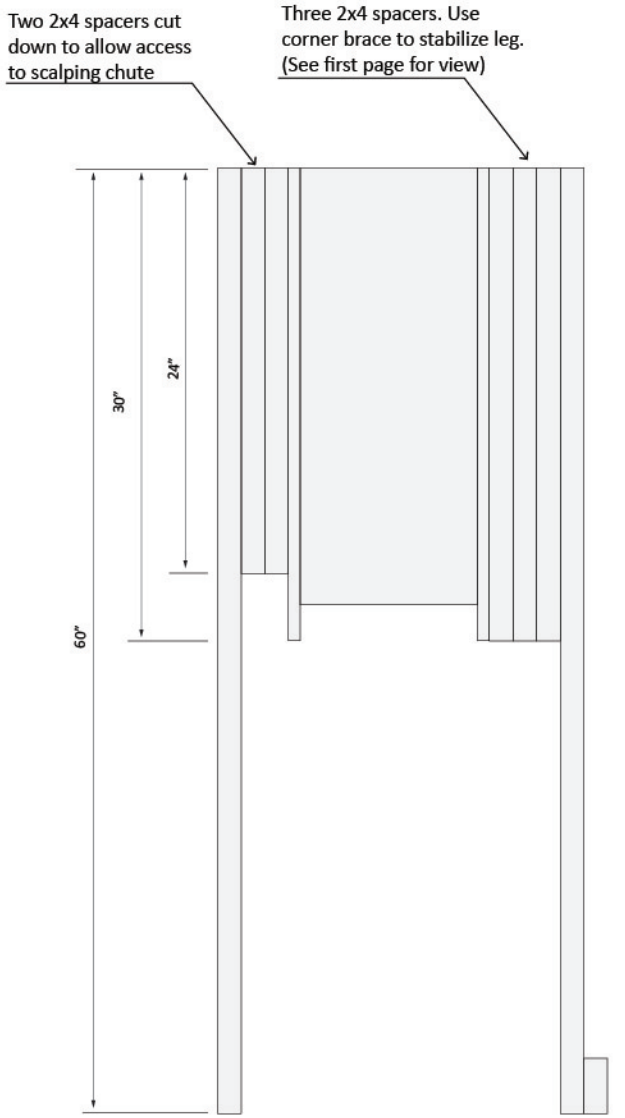
Dado Detail

STEP 2

SCREEN BOX FRAME

Next attach the 2x4 leg spacers and legs. Finally the bracing and back door can be attached. At this point the 1/4" rods that the screens pivot on can be installed, or that can be left for the metal working phase of the construction. The 2x4 spacers on the drive side of the screen box allow the main transmission to align. On the non-drive side, the spacers just allow room for the scalping chute.





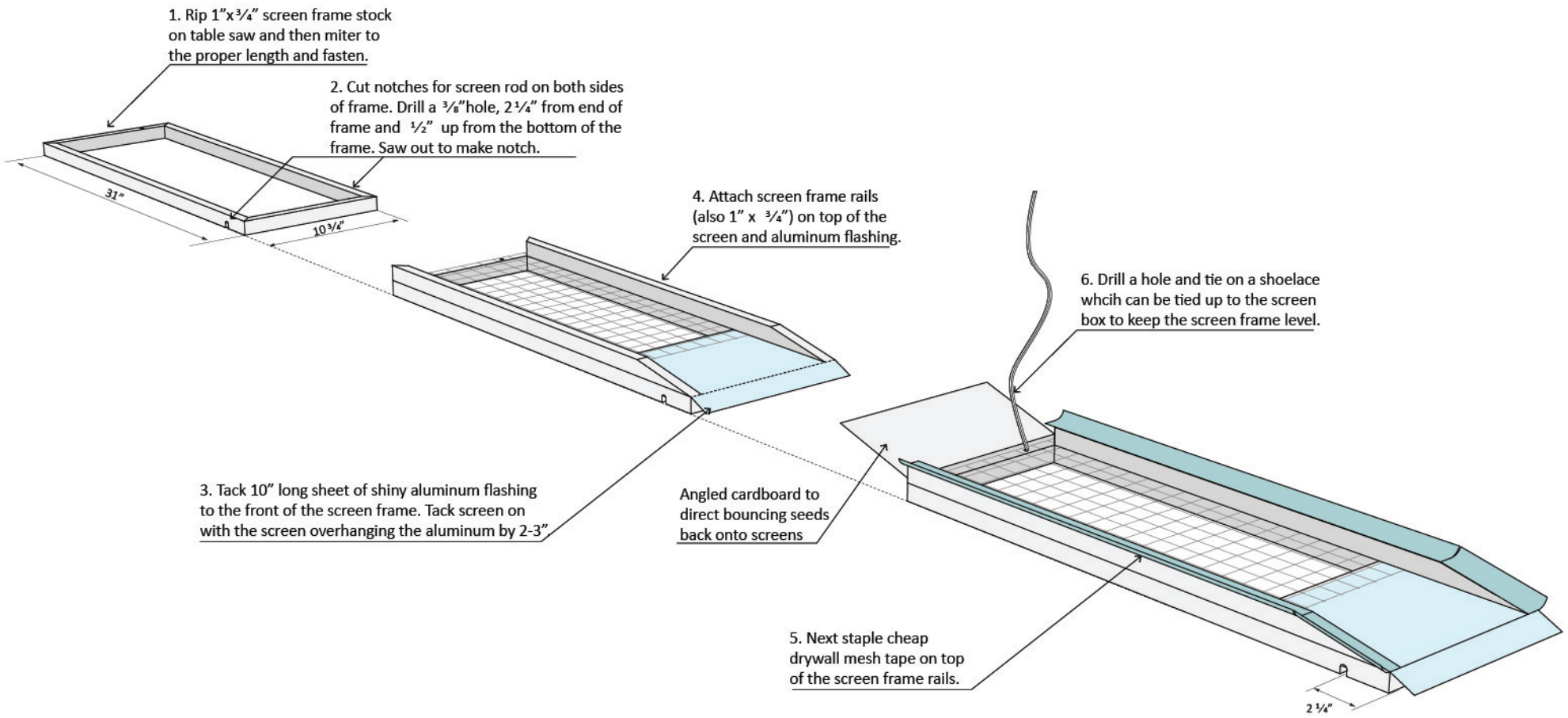
STEP 3

SCREENS

The screen frames are all the same size, so depending on how many different screens you plan to use, the parts for the screen frames can be mass-produced. Note that on screens used on the bottom level (grading screens) of the fanning mill it may be necessary to chisel off some wood from the left side of the screen frame rail so it is easier to put in and remove the screen from the frame box. When a screen is in use the proper angle of the screen in the screen box (for a given crop) will be determined by trial and error. Once a good angle is determined, the space in the screen box behind the screen needs to be filled with an angled piece of cardboard that directs bouncing seeds back on to the screen.

One good way to select screen size for a given crop is to take a sample of the crop and manually sift it with different screens until the correct screen is found. The exact type of screen and the exact shape of the seeds can make screen selection tricky and surprising.

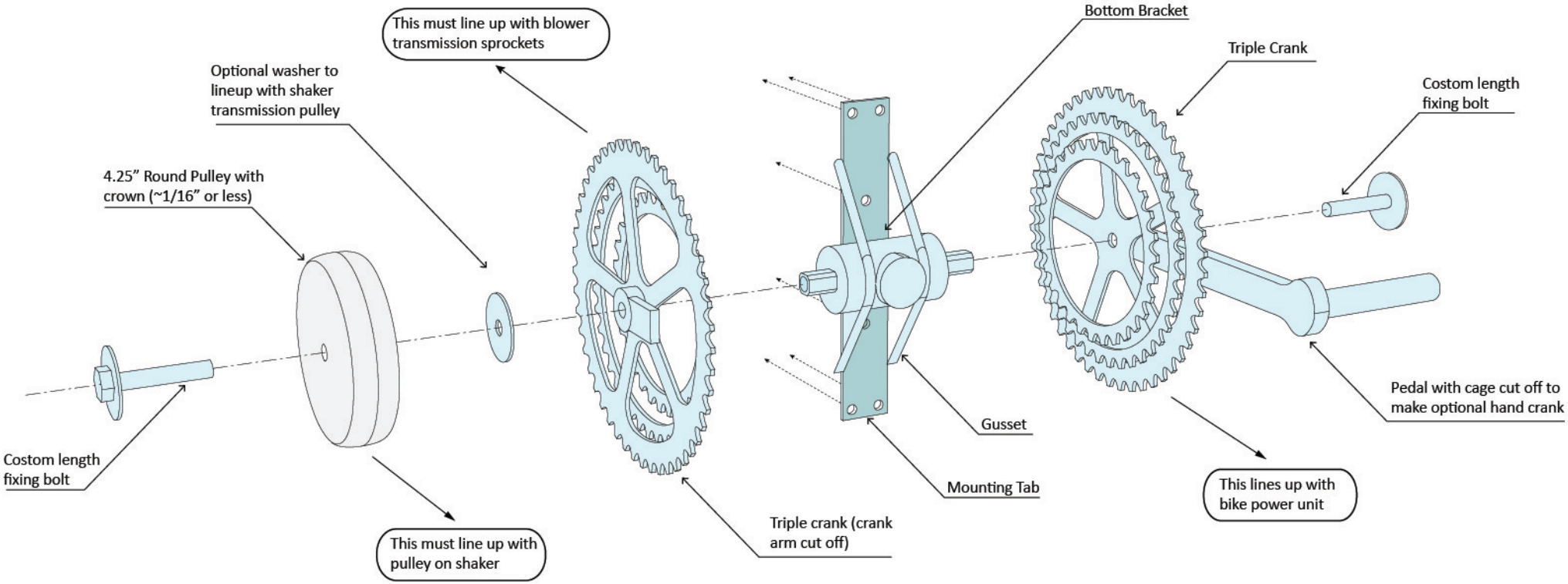
A 24"x 12" piece of screening is enough to build one screen. The purpose of the screen is to sort the seeds by size. The purpose of the shiny aluminum flashing is to allow seeds to slide easily down the non-shaking end of the screen and sail with some speed into the winnowing tower.



STEP 4

MAIN TRANSMISSION

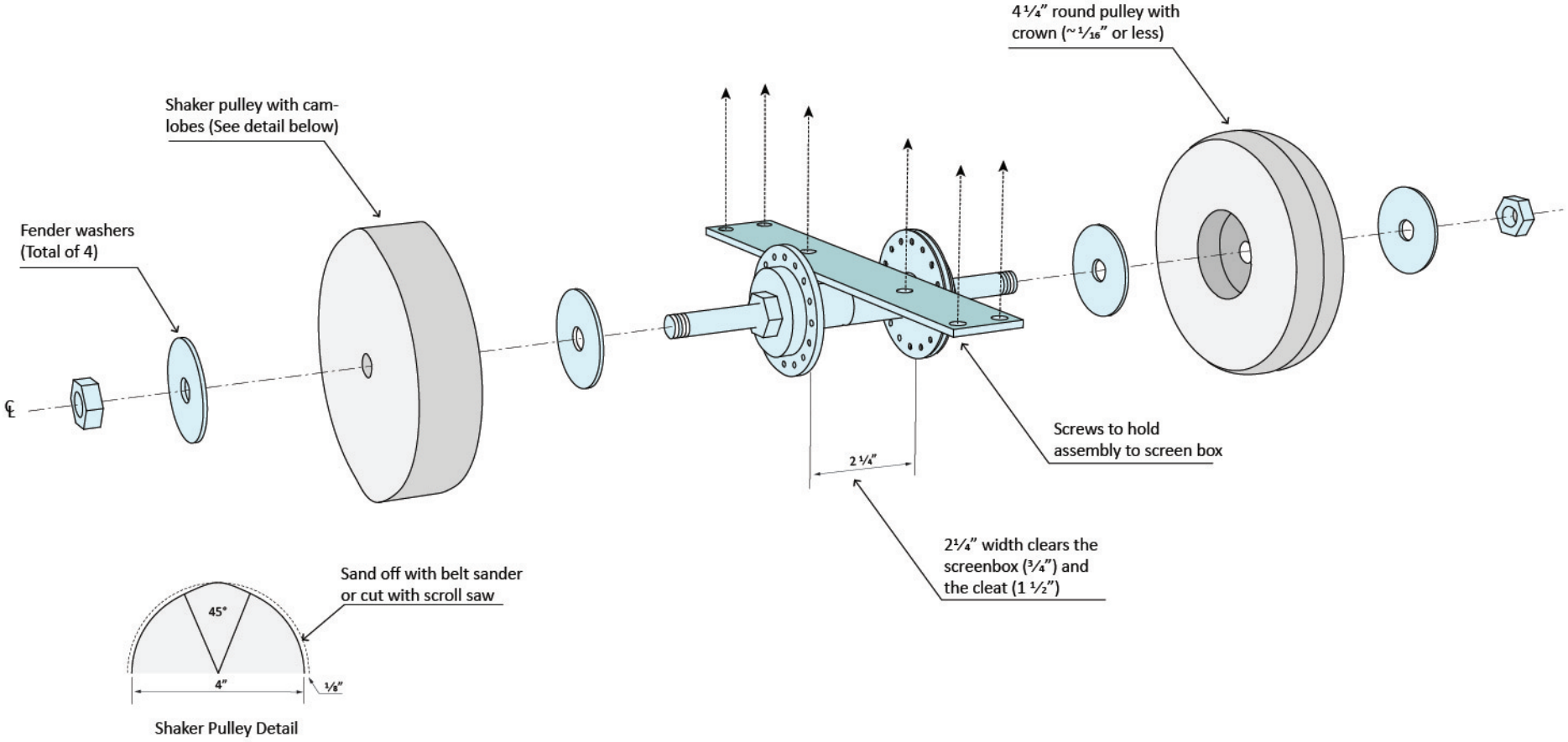
The main transmission is made from a couple of scavenged triple cranks and a bottom bracket. The bottom bracket is cut off the bike frame and taken apart. These instructions assume a bottom bracket spindle with threaded holes for the fixing bolts. If yours has threaded studs for fixing nuts, that's OK. To the bottom bracket shell attach some pieces of flat steel strap with mounting holes. Also, take the opportunity to weld the holes into the bottom bracket shut and install a zerc fitting for ease of lubrication in the future. Take care to protect the bottom bracket threads from weld spatter. Reassemble the bottom bracket. On to the right side spindle mount a triple crank with the crank arm and a pedal shaft (The pedal shaft is so you have the option of hand cranking the machine in addition to pedalling it). On to the left side spindle mount a triple crank with the crank arm cut off. A 4" diameter by 1" thick crowned flat belt pulley will also mount on this side. You will need to fabricate or buy a custom length fixing bolt to secure the left side assembly of pulley plus crank arm. The standard size female thread in a spindle is 8mmx1mm. If your spindle has a threaded stud, just weld an extension of threaded rod (3/8" for example) to it and use a fixing nut on the outside. Mount the transmission on the leg of the frame box, check the alignment of the flat belt pulley on the left side crank with the flat belt pulley on the shaker mechanism (see step 5). The transmission can be slid sideways to help the alignment, or a washer can be added between the crank arm and the pulley.



STEP 5

SHAKER TRANSMISSION

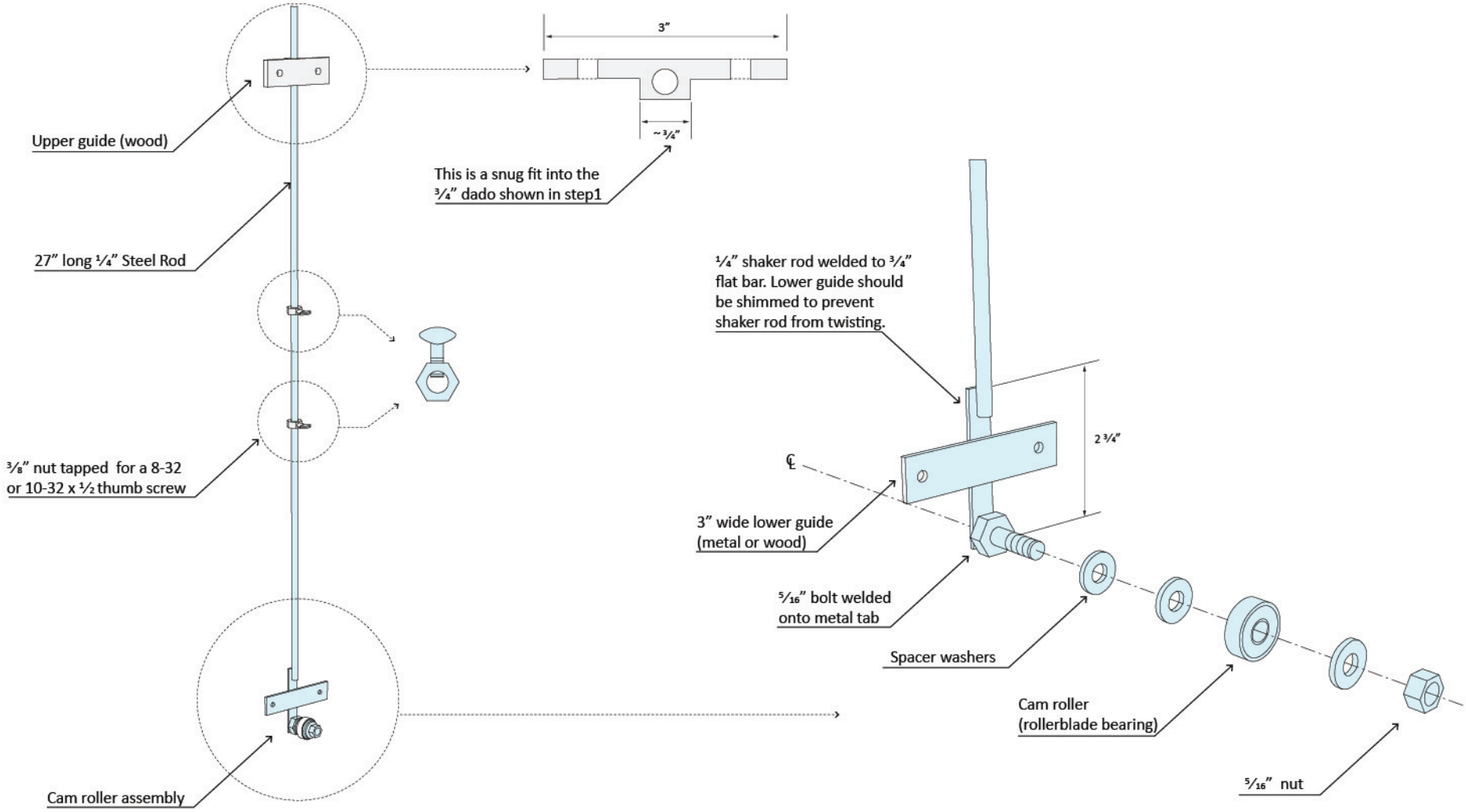
Begin by scavenging a steel front hub from a bicycle. Disassemble the guts from the hub shell and set them aside. Cut the hub shell with a grinder and tack weld it back together so that the inside width between the flanges is 2.25". Also tack-weld on a piece of sheet metal with holes as shown in the drawings. In order to keep the hub axis straight while it is welded, it might help to reassemble the axle guts before welding. If possible, avoid changing the axle length, as it will be helpful in the next steps to have the axle as long as possible. If the un-threaded part of the axle makes this impossible, consider using a different axle. When the welding is done, the hub will now mount nicely on the bottom of the screen box with the hub flanges snug around the bottom of the screen box. Next, measure the size and depth of a hole whose diameter clears the cones and locknuts of the hub, and will in depth allow the pulleys to be located within an eighth inch of the sides of the screen box. The pulleys are made from 1" thick plywood. If a scrap of 1" thick plywood can't be found, two sheets of 1/2" plywood can be laminated together, or pieces of lumber can be laminated together. The pulley circle is cut out with the center marked. The exact diameter of the pulleys is not important. Then the hole on the hub flange side of the pulley is bored, and then the rest of the pulley axis can be drilled out to the size of the front hub axle. The pulley is mounted on the hub in a sandwich of fender washers --that is-- fender washer, wooden pulley, fender washer, axlenut.



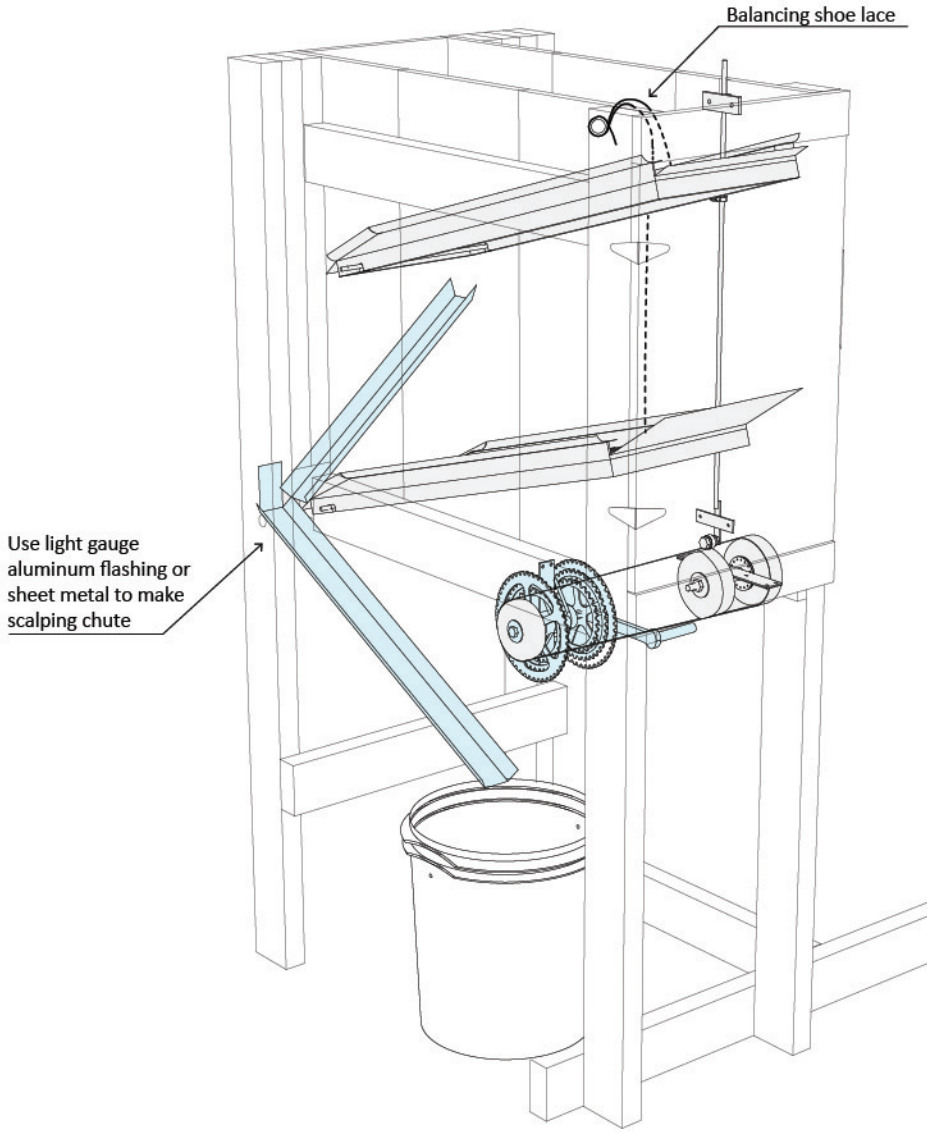
STEP 6

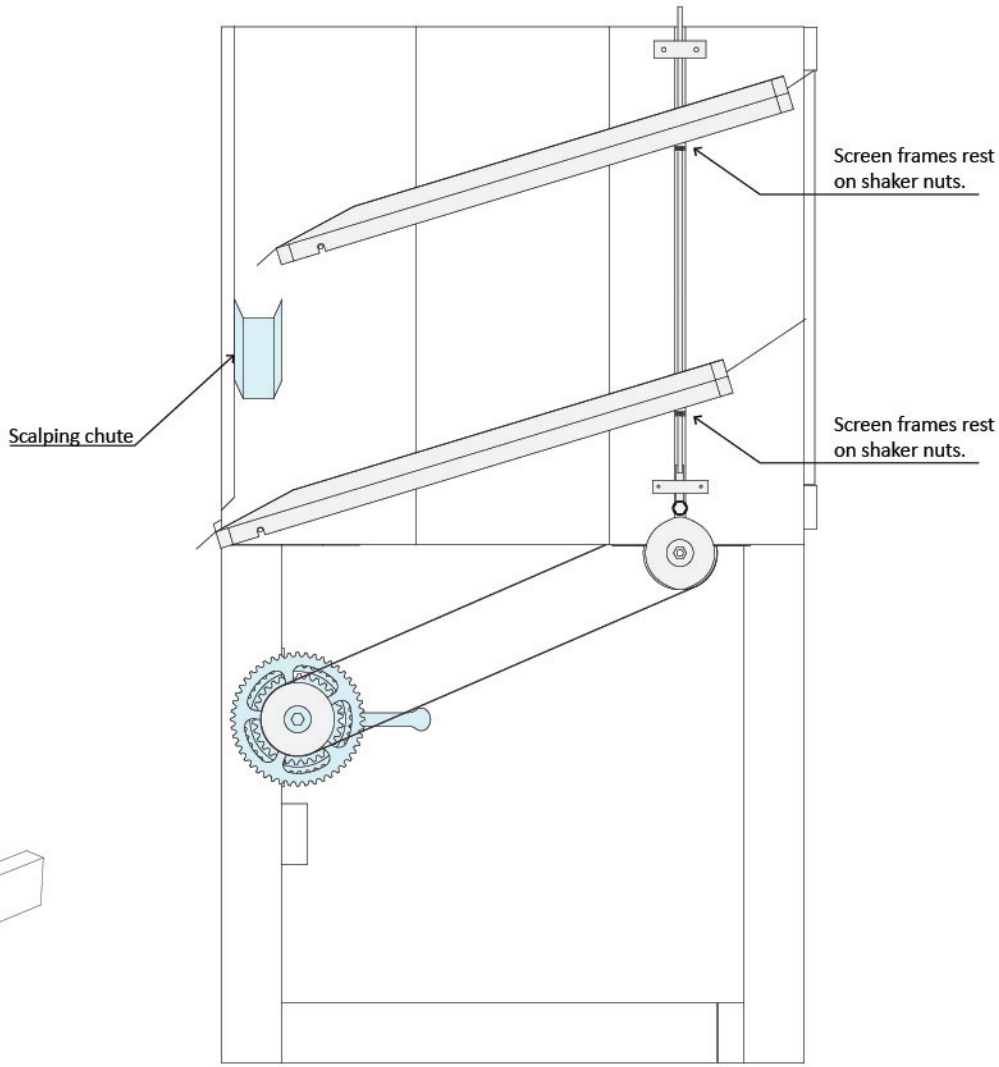
SHAKER ROD

The shaker rod is driven up and down by a roller blade bearing rolling on a rotating pulley with cam lobes. The screens in the screen box are bumped by an adjustable nut. The frequency of the shaking can be adjusted by varying the pulley sizes. The amplitude of the shaking can be adjusted by changing the size of the cam lobes. The guides are just bushings that hold the shaker rod in the dado on the screen box and can be made of wood or metal. The tab on the bottom of the shaker rod is only there to make welding a bolt on easier. The bolt could also be welded directly to the shaker rod.



SCREEN BOX ASSEMBLY

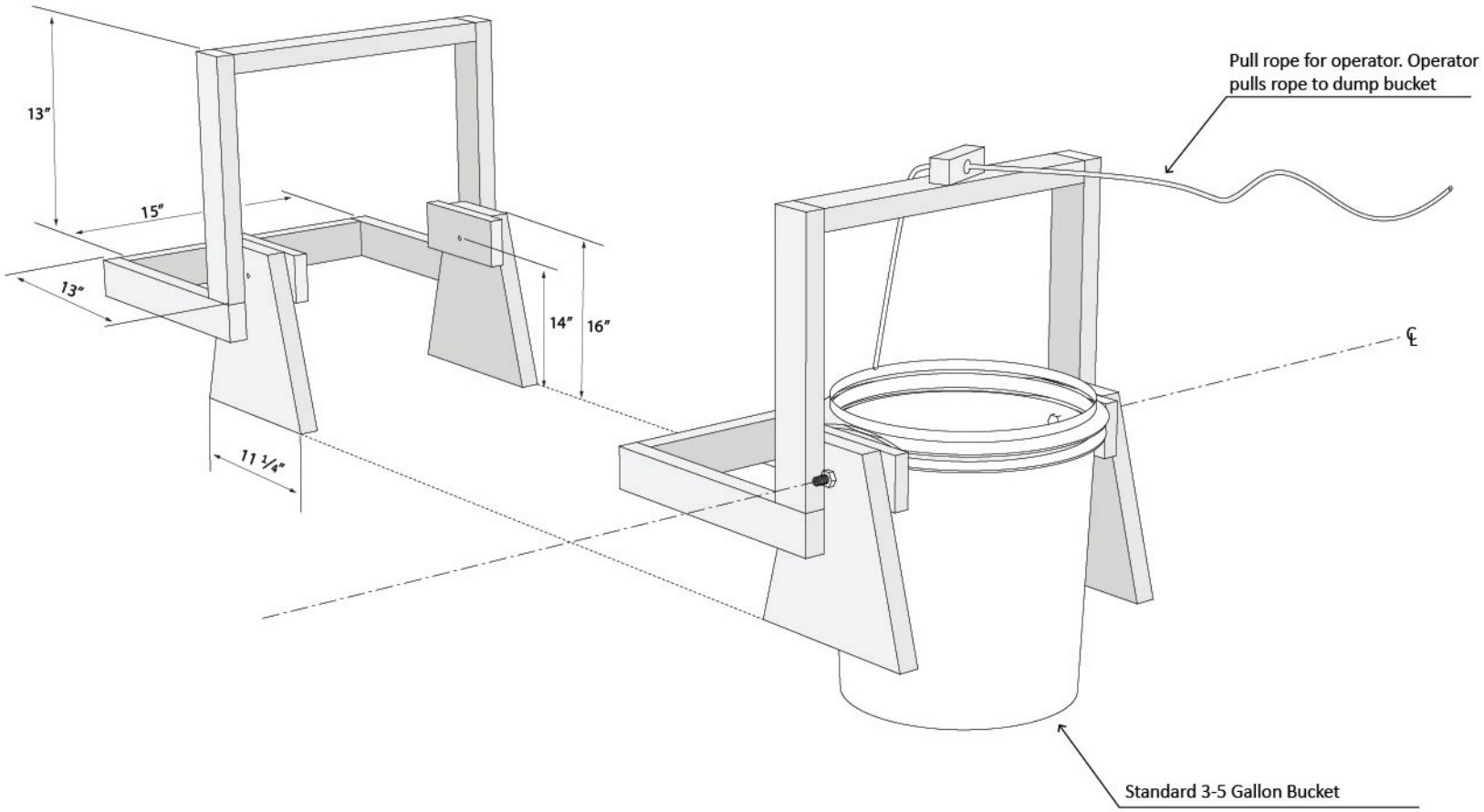




STEP 7

TIPPING BUCKET

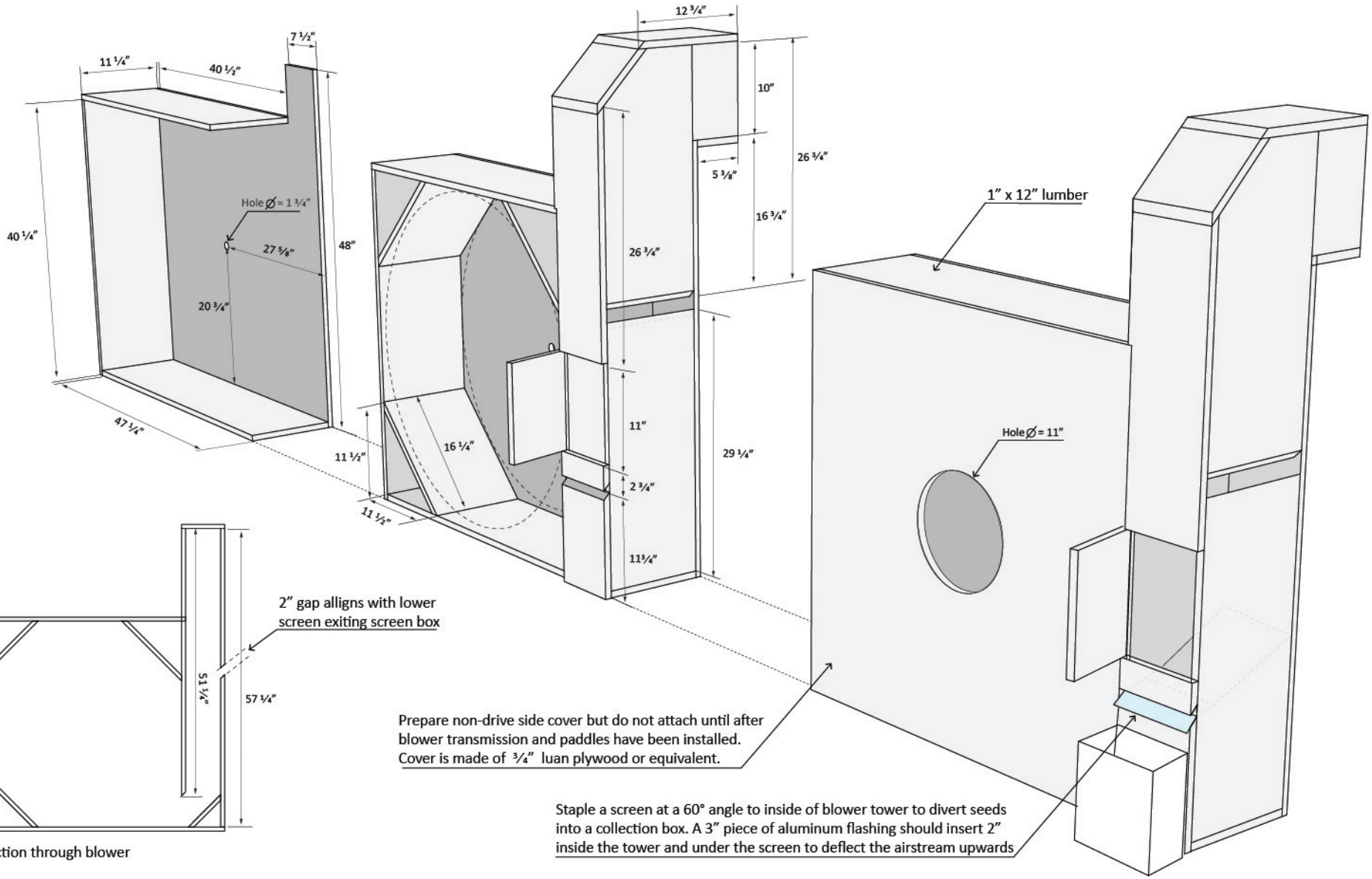
The last step to complete the screen box is to make a bucket and yoke so that a person operating the fanning mill can control the pouring of the material on to the top screen of the fanning mill. A suitable 3-5 gallon bucket is attached by two bolts to a rigid wood frame (made of scraps) that spans the top of the frame box. The yoke is designed to stabilize the loaded bucket and is allowed to slide a little along the top of the frame box so that the location on the screens where the bucket dumps the plant material is adjustable.



STEP 8

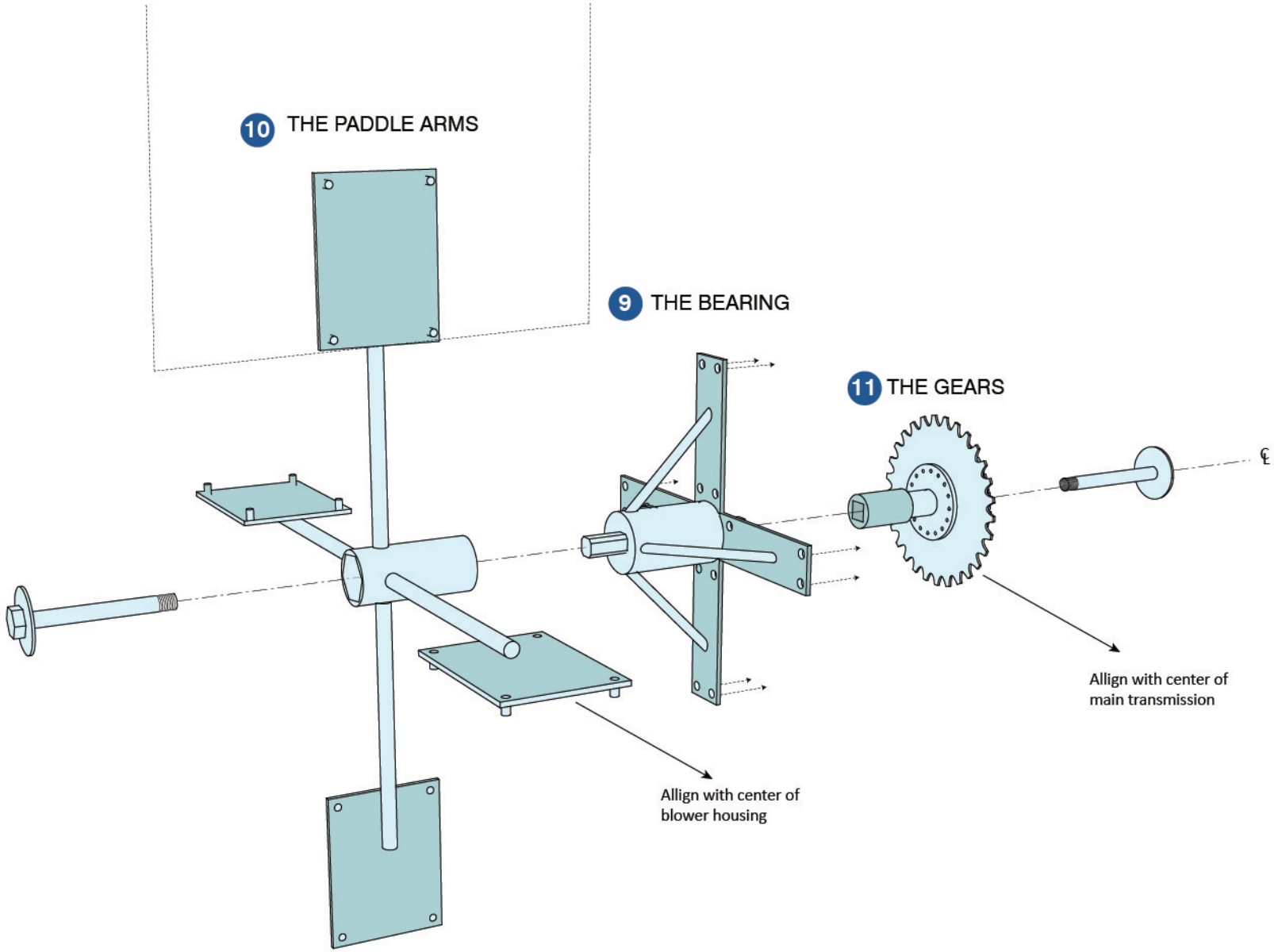
BLOWER HOUSING

Start by cutting out the drive side cover from a sheet of 3/4" plywood. Then attach the 1x12 frame pieces. The frame pieces that are along the back of the winnowing tower will need to mate face to face with the 1x12 on the front of the screen box, slots aligned for the bottom screen to pass through, so make sure those are smooth and flat. The pieces of wood (and small hinged door) that seal up the non-drive side of the winnowing tower should be assembled carefully so that air (or seeds) don't leak out. The design of the blower housing allows the non-drive side cover to be removed quickly and easily so that the inside if the blower can be cleaned, or a piece of debris obstructing the blower paddles can be removed.



BLOWER TRANSMISSION - OVERVIEW

The construction of the blower is described in 3 parts, first the bearing, then the paddle arms, then the gears. However, the alignment of the gears with the main transmission, and the alignment of the blower paddles with the blower housing, must be kept in mind during the construction of the three parts.

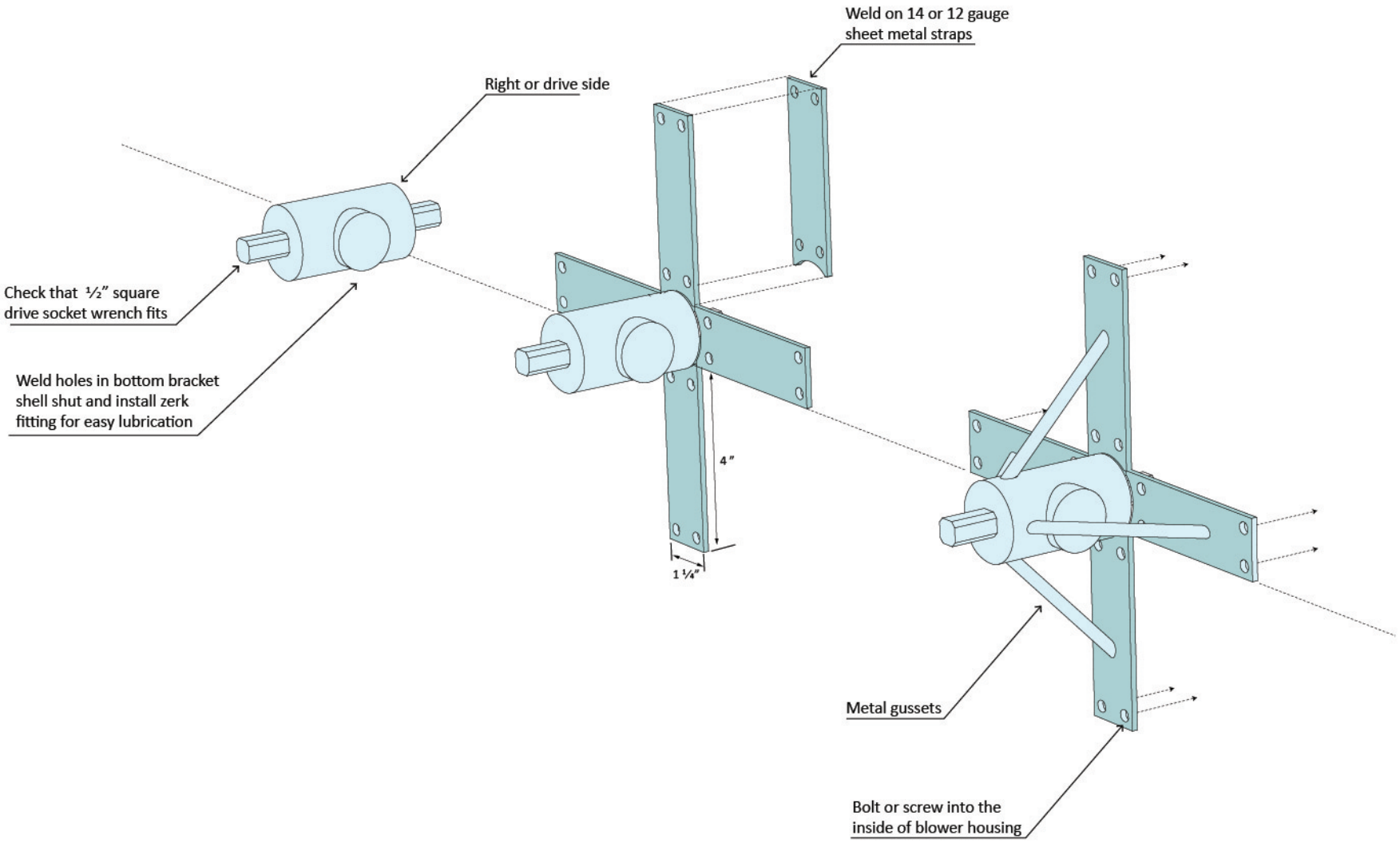


STEP 9

BLOWER TRANSMISSION - THE BEARING

First, a bottom bracket is cut from a bicycle and disassembled. Although there are different bottom bracket spindle standards, most spindles have a square tapered end. Check that a standard 1/2" square drive socket wrench socket slides on to your square tapered spindle. This is the trick that will make the whole part possible to easily build. Then, four sheet metal straps with mounting holes are welded to the bottom bracket (right side or drive side), along with some metal gussets to stiffen the assembly.

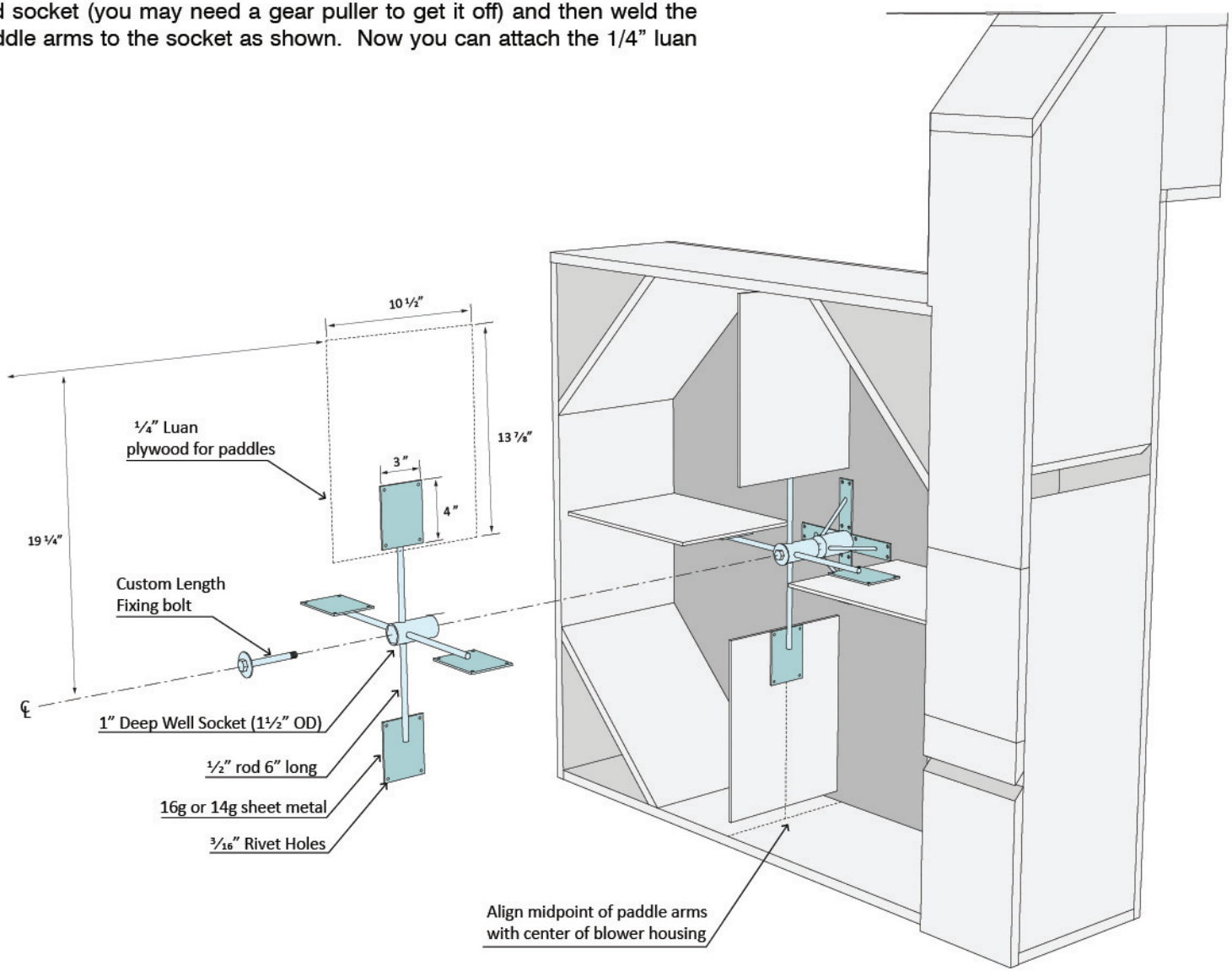
Take this opportunity to weld the holes into the bottom bracket shell shut, and install a zerk fitting for future ease of lubrication. Take care to protect the bottom bracket threads from weld spatter. Then reassemble the bottom bracket. The bottom bracket will now mount to the inside of the blower housing, with its right side spindle-end protruding through the hole in the blower housing. The left side spindle-end will be inside the blower housing.



STEP 10

BLOWER TRANSMISSION - THE PADDLE ARMS

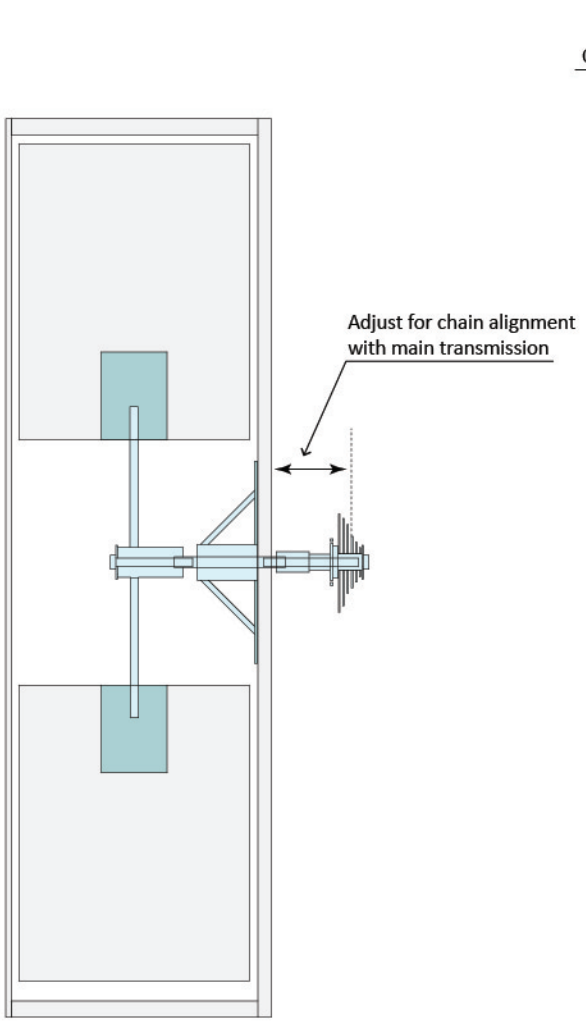
On to the left side of the spindle will mount the blower paddle arm assembly. Take a 1/2" drive by approx 1" deep well socket (approx 3" long) and make a custom fixing bolt (or threaded rod extension, if your spindle has a threaded stud- instead of a threaded hole) that allows you to mount the socket on the spindle where the crank arm would normally mount. Tighten the fixing bolt. Measure from along the socket and mark the point that corresponds to the center of the blower housing. Remove the fixing bolt and socket (you may need a gear puller to get it off) and then weld the paddle arms to the socket as shown. Now you can attach the 1/4" luan plywood paddles to the paddle arms with 3/16" aluminum rivets or small bolts. Or, you may want to wait to attach the plywood paddles to the blower assembly until everything is mounted so you can exactly center the paddles on the blower housing. Either way the finished paddle wheel can be spun and checked for clearance before the non-drive side plywood cover is attached.

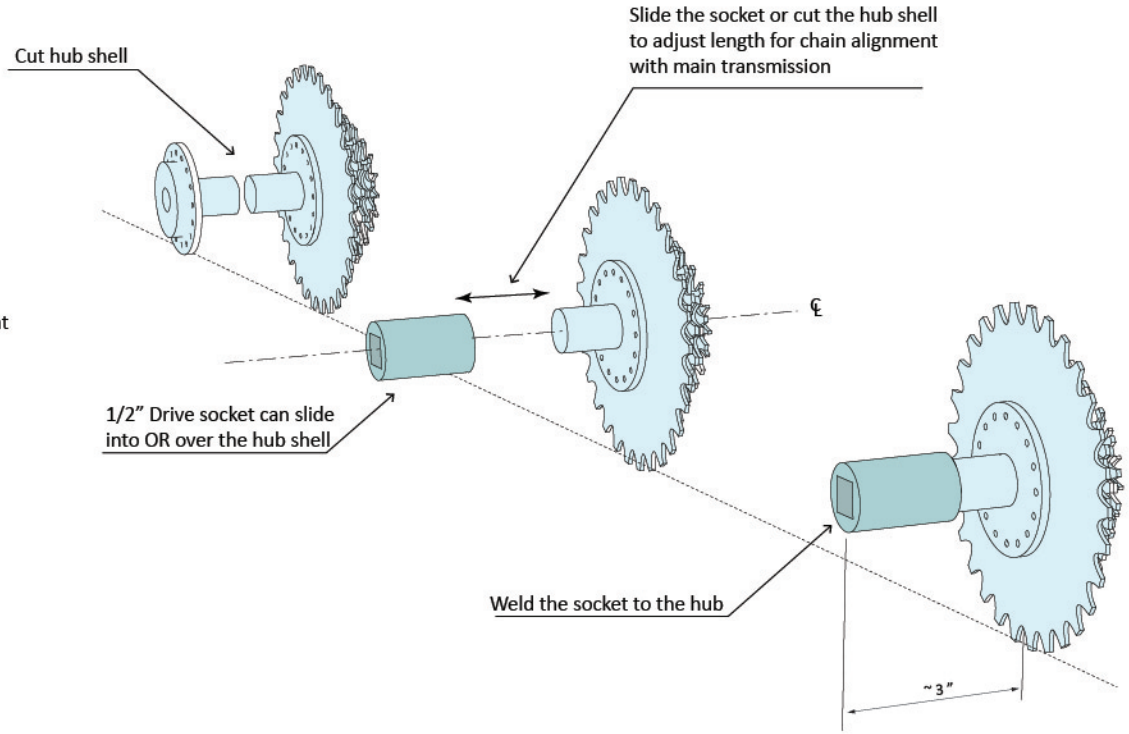


STEP 11

BLOWER TRANSMISSION - THE GEARS

For the gears, find a steel rear hub with a 5,6,or 7 speed freewheel. Remove the guts from the hub. Cut the hub shell just inside the left hand flange. Check that there is now a smooth bore inside the hub shell. There may also be a smooth bore on the outside of the hub shell. Now find a 1/2" square drive socket whose OD just slides inside the ID of the hub shell, OR whose ID just slides over the OD of the hub shell. This allows you to tack weld the socket to the hub shell and maintain a straight center axis. Now mount the socket on the spindle and figure out how far from the end of the spindle the freewheel must be to provide good chain alignment between the main transmission and the blower transmission. You can now slide the hub shell and freewheel on to the socket and tack weld them together. Try to use a minimum of weldment to minimize distortion. Finally, fabricate a fixing bolt the correct length to attach the gear assembly to the spindle.





STEP 12

BIKE UNIT

Virtually any exercycle made with bicycle parts can be used to power the Fanning Mill. If the exercycle has a flywheel it will work better because the blower will supply a more consistent air stream to the winnowing tower. Some exercycles may need structural reinforcement.

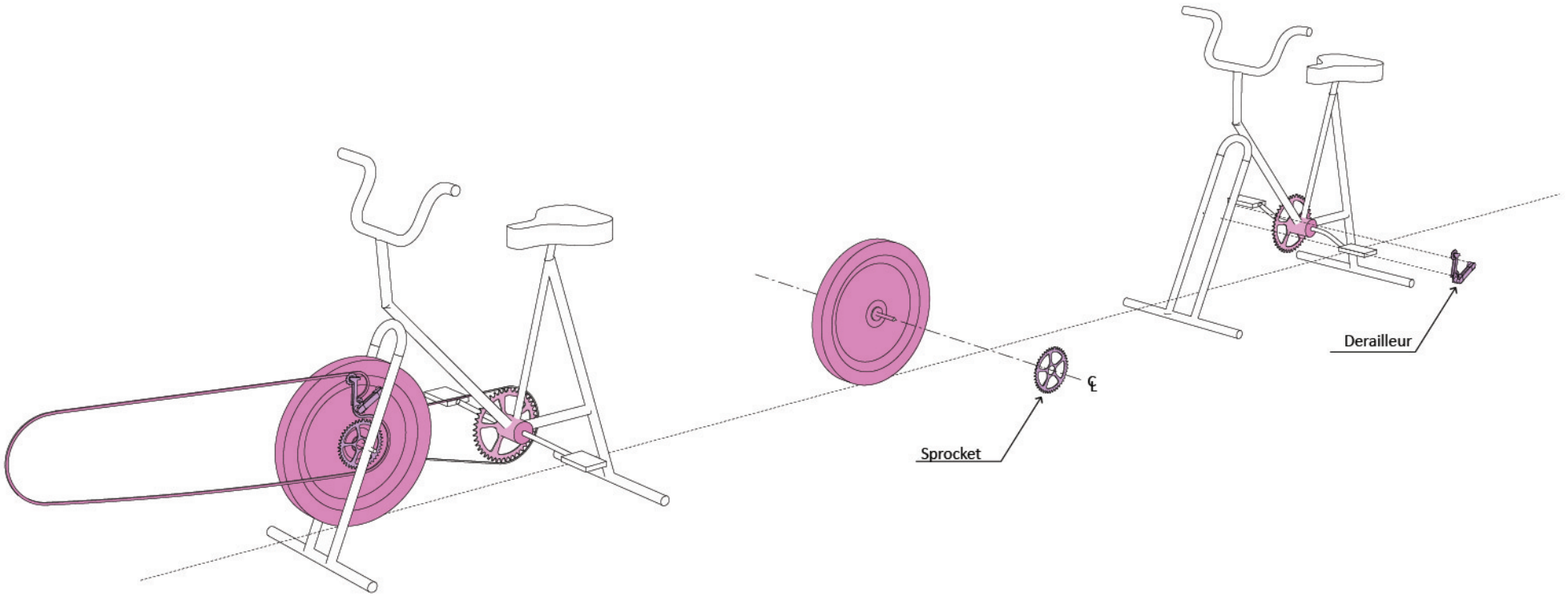
First, remove the flywheel from the exercycle. On the non-drive side of the flywheel hub attach a 20-30 tooth bike sprocket as follows: Depending on what is used for a sprocket, the center may have to be removed (with a blow torch, hole saw, or grinder) so it clears the hub parts. Then three holes should be drilled in the sprocket through which screws (eg 10-32) will thread into corresponding holes drilled and tapped in the cast iron of the flywheel hub. The challenge is locating, drilling,and tapping these holes while keeping the sprocket precisely centered on the axle of the flywheel. A compass divider helps.

For ease of future maintenance, the bottom bracket of the exercycle can be outfitted with a zerk fitting.

An old rear derailleur should be welded upside-down to the non drive side to act as a chain tensioner and chain alignment guide.

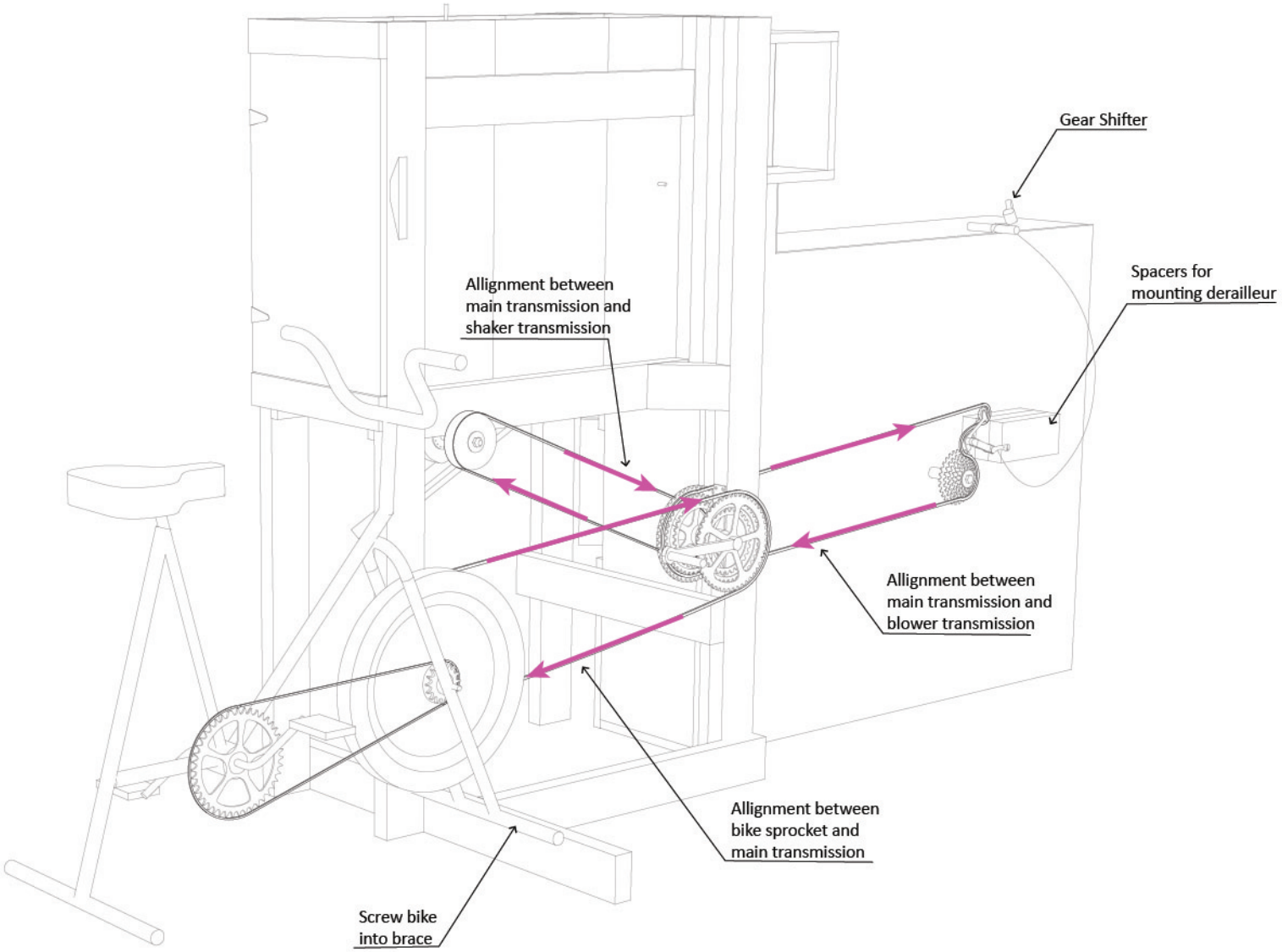
Drill quarter inch holes in the legs of the exercycle so that it can be screwed to the wood frame of the fanning mill.

Reassemble the exercycle, screw it to the fanning mill, and install a bicycle chain from the exercycle's non-drive sprocket, through the upside-down derailleur, and over to one of the chain rings on the fanning mill's main transmission.



POWER ASSEMBLY

The bike unit, main transmission, shaker transmission, and blower transmission are aligned and connected to each other. The bike unit is screwed down to the wood frame of the screen frame. Bike chain connects the left side of the bike wheel to the right side of the main transmission--select any one of the three chainrings. Then a second bike chain connects the left side of the main transmission to the blower transmission. Here gearing can be selected to achieve the desired speed of the blower, and hence strength of the air current in the winnowing tower. Finally, a flat belt connects the main transmission flat belt pulley to the shaker transmission flat belt pulley.



OPERATIONS

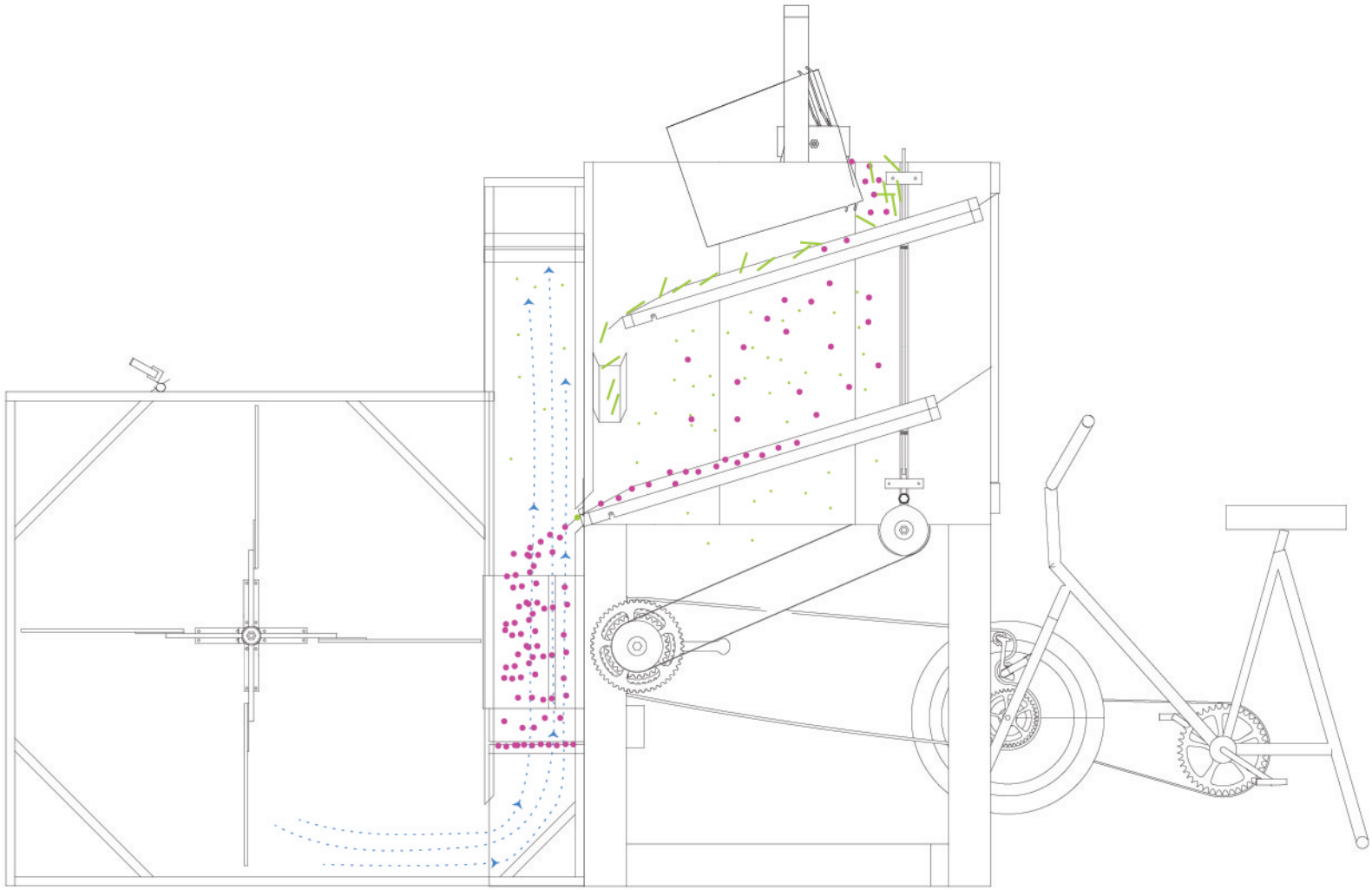
The fanning mill can be used to sort, clean and grade many kinds of seeds. The operator selects the screen sizes, screen tilt angle, and blower strength for the specific crop being processed.

Top Screen (scalping screen, or large screen): This screen is selected to allow the desired seed size to pass through it, while sending larger items (larger seeds, seed heads or pods, and debris) to a chute.

Bottom Screen (grading screen, or small screen): This screen is selected to allow all debris smaller than the desired seed to pass through (fall on the ground) while the desired seeds slide down into the winnowing tower.

The angle of each screen is adjustable. The angle of the screen is adjusted by loosening the set screw on the adjuster stop, sliding it up or down to the new position, then tightening the set screw. The angle of each screen is chosen so that the material slides down the screen when the screen is shaking, but not so fast that the screen fails to sort the material. Once the angle is selected, the open space between the rear of the screen and the back door of the screen box must be filled with a piece of cardboard that directs bouncing seeds back on to the screen.

(continued on next page)



OPERATIONS (cont.)

General note about screens: Screen selection is tricky. There are different types of screen, and even between two screens of the same size there may be a different amount of crimping in the wire that changes the way the screen interacts with the seeds/debris. In general, for the top screen select the smallest size that does the job, and for the bottom screen select the largest size that works. Specifically, a quick test by throwing a handful of the seeds/debris to be threshed on a screen and checking if the seeds find their way through the openings is a good start. There are also types of perforated metal and expanded metal. These have the advantage that perforated metal does not catch bits of fiber the way a wire screen does. However, perforated metal is usually more expensive than screen. The commercial screens for sorting seeds often use flat sheet metal with slot shaped holes punched out. Finally, the size screen used on the thresher will affect the screen selection and performance of the fanning mill. It is important to use the smallest size screen or expanded metal on the thresher that allows all the seeds to fall through it.

The frequency with which the screens shake can be adjusted by changing the pulley size on the shaker flat belt or by making a cam-pulley with more or fewer lobes.

Once sorted in the screen box, the desired seeds enter the winnowing tower, where they fall down through a column of air which is blowing up. The good seeds (that are heavy) fall down into a collection tub. The lighter chaff and bad seeds (that are light) get blown up and out of the winnowing tower on to the ground. The strength of the blower can be adjusted by changing gears on the blower transmission. To tune the blower, increase the blower strength while holding a hand in front of the winnowing tower until good seeds get thrown against your hand; then decrease the strength of the blower a little. The rider can also adjust the blower strength by pedaling faster or slower. Finally, for winnowing small, light seeds it may be necessary to reduce the strength of the blower by partly covering the air inlet hole on the blower housing.

Some crops require two passes through the fanning mill. For example, rice is first passed through to separate the seeds from the chaff. Then the seeds are de-hulled. Then the de-hulled seeds are passed through the fanning mill again to separate the grains of rice from the hulls. On the second pass, it is not necessary to use the top screen.

On some crops debris tends to pile up on the screen or at the passage between the screen and the winnowing tower. On small batches of seed it is possible to just open the back door of the screen box and manually clean the screen or shake it to shake down stuck material. On larger batches tuning the screen angles, changing the type of screen used, and tuning the size of the screens (both in the fanning mill and in the thresher) can solve most problems.

When done using the fanning mill it must be opened up and thoroughly cleaned of all debris and seeds. Leaving seeds around in the machine will encourage rodents to move in, contaminate the machine with rodent urine and feces, and chew up the wooden parts. Store the fanning mill inside protected from rain, sun, ground moisture, rodents, and insects.

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

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