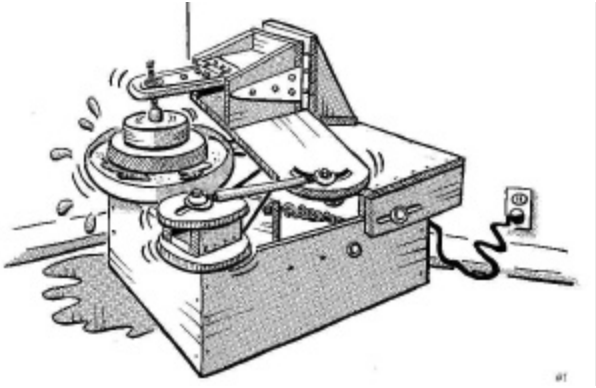


Building Mirror-o-Matic

Dennis & Bob Rech

A Construction Manual
For The
Mirror-0-Matic

Written By
D.W. Rech

Illustrated By
R.A. Rech

To order this manual postpaid send $15.00 to:
Bob Rech
5181 Hasbrook Ave. N.
Salem, OR 97303

Questions concerning construction should be E-Mailed to:
dennisrech@attbi.com
Be sure to put Mirror-o-Matic in the subject.

Or U.S. Mail to:
Dennis Rech
2713 Wiggins Road
Olympia, WA 98501

Additional information, notices, updates and current e-mail list server information can be found at: www.mirror-o-matic.com

This is plan set # _____
Revision: 3/2002

Mirror-o-Matic was designed to be a very low cost astronomical mirror grinding, polishing and figuring machine.

Its attributes are:

1. It can be built for somewhere between $200 and $400.
2. It is constructed of hardware store items and it needs no machined parts.
3. It is constructed primarily of 3/4 inch plywood and has few close tolerances.
4. It uses a single readily available 1/4 hp 1725 rpm motor.
5. It is very sturdy and capable of grinding and polishing 12.5 inch mirrors.
6. The physical size is small.It can be stored in a closet or under a table.
7. The motor and belt assemblies are very quiet.
8. It can be built in a weekend.

Its disadvantages are:

1. The belt drives require a few minutes to change speeds.
2. The single speed motor does not allow infinite speeds or ratios.
3. If the eccentric slots are cut imprecisely, fine overarm adjustment will be difficult.
4. It's kind of ugly.

I hope that you find that the good points outweigh the bad.

The history of Mirror-o-Matic has been highlighted in Issue 13 of the *Amateur Telescope Making Journal.* (2500 15th. Ave. West Seattle, WA. 98119). This is a magazine well worth subscribing to.

Have fun building and grinding and do not be afraid to modify and improve the design. Please keep me informed of your progress.

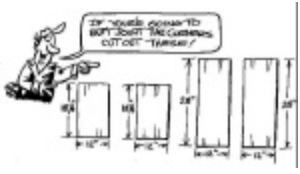
Dennis

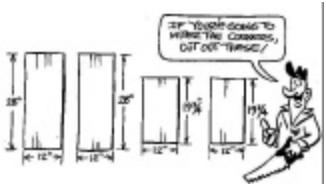

DON'T WORRY! YOU DON'T HAVE TO BE A ROCKET SCIENTIST TO BUILD THIS PROJECT!
NOPE! NOT AT ALL!
ABC
XYZ


MY PARTNER AND I WILL BE ASSISTING YOU EVERY STEP OF THE WAY!
LET'S HIT IT!

Building the base box.

The base of Mirror-o-Matic starts with a simple box with outside dimensions of 28"x19-3/4". The corners may be mitered or butted (adjust your cuts accordingly). The dimensions are not critical, 1/4" is fine.





There is a fair amount of torque passing through the box, so be sure to glue all joints. I prefer using polyurethane glue. It is very viscous and swells slightly as it sets so small gaps will be filled. Align parts carefully. Once it sets, you will not be able to break the joints. Read the instructions for humidity requirements. Someglues require that the wood be dampened.

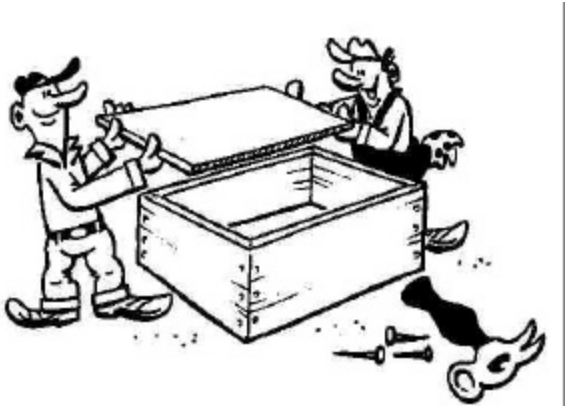
Use care, polyurethane glue will stain your hands and clothes a rich dark brown which will take a week to wear off.

Carpenter's glue or white glue such as Elmer's will also work.

All wood parts in this project can be nailed, screwed or clamped until the glue

I recommend building the box and most other parts from 3/4" birch 7 or 9 layer plywood. Almost any other "cabinet grade" plywood will do. Typical fir "construction" plywood such as CDX is not very good because of the many voids which will compress when bolts are tightened into it.

Complete the base by putting a floor in it. I used 3/4" melanine(tm), a plastic coated particle board used for shelving and cabinets. The same 3/4" plywood that was used for the rest of the box is also fine.

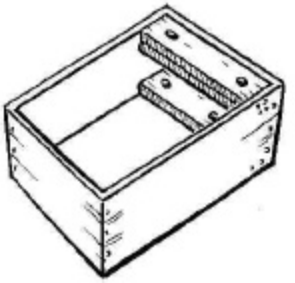


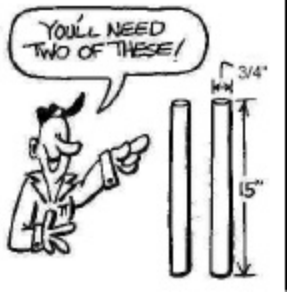
Shaft Supports

Shaft supports need to be madenext. I used two layers of 3/4" plywood on top and one layer on the bottom. A single layer on top will probably work

Stack the three layers together and nail or clamp them so that all three pieces are drilled in alignment. If the holes are not kept in alignment, the shafts will be crooked and almost impossible to install.

The holes should be centered about 1 inch in from the inside edge of the box.





You will need two 15" lon polished blower shafts. I used 1 diameter shafts, but 3/4" will als work. These plans will assume that you are using 3/4" shafts. If you use any other siz adjust collars, flange bearings and pulleys accordingly.

You will also need a drill bit that makes a tight hole for the shafts. I bought a set of Silve and Deming bits (a generic name for large drill bits that have their shafts turned down t 1/2" to fit a standard 1/2" drill chuck. If you are using a hand drill you will probably wan to use Forstner bits.

Practice on a piece of scrap and make sure that the shaft will be a fairly snug fit. Yo should be able to press it in by hand, but not be able to spin it easily.

Separate the three boards after drilling and smear the holes with polyurethane glue. Slid the shafts into position and glue and nail the boards into position. Let the whole assembl set for a few hours.

After the glue sets, the shafts should be tight. Scrape any excess glue off the shaft.

Slide a 3/4" collar and bronze thrust washer over each shaft.

Tighten the set screw on the collar lightly for now. It will be adjusted for height later when aligning turntable and eccentric pulleys.

Building the Power Head

The heart of Mirror-o-Matic is the power head assembly. A single speed 1725 rpm 1/4 horsepower motor is used along with a pair of belt reduction shafts and pulleys.

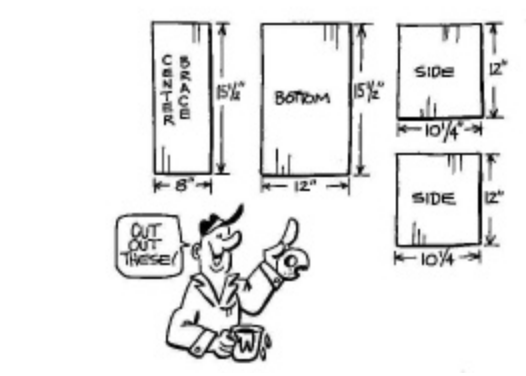
By using different pulley-shaft-belt combinations, a wide variety of turntable and overarm eccentric speeds can be achieved.

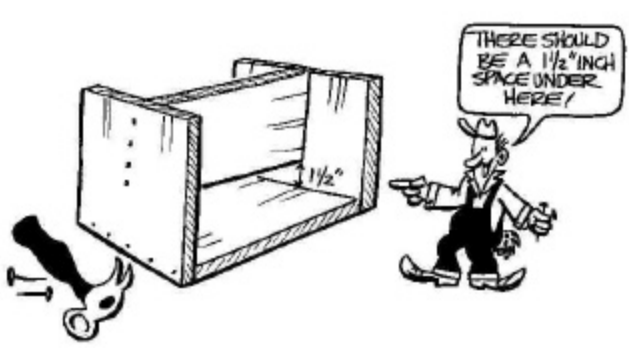
The powerhead assembly rides loose in the base box and a pair of tension springs self-adjusts the belt tension.

The motor is attached to a mount constructed from 3/4" plywood.

Just follow the cartoons.

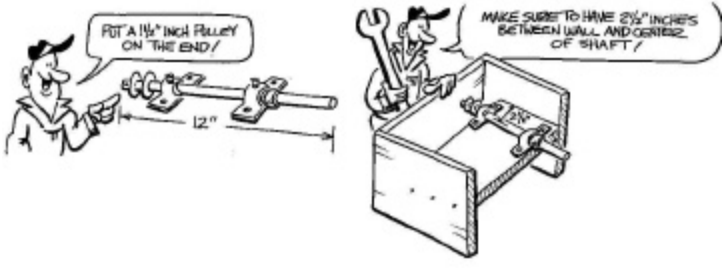
Cut out the following parts from 3/4" plywood and assemble them as shown.



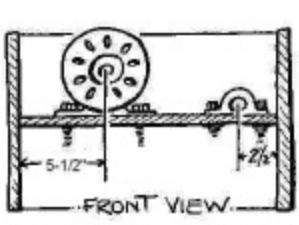


Attach a 1-1/2" pulley to the end of a 5/8" x 12" long shaft. Set the socket screw. This is the mediumspeed shaft. Slide this shaft through two bearing sets and bolt this assembly to the frameas shown. Leave 1/2" between the pulley and the bottom of the frame. Make sure that the shaft is square with the frame. Use 5/16"x1-1/2" bolts and nuts. Use a 5/8" locking collar to position the shaft.

Mount a 10" pulley (not shown) to the other end of the shaft. Tighten the set screw only snug for now.



Use a 1/4 hp clockwise turning motorwith a **type 48 or 56** frame.This framehas slotted holes in it's base which are used to tighten the drive belt between the 1-1/2" motor pulley and the 10" intermediate drive shaft pulley.



Install a 1-1/2" motor pulley on the end of the motor shaft. Tighten the set screw.

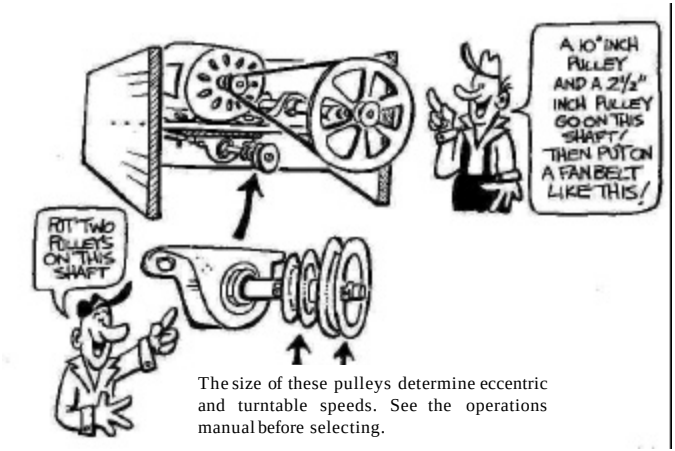
Position the motor as pictured. Make sure that the pulley sticks 1/2" above the top of the frame for belt clearance. Make sure that the motor is square with the frame.

Trace the four slots of the motorframeonto the plywood mount.Removethe motorand set it aside.

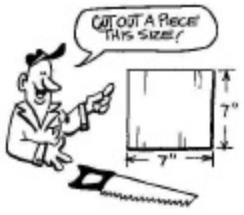
Drill (4) 5/16" holes in the frame on the side of the tracing away from the already mounted shaft.

Set the motorback on the mountand bolt the motordown with 5/16"x2-1/2"bolts, flat washers and nuts. Just snug the nuts for now.

Place a 10" pulley on the intermediate shaft and trial fit a 4L36 belt on it and the 1-1/2" motor pulley. Slide the motor away from the shaft until the belt is tight. Hand tight is good enough or a bar clamp can be used to pull the belt tighter. Tighten the

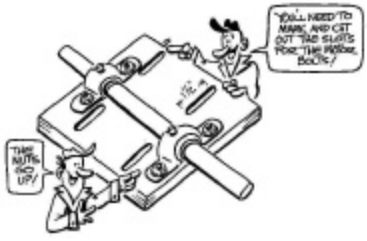


The size of these pulleys determine eccentric and turntable speeds. See the operations manual before selecting.



Cut the 7"x7" low speed shaft mount from a piece of plywood.

You will also need a 5/8"x13" shaft and two bearing sets.

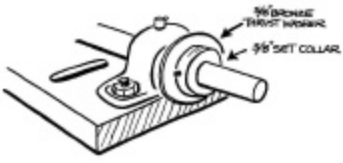


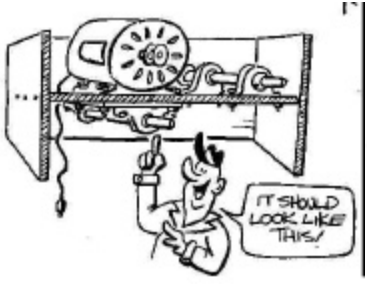
Measure the distance between motor bolts and layout 1-1/2" x5/16" slots to match the motor bolt pattern. This assembly will slide on the 2-1/2" motor bolts and allow the low speed shaft belt to be tightened.

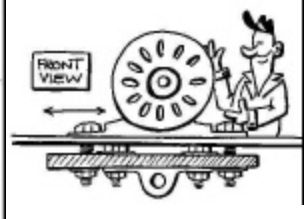
Cut the slots.

Mount the 5/8"x13"shaft onto the 7"x7" mount with a bearing set as shown.

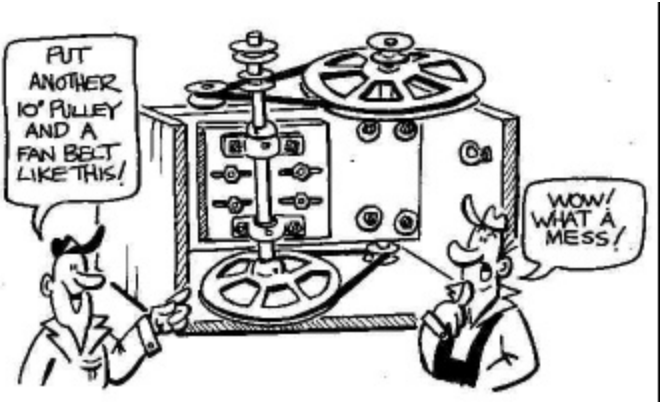
Set collars and thrust washers are required to keep the shafts from sliding down. Place them on all shafts as shown in the pictures.







Mount the 7"x7"base onto the 2-1/2" motor bolts. Make sure that the base slides on the long bolts. Add 5/16" washers and nuts to the long bolts and tighten just barely snug.



Place a 10" pulley on the low speed shaft across from the 1-1/2" pulley on the intermediate shaft. Run a 4L38 belt between these two pulleys. Use flat washers and nuts on the 7"x7" low speed shaft assembly. Pull this assembly tight against the belt with a clamp and tighten the nuts.

Add a set collar and bronze thrust bearing to the slow speed shaft to keep the shaft from dropping.

Add drive pulleys to the low speed shaft as shown. Size the drive pulleys from the operations manual. Make sure that all the pulleys are aligned so that the belts run true.

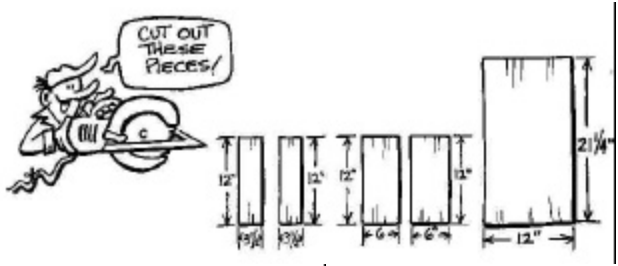
Tighten all belts and collars.

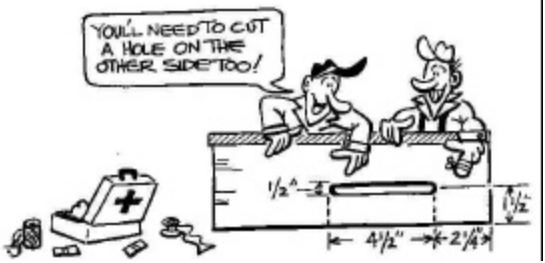
Use caution!!!

When everything looks OK, plug in the motor and watch the power shafts turn slowly. There should be very little noise. Looking down, the shafts should turn

OverarmPlatform

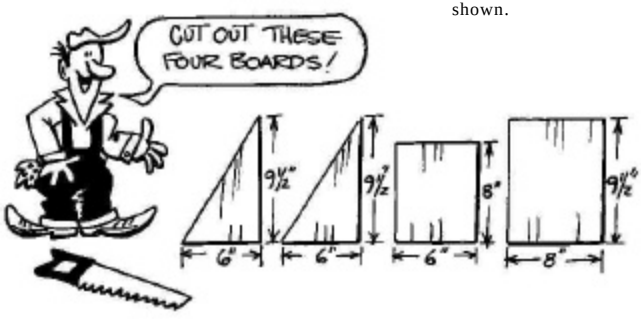
Cut out the pieces as shown . Assemble them and cut the side slots per the given dimensions.



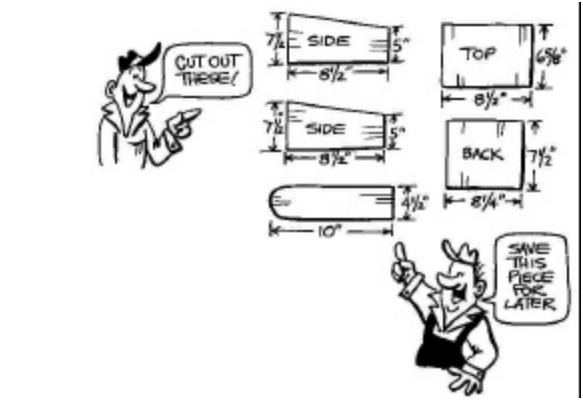


Overarm Platform Tower

Cut out the parts and assemble them as shown.

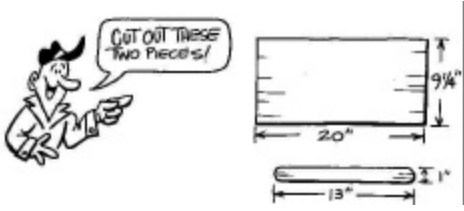


OverarmSupport

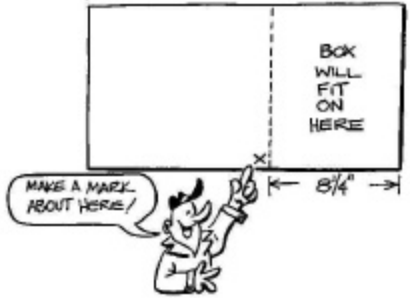


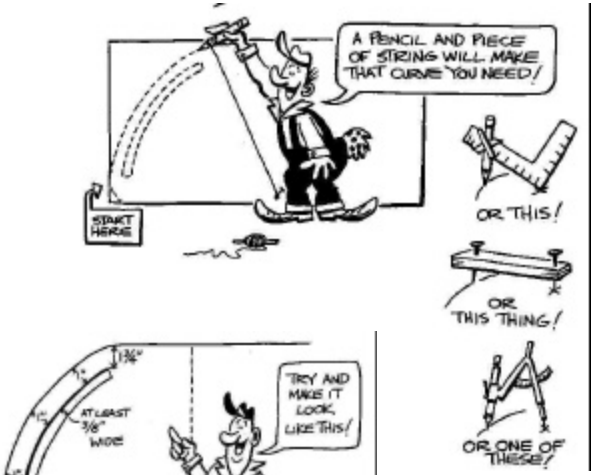
Once again, cut out the parts and assemble them as shown.

Hold the horizontal top shelf up high to provide adequate mirror to overarm clearance.

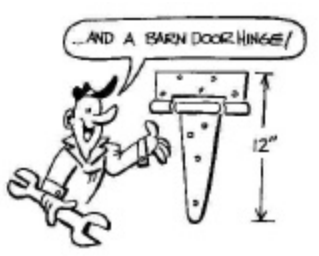


Set aside the 1"x13" piece for a little while.




A PENCIL AND PIECE OF STRING WILL MAKE THAT CURVE YOU NEED!
START HERE
OR THIS!
OR THIS THING!
OR ONE OF THESE!
TRY AND MAKE IT LOOK LIKE THIS!
AT LEAST 3/8" WIDE
1¾"
1"
½"
2"
THIS GOES HERE, LIKE SO!

Assembling the Overarm

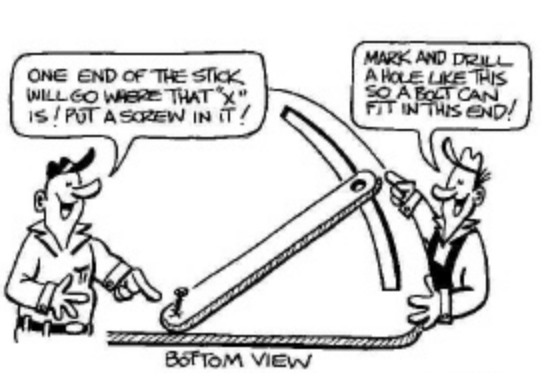


Following the pictures, fasten the parts together. Bolt the hinge onto the overarm support with (5) 5/16"x1-1/4" bolts, washers and nuts.

Bolt the overarm onto the hinge with (3) 5/16"x1-1/4 bolts, washers and nuts.

See the Addendum on page 44 for information on building an arm stop.

I recommendusing polyurethane glue between the hinge and plywood surfaces. It will work loose

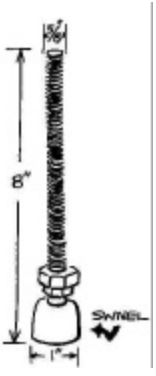

ONE END OF THE STICK WILL GO WHERE THAT "X" IS! PUT A SCREW IN IT!
MARK AND DRILL A HOLE LIKE THIS SO A BOLT CAN FIT IN THIS END!
BOTTOM VIEW


NOW TURN IT OVER SO WE CAN ATTACH THIS!

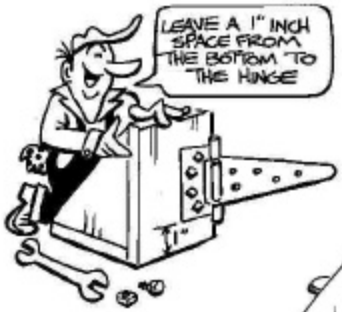

PUT A FRONT T-NUT HERE!


IT SHOULD LOOK LIKE THIS!

Installing the Swivel into the Overarm



I used a piece of 5/8" threaded rod as the pin that will fit into the mirror or tool. The swivel (also called a toggle or leveling pad) is threaded for a 5/8"x11tpi rod. A 5/8" jam nut will keep the swivel from working loose.



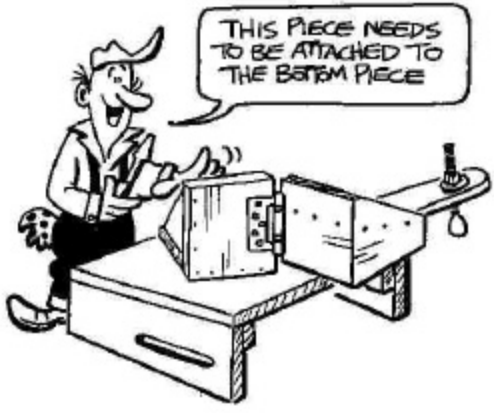
Install a hinge onto the tower as shown. Use glue and (4) 5/16"x1-1/4" bolts, washers and nuts.

Hold the hinge and overarm support up 1" from the bottom of the tower.

Bolt the support to the tower with (3) 5/16"x1-1/4" bolts.

Use polyurethane glue under the

I did not glue the tower to the platform.It is only screwed down.Thismakesstorage and moving a little easier. Polyurethane glue is forever.



Building the Turntable Platter

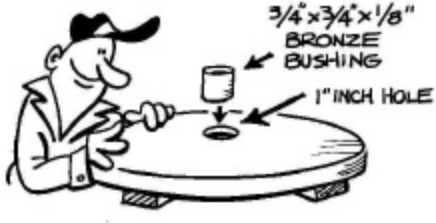
The turntable platter will ride directly on the 12" final drive pulley. It is indexed to the pulley with one to three plywood dogs. This allows the platter to be removed from the machine easily for cleaning and mirror checking. A single dog is enough, but three will allow the platter to sit even while off the shaft. I used a single dog.

A 3/4" plywood mirror carrier of the same diameter as the mirror will be later screwed to the platter. The mirror will be duct taped to this carrier. A dam will be built around the platter in a later step.

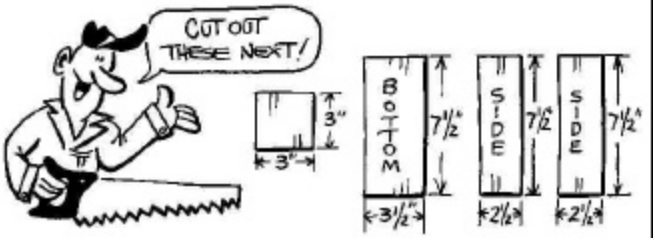
Since the turntable is turning around the fixed 3/4" shaft, a 3/4" ID x 3/4" long bronze bushing should be inserted into the turntable. Although not absolutely required, it will make turntable installation and removal from the pulley that it is riding on much easier. The hole has a tendency to swell when wet.

Be sure to paint the turntable to protect it fromwater damage.

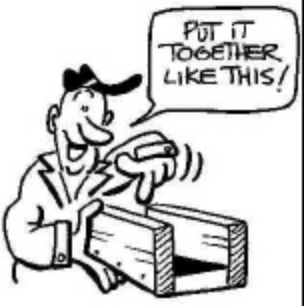
The turntable can be made as large as 16 inches in diameter. Larger diameters will give more area for grinding slurry to collect. It also gives a larger area around the mirror to place adjustable blocks if you would rather not use tape to hold the mirror in place. Three or four adjustable slotted blocks around the mirror perimeter make centering the blank on the turntable easier.

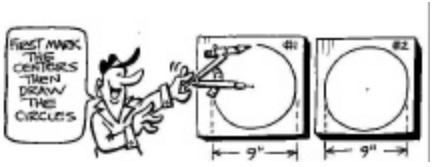


Building the Eccentric

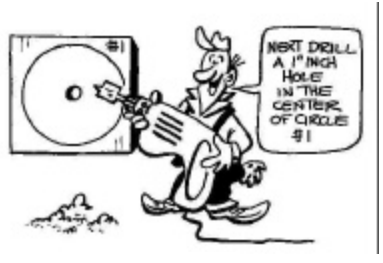


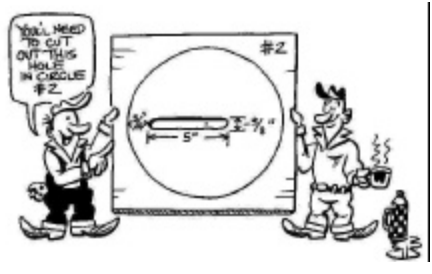
Cut the pieces out of 3/4" plywood and assemble as shown.



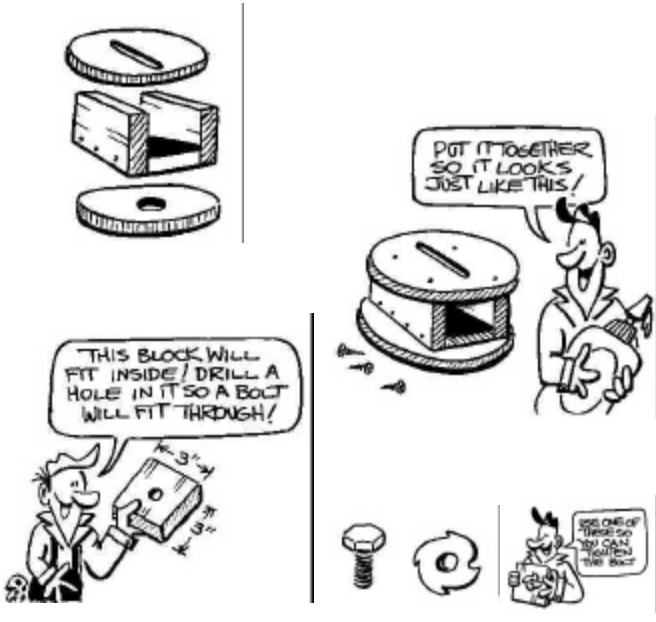


More 3/4" plywood pieces.





Note: Theslot can be made 4 inches long and stopped at the center of the circle. This will make finding the zero eccentric location easier.



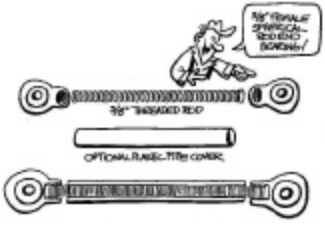
Drill a hole as required in the center of the 3"x3"block. A 3/8" threaded insert (3 prong T-nut) needs to be pressed into it. This block will rest in the "tunnel" of the eccentric and catch the bolt that goes through the rod end bearing of the eccentric drive rod.

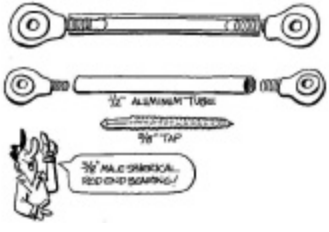
Making an Eccentric Drive Rod

The eccentric drive rod can be made with either male or female rod end bearings.

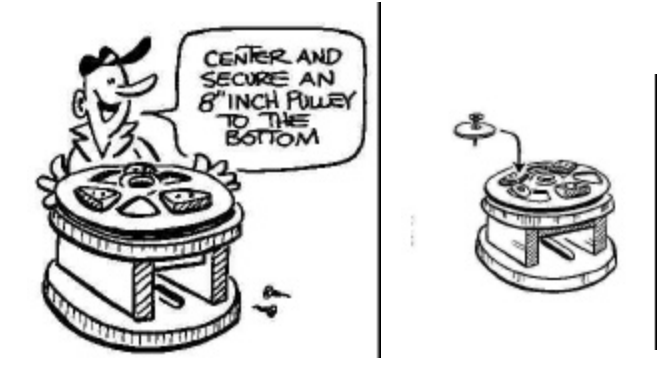
I used male rod ends and a piece of 1/2" aluminum tubing tapped for the rod ends.

A piece of 3/8" threaded rod will also work with female bearings. No tap is required, but the threads should be covered to keep them from carrying grit onto the mirror.

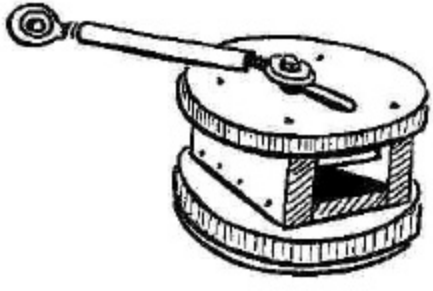




Back to the Eccentric

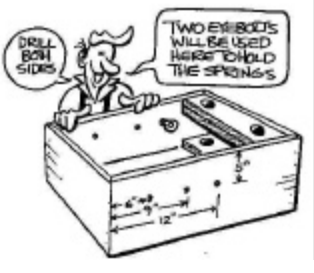


Cut three plywood dogs and attach them to the bottom of the eccentric in the same manneras the mainplatter. I also ran a screw and washer into the dog next to one of the pulley webs to avoid rocking of the eccentric. It is under some stress when polishing.



Installing Spring Adjustment Hooks

Drill holes into the sides of the base box as shown for the spring eyehooks. These will be used to tension the drive belts from the powerhead. By moving the hooks, the powerhead can always be in a position to tension both belts.



Assembing the Parts.

If you have not yet done it, install a 3/4" collar and thrust washer on the turntable and eccentric shaft. This will keep the pulley from contacting the plywood base. The eccentric collar should be 1" higher than the turntable collar. Now install a 12" pulley on the turntable shaft. Make sure that the pulley heights are correct and that the belts run true. **Do not** set the allen head in the pulleys. Throw it away. The aluminum pulley runs directly on the shaft. Use a little oil or grease.

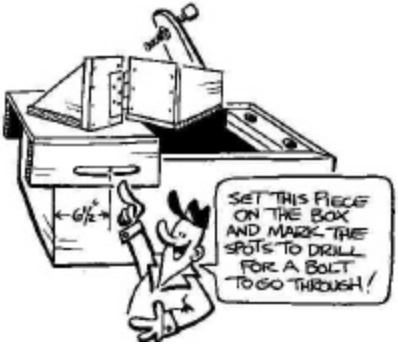
Add 2 eyehooks to the powerhead frame.

Install the eccentric and pulley combination as shown. Do not set the allen head in the 8" pulley.

The picture shows each belt coming off the low speed shaft, but either could come off the mediumspeed shaft. By using different pulleys and belts, all sorts of speeds are available.

Fit the drive belts and install the springs. The belts should be snug . When the machine is running, the platter and eccentric should be capable of being stopped by hand. Do not put so much tension on the belts that they cannot be stopped by hand. This is a safety feature.

If the power head rocks slightly under load, a 1-1/4" long #10 wood screw can be run down through it's base into the box floor after tightening the belts. This probably will be required when polishing larger mirrors.



Set the entire overarm assembly on the base box and mark and drill the holes that secure them to each other. A 5/16" threaded insert needs to be installed inside the box to catch the 5/16" x2" bolt and washer that holds the pieces together.

Place the swivel directly over the turntable shaft. Mark the bolt head location on the overarm assembly so that it is easy to know if the tool and mirror are running center-over-center. The overarm assembly can be moved off center-over-center for certain polishing (blending) operations.

Install the turntable platter.

Connect the eccentric rod arm to the slots as shown. Put the eccentric rod end near the center of the eccentric. A little throw goes a long way. If too much is put in, the arm will go off the turntable and you will be glad that you left the belts a little loose.

The distance from center of eccentric will set the total throw. The position of the overarm table slot rod end will determine the position on the mirror.

I usually set the eccentric to zero throw, the swivel to center over center and then tighten the overarm table rod end bolt.

If everything looks OK (look really hard) raise the overarm just to be safe and turn the unit on.

It should be quiet with nothing hitting or rubbing.

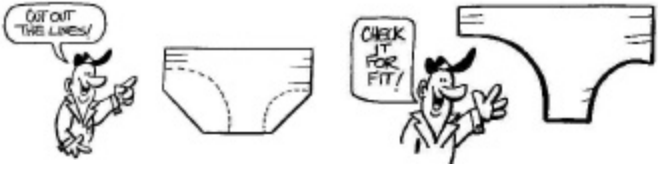
I did not install a motor switch. When I reach in the machine to change belts or tension, I want to know that it is unplugged. Install a switch or even a timer switch as used on a

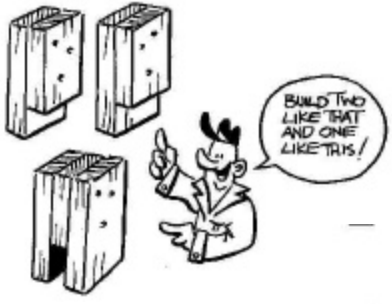
Building the Grit and Safety Shield

Even if you do not believe in safety shields, build this one anyhow. It serves the dual purpose of keeping the grit and water off the belts, pulleys and motor. It will also keep animals and small hands (and big ones) from messing with the belts.

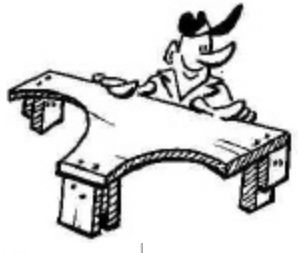
Cut the top piece out of 1/4" plywood or sheetmetal and the small pieces out of 3/4" plywood and follow the pictures. It wil be necessary to remove the platter, eccentric, overarm, pulleys and belts. This is important, so just do it.


PUT YOUR PIECES BACK ON AND TRACE AROUND THEM!
3/4" HANG-OVER ON FRONT


CUT OUT THE LINES!
CHECK IT FOR FIT!

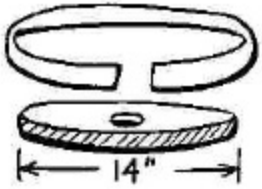


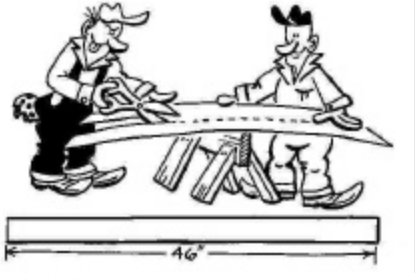
If your shaft support is not recessed, you will not use the inside front support. A small pair of blocks on the inside of the box sides will keep the shield from moving forward.



FinalDetails

A dam needs to be added to the 14 inch mirror platter. Cut a 1-1/2" strip of fiberglass, plastic or thin aluminumthat will go around the platter. Glue, resin or RTV caulk it into place. If you have made a larger turntable, adjust the length of strip.





Build a hat section of 3/4" plywood the same diameter as the mirror or tool that will be attached to the turntable.

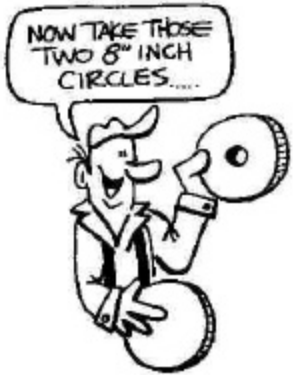
Use a piece of 3/4" shaft to align the center holes and screw the hat to the 14" turntable platter.

Coat all the plywood with resin or paint to make it waterproof.

The mirror or tool will be taped to this hat when grinding or polishing.

Either masking or duct tape works

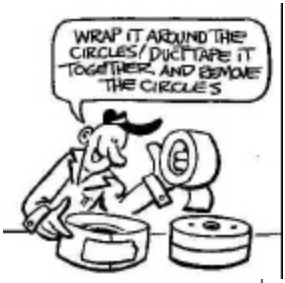
Building a TileTool



This is an example of how I built an 8" tile tool. I do everything tool on top. The tool should be about 70% the size of the mirror. See the Operations Manual for sizing details. We will use an eight inch tool for an example.

Cut two 8" diameter circles out of plywood. Drill a centered 1" hole in one of them. You can also drill an oversized hole and install a bronze bushing similar to that in the turntable.

Follow the instructions.


WRAP IT AROUND THE CIRCLES/ DUCTTAPE IT TOGETHER, AND REMOVE THE CIRCLES


TAPE IT DOWN ON A BOARD.


FILL BOTTOM WITH SMALL BATHTILE FACE DOWN!
IT SHOULD LOOK SOMETHING LIKE THIS!


MIX UP SOME POUR STONE AND COVER TILES ABOUT 1/2" INCH!
POUR STONE


PRESS THE CIRCLES BACK IN (HOLE UP) AND LET DRY!

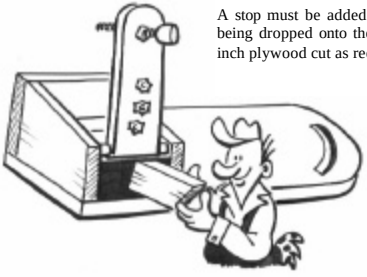

LATER
REMOVE CARDBOARD AND DUCTTAPE AROUND THE EDGE TO HOLD EVERYTHING TOGETHER!


THIS WILL FIT HERE LATER!

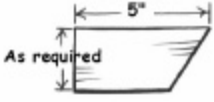

TRY A LITTLE WEIGHT TO SPEED THINGS UP!
2 LB


SEE YA!
BYE BYE...

Addendum One - Adding An Overarm



A stop must be added to prevent the overarm from accidentally being dropped onto the mirror below. This can be a piece of 3/4 inch plywood cut as required to fit the cavity.

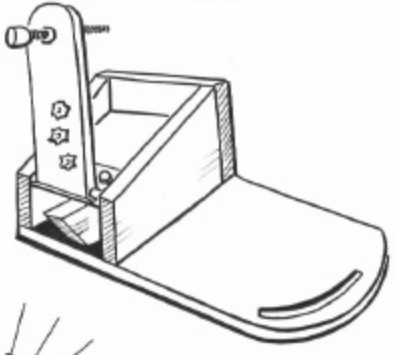


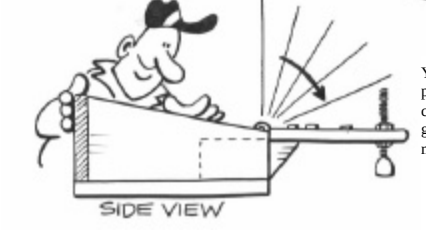
When grinding or polishing, never allow the slurry to dry out.

If this happens, the tool and mirror will stick to each other. The energy in the turntable will toss the tool out and the swivel will crash to the mirror below.

This stop will prevent this and accidental arm dropping from occurring.

I built my stop as a snug fit and just ran two screws through the top plate to give easy removal of the hinge bolts.





You may also want to use a small piece of sheetmetal or cardboard to cover the overarm cavern. Grit can get into it and later fall out onto the mirror.