Free Floating Circle Cutting Router Jig

by Santé

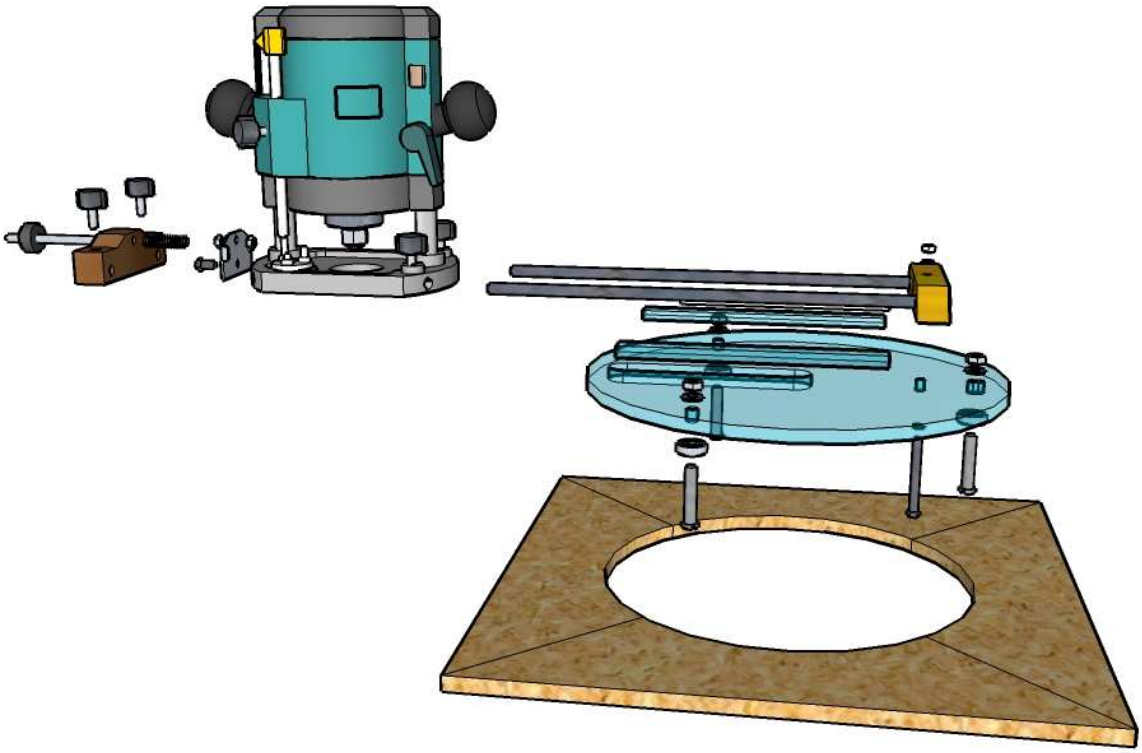
Description

This is a jig for your router that will allow you to cut precision holes or make precision disks without blemishing the disk or the bounding workpiece. You do not drill a centre point. Instead, you can employ cross hairs to “set” your centre. Replace the cross hairs with your hole cutting disk and cut your circle. You can cut a circle from 0 to 280 mm (0 - 11") in diameter. The radius or diameter can be set or adjusted on a scale. The jig is very accurate.

The jig may appear complicated but it really isn’t. It is just a piece of polycarbonate or other stiff plastic riding over a large hole on some nylon bolt heads (optional) and held properly centered by three bearings. The router sits on the plastic and the bit protrudes through the plastic(to cut your circles. I duplicated your edge guide to make the fine adjustments to the router position and added a slot for a guide bushing to run in for easy adjustment and repeatability.

Principle

The principle is very simple: a router sits on a Plexiglas disc. It can move from the centre of the disc to the circumference. This disc then rotates in a 300mm (11") hole in a piece of MDF, guided by three ball bearings. Voila, perfect circles.



(The router of this blow up, made with Sketchup, was kindly provided by my friend Bgum, an eminent 3D design specialist)

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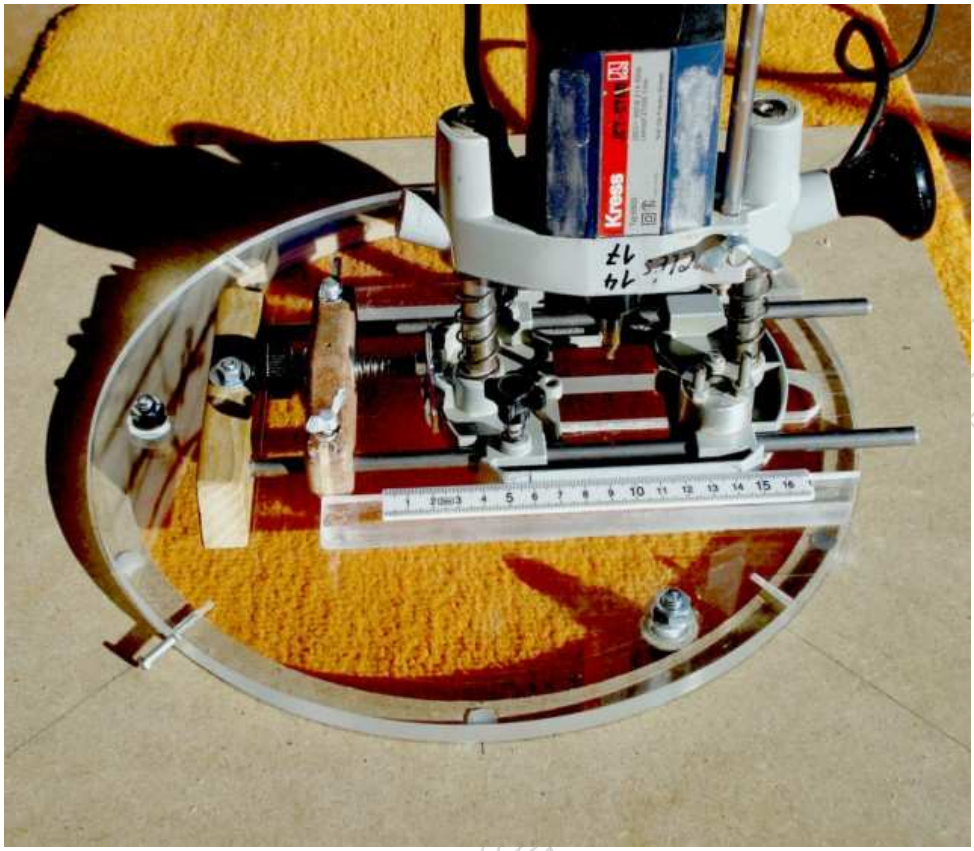

List of Materials

MDF: (Mediam Density Fiberboard), ½" thick
- 1 x 450mm square,
- 1 x 300mm diameter disk

Plexiglas: 10mm/ ” thick (Acrylic, polycarbonate - stiffness is the only major criteria)
- 1 x 330 mm diameter disk
- 2 x 8mm x 20mm x 200 mm

Metal:
- 2 x 5mm inserts
- Two round bars of 8mm x 300mm

Bearings:
- 3 x 8mm x 22mm bearings

Bolts:
- 3 x 8mm x 30mm
- 1 x 6mm x 40mm
- 1 x 6mm knurled nut
- 2 x wings bolts 5mm x 20mm
- 1 x threaded rod 6mm x 70mm

Miscellaneous:
- Some washers and nuts 6mm and 8mm
- 2 x small hardwood stock
- about 20mm of old measuring tape, preferably starting at “0"
- some ¼”x20 nylon bolts (about 6 or so)

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The Base

The base is simply a square of 12mm (½”) thick MDF. It should be 450mm (17¾") square with a 300mm (11 ”) hole in it. Here’s how to make it.
Draw two diagonal lines from corner to corner to find the centre.
You want to cut a 150 mm radius hole. I used my router and a trammel to cut the circle to a depth of 5 or 6 mm (1/4",) then cut the remainder with a scroll saw leaving some salvage. I removed the salvage with a bearinged straight bit like a flush-trim bit or template bit riding on the smooth router-cleaned part of the edge. This will give a nice clean, even edge with no tearout.
This hole must be perfect, without any bumps or divits. If you goof, do it again. You did get enough material didn’t you? Every imperfection here will be an imperfection in every hole or disk you cut with this jig. You also don’t want your router binding or wandering while you’re cutting your circles.
once you’re content with your large hole, locate, drill and place your nylon bolts around the edge of the hole, like above for the larger plastic disk to slide on while turning.

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The Plexiglass disk

The disk is the mounting platform for the router. It is plastic so you can easily see what is happening at the bit.

Construction is a bit more complicated, but keep in mind there is a centre reference line and everything works from that line.

The disc is cut from a 10mm (3/8”) thick piece of Plexiglas. You don’t want plastic much thinner than this.

The three bearings are fixed to the underside of the disk and the router to the top side. You will want a minimum radius of 165mm (6½") so make sure your plastic is large enough for that.

Scribe a line across the diameter through the centre of the disk. This will become your reference line for the rest of the construction.

You will drill a small slot and two more holes for the three bearings. You’ll also cut a slot for the router bit to go through and to keep it all organized you’ll scribe a circle to locate your bearing holes. Follow the instructions below as carefully as possible.

Drill a 2 mm hole in the centre. This is to anchor your trammel while cutting the circumference of the disk.

Cut a 330mm (13") circle, using a trammel and your router, about 5 or 6 mm (1/4") deep. Don’t go all the way through. We will finish this cut, later.

Using compasses, score a 139 mm (5½") radius circle. This establishes where the bearings will be mounted. Adjust this circle to accommodate the bearings you have. (139mm = 150mm radius of the big hole, minus the 11 mm radius of the ball bearings.) These bearings, 22mm x 8mm come from second hand roller skates.

Ok, now for a bunch of holes to cut and drill.

At the meeting of the reference line and the 139 mm circle cut a slot 8 mm to 16mm long. This slot is to allow for a bit of adjustment of the bearings. The slot should be centred across the 139mm circle and along the reference line. This is to allow the bearing to move in and out for a snug but not tight fit.

Two other 8mm holes (not slots) are drilled at + & - 120 degrees on the 139mm circle. These are for the other two bearings. That is, there are bearing mounts spaced 120 degrees apart around the 139mm circle. There is no adjustment for the other two bearings.

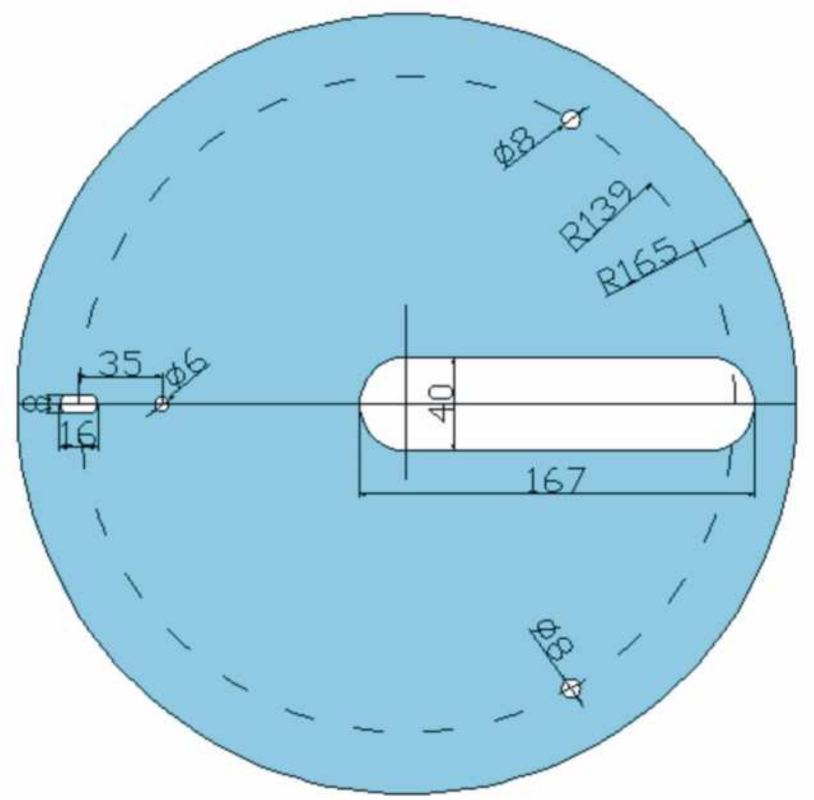
A 6 mm hole is drilled on the reference line 35 mm ($1^{3/8}$”) inward from the bearing adjust slot. This hole is for the bar at the end of the edge guide.

Lastly, the slot for the template guide must be cut. This slot will be ±170mm long by 30 or 40mm wide (or match the width of your guide bushing) and come up to ±15mm from the outside edge of the disc. Centre the slot on the reference line. Just like the circumference of the disk, do not cut this hole all the way through. Until we’re done, we need to keep the centre of the disk intact.

When all of the holes are made, finish the circle cut. When the router cut the circumference of the disk, it created a trough. Cut the side of the trough closest to the outside edge of the disk with a scroll or jig saw. To prevent the Plexiglas from gluing to the blade of the saw, pour a little oil in the groove and use the slow cutting speed.

To finish of the disc, use a bearing bit (either mounted in a table or freehand) to clean off the scarf of the jig saw cut. The bearing should ride against the part of the circumference cut by the router bit. Make sure it clears the scarf of the jig saw cut.

Repeat this process (jig saw then router bit) with the slot for the router bit and template guide. Make sure to use the router cut as the guide for the bearing and remove only the scarf.



All radii and measurements are in millimeters

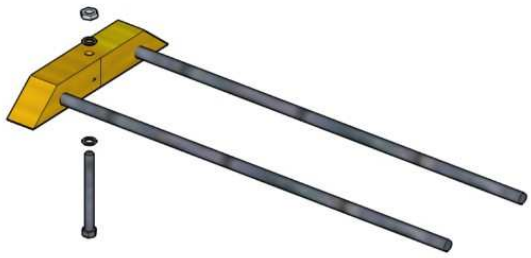
The Router Mount

This part takes some explanation before proceeding. There is an edge guide that comes with (or optionally available for) your router. This is a bridge with two rods attached that fit into corresponding holes in your router. There is a clamping arrangement on the router to fix the location of the edge guide. On the bridge end, there's usually a few adjustments that allow you to fine tune the cut. We will use the holes and the fixing arrangement on the router and we'll duplicate the bridge and guide rods and the adjustment mechanism.

Your application may require a similar but different solution. You'll have to investigate your chosen router and how you want to apply your solution. Here's how I proceeded with my router Kress

> Take your edge guide (if you have one) and look at it closely. How big are the rods - diameter and length? More importantly, how far apart are they spaced? Now, look at the router. There are holes that accept the edge guide rods. Put the router on a table, sitting on it's base plate, the chuck withdrawn so as not to protrude below the baseplate, and measure the distance from the table to the centre of the edge guide holes. For my two Kress routers, the spacing between the bars is 84 mm, centre to centre, and 9mm in height from the sole of the baseplate.
> The objective is to duplicate your edge guide.
> Use a block of wood about 20mm x 25mm x 140 mm. Drill two holes of the correct size for your rods, properly spaced and at the correct height from the bottom of the block.

Next, remember that 6mm hole beside the bearing adjustment slot in the plastic disk? This is where we create the part to fit there.
Exactly half way between the holes for the rods but on the bottom surface, mark to drill a hole there. Now, caution – you want to put a bolt through the plastic and through the block of wood but the threads cannot mar the hole in the plastic disk. You want the unthreaded part of the bolt to fill the 6mm hole. Drill an appropriate sized hole for your bolt in the wooden block.
The two bars were glued (use epoxy 2-component glue) in a block of wood about 20 x 25 x 140 mm. Put the rods in the router and lock them in place with the router thumb screws. Glue the rods to the block of wood. This will support the rods while the glue is curing and keep them in perfect alignment.
You can now mount the 3 ball bearings under the disk. I had to insert a thin washer between bearing and the Plexiglas disk to allow the bearings to rotate freely and without binding on the plastic disk.
To mount these bearings, I used carriage bolts. Here's what you want. The "shoulders" of the carriage bolts should rest inside the race of the bearing. The spacer should sit between the head of the carriage bolt and the square shoulders spacing the head off slightly so the bearing runs freely. Then, a second spacer goes between the bearing and the disk, and finally a washer on top of the disk to relieve some of the pressure of the nut against the plastic and, lastly, the nut. An Acorn nut would be appropriate but not vital. Alternately, replace the carriage bolt by grinding part of the head off an appropriate sized bolt. Insert the bolt but do not tighten.
Install your template guide in the router and your preferred bit for this jig. Slide your router onto the bars and place the template guide in the slot. Tighten down the bolt holding the bridge and rods onto the disk. Lock your router onto the rods where it is convenient, for the moment.
You can use the jig now so this next step is optional and depends on your router and base plate. Glue two guides + / - 20 x 8 x 200 mm on the disc, along the sides of the router base plate. These two strips (Plexiglas or other material) will guide your router if you do not have the guide bushing mounted.
Your router should move freely, without any play between these two guides. At least one of these strips should be sufficiently wide for the tape measure to be glued onto it



Your circle jig is now operationat

Calibration

Calibration is somewhat of a necessity. It is difficult to measure from an imaginary centre to the cutting edge of the bit with the whole jig assembled and clamped over the workpiece. Accuracy is important so practice and understand this before you do it. There is nothing difficult about it though.

Step 1:assemble all you'll need to glue your tape measure along side the router; glue, suitable for attaching metal to plastic (or, according to your needs); a piece of tape measure or plastic ruler; method of making a thin permanent mark on your router.

Step 2: Glue your ruler alongside the router base, on the plastic disk and parallel to the template guide slot. Do not attach the ruler in the path of the router.

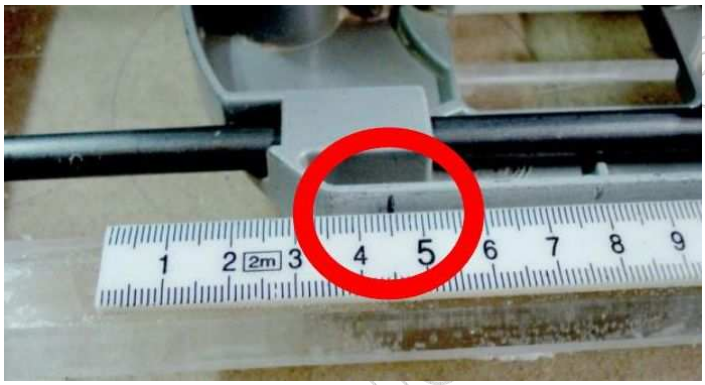
Step 3: take a piece of scrap MDF or something large enough to cut a circle in. MDF is better because it routes to a clean edge. Plywood might be a bit messy with tearout.

Step 4: cut a circle about 100mm (4") in diameter and 5 or 6 mm (≈1/4") deep but when you're finished, don't move the router. Instead, unclamp and remove the whole jig as one part. It is critical that the router not move on the central disk.

Step 5: with a set of vernier or digital calipers, measure the diameter of the disk you've just cut and add the diameter of the bit you've used. This will give you the diameter at the centre of the bit. Divide by two this will, give you the radius from the centre of the circle to the centre of the bit.

Step 6: make a mark on your router's base like the picture below. This mark will correspond to the radius of the circle you cut but at the centre of the bit.

Remember, this marking on the router base is to the centre of the bit. You will have to add or subtract the radius of the bit when doing a cut depending on whether you want a disk or a hole. For example, I use a ¼" bit to cut a 3" disk. I set the radius to cut at 1⅝" = = 1½" for the disk plus ⅛" for the radius of the bit. Here's the setup but in metric.



This disk is made with a 10mm bit. The results is an 80mm disk and a 100mm hole.

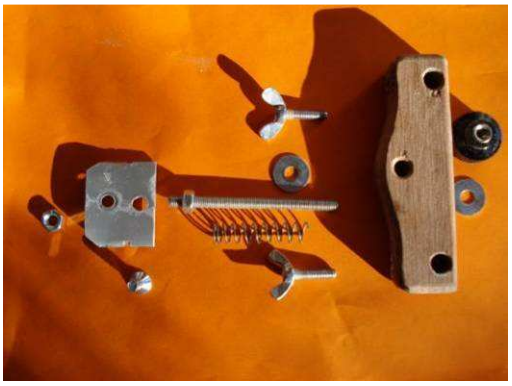
Micro adjuster

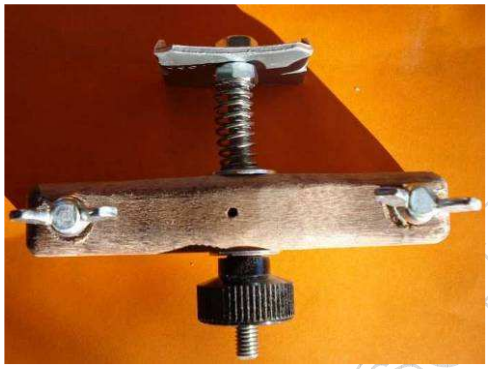
This is a nice optional extra. It allows you to micro-adjust the position of the router relative to the centre of the circle. It is possible with the Kress router because it has a 6mm threaded hole in just the right position. If you don't have an appropriate hole, you will either have to drill and tap your router base (or, take it to a machinist to have him do it) or find another way to attach an adjusting screw.

In the picture above you'll see one setup for the adjusting screw. The adjusting screw can also go on the other side of the router, depending on how large a circle you want to cut. You might have to experiment a bit to figure out what I'm trying to say.

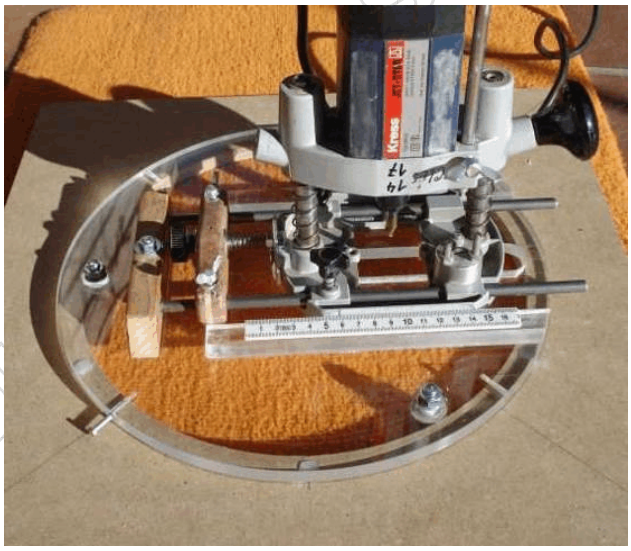
Create a small stick that is a duplicate of the one we made for the Router Mount, above, Instead of making a hole in the bottom, figure out how you're going to attach an adjusting screw to your router and

fashion your stick accordingly. In the pictures below are a suggestion of the parts and how they are assembled. Your method should follow something along these lines.





I tried longer bars to avoid relocating the fine adjustment mechanism but the bars interfered with the clamps holding the base.



If you look carefully at this picture, you'll see that there are screws inserted into the edge of the disk. This is one method of creating indexing. However, an alternative is to drill "stops" around the edge of the disk in the base and use only one pin or screw on the disk. Put "pins" in the base. The advantage of the latter method is when you remove the stop you know you've completed that index.

The "telescopic sight"

This can be done several ways, a piece of MDF with a plexiglass "sight" in the middle or a piece of plexiglass the full size of the jig hole with "cross hairs" in the middle.
The hole in the triangle and the "glass" were cut using the compass. The plexi glass is a friction fit with no glue. The cross hairs are on the bottom, next to the work piece so there is no problem with parallax.
Note, on the top side of the "cross hairs" is a dimple made with a very sharp pointed bit chucked in the router. This marks "0" for the router. Flip the plexiglass over and scribe the cross hairs, intersecting exactly below the dimple we made with the router.

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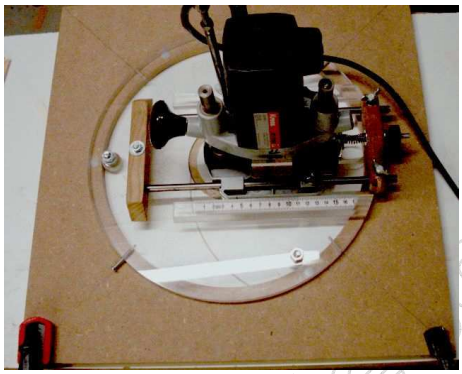
To use your compass

Mark your centre on the work piece.

The “telescopic sight” is placed inside the base, and the cross hairs lined up with the circle notation on the work piece. Clamp the base.



Remove the sight and replace it with the disk and router. Set your cut radius and make your cut.

The cut

Text, Drawings and Photos: Santé, Layout: Bernard Limont, english editing: Allthunbs