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FMT PRO CHAPTER 4

Mortise & Tenon Routing Procedures

Single Mortise & Tenon, Test

Production Procedures

Production Procedures for Small Joints

Routing Joints Smaller than 1/4"

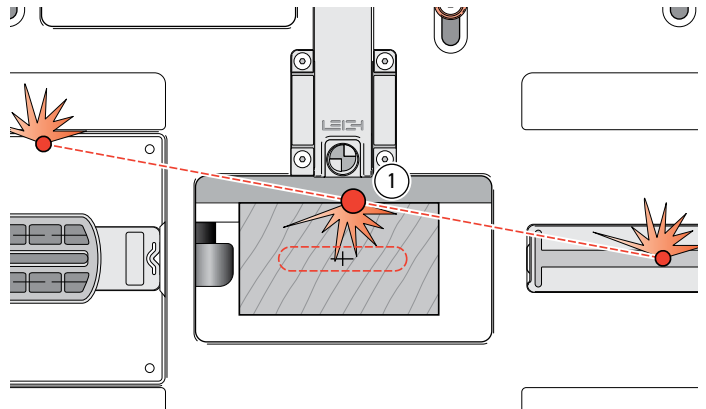
See Appendix I for complete joint specifications and guide and bit selection.

Before using your Leigh FMT Pro you must have completed all of the preparatory steps including reading the router safety recommendations on the previous pages. If you haven't done so, it is essential that you do it now.

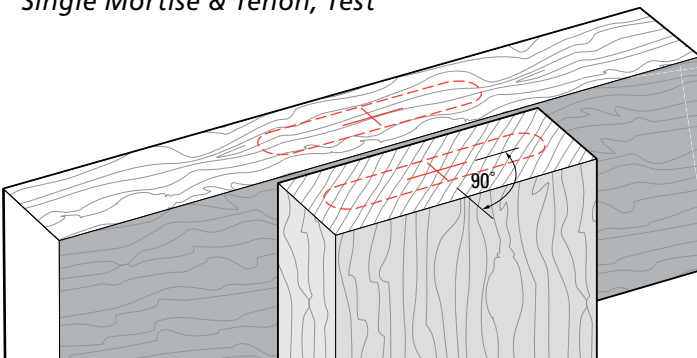
⚠ IMPORTANT SAFETY NOTE

Take great care to not “trap” the bit against the side of tenon rails ①. Do not attempt to rout center tenons in rails thicker than $1\frac{5}{16}$ " [34mm] before referring to 5-39 through 5-44.

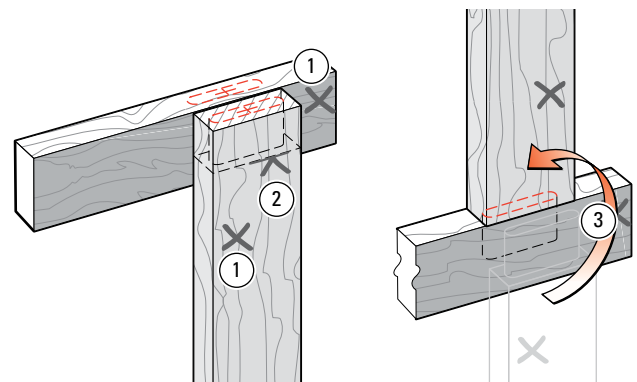
Without using the table movement as prescribed, the bit would have to be plunged into the side of the tenon rail causing the bit to powerfully “drive” the router across the jig. **This could be dangerous and can damage the jig.**



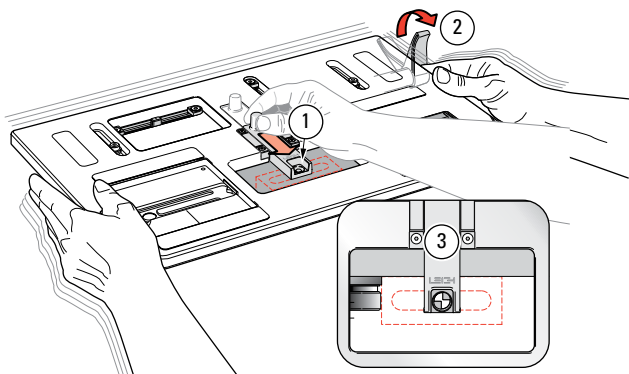
Single Mortise & Tenon, Test



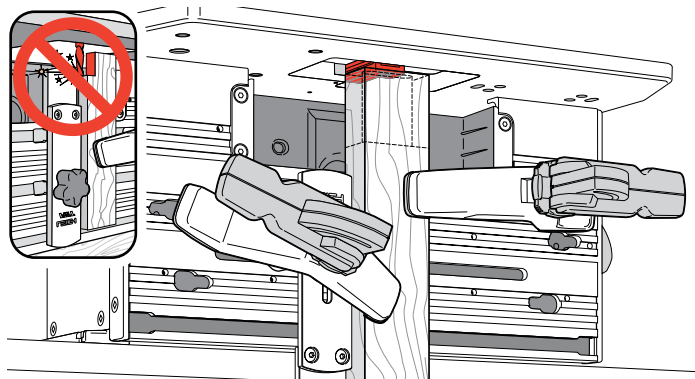
4-1 Let's make a plain single mortise and tenon. Using a fine pencil, mark a cross at the center of the required tenon and mortise. The cross lines along and across the axis lines of the joint must be at 90° to each other. Mark the mortise several inches [10cm] or so away from the end.



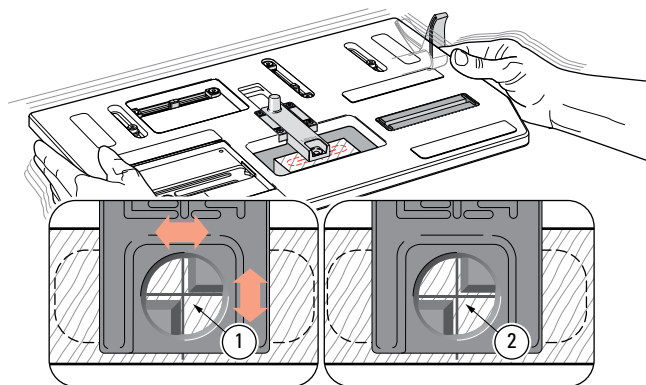
4-2 In almost all cases, it is critical to have the same side of workpieces reference against the clamp plate for each tenon and mortise. Mark one side of each workpiece to reference “this side toward the clamp plate” ①, or “away from”. Make a pencil mark ② to the required shoulder depth on the tenon workpiece. When the joint is cut, the tenon piece is rotated 180° to assemble ③.



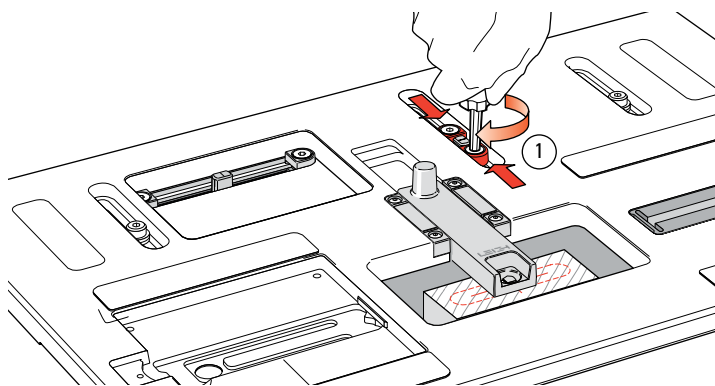
4-3 If you have not yet mounted the side stop fence, do so now (see 3-13 to 3-15). Place it off center by about half the width of the tenon piece; either side, it doesn't matter. Pull the table sight forward to its stop ①. Release the table clamp ② and move the table to position the sight over the approximate tenon piece position ③. Lock the table. Always lock the table before positioning workpieces.



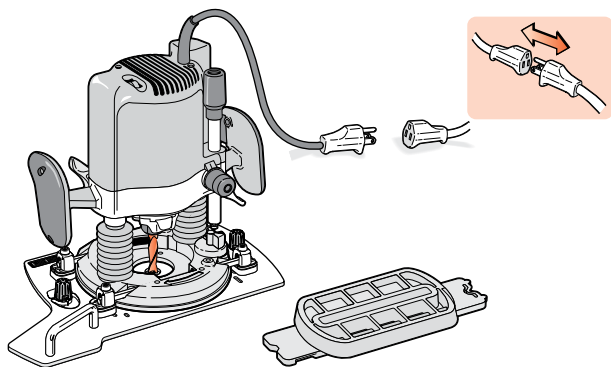
4-4 Clamp the tenon piece with the end edge **lightly touching the underside of the sight**. Its side edge should touch the previously set side stop fence, with the marked side toward the clamp plate.



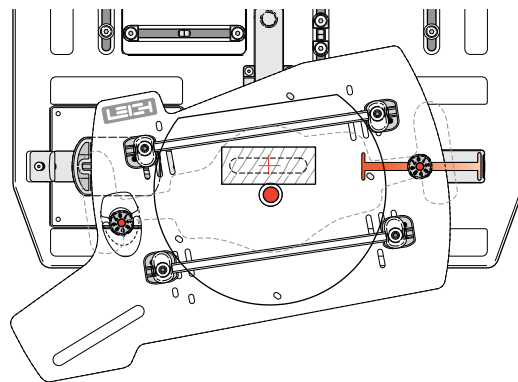
4-5 Release the table clamp and move the table until the sight opening is positioned equally around the cross lines on the workpiece. Lock the table. Because the human eye excels at comparisons, differences as small as 0.004" can be perceived in the space between the edges of the line and the triangles as shown here ①. You can readily center the sight using slight table movements until the spaces appear the same ②.



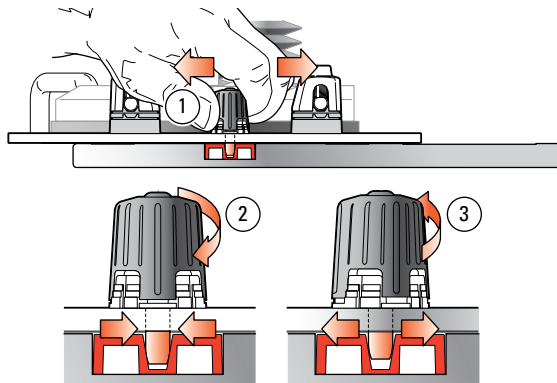
4-6 Unlock the two **FB** front/back limit stops. Move both so they touch the Stop Post and tighten both stops ①. This prevents front-to-back movement of the table when later sighting the mortise. Retract the sight.



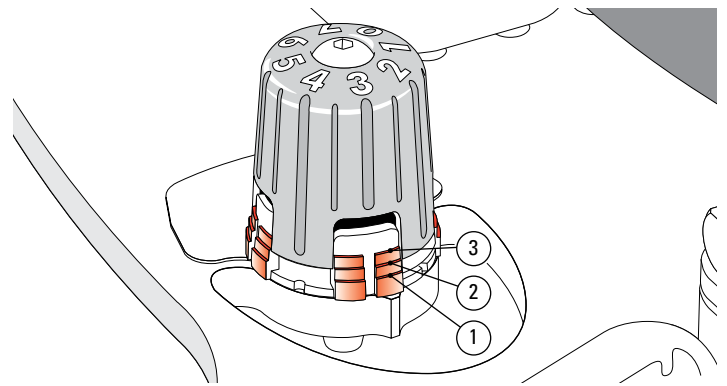
4-7 Unplug the router. Insert the selected guide in the guide recess and the matching diameter bit to the router. **Note:** See Appendix I for Guide and Bit Selection.



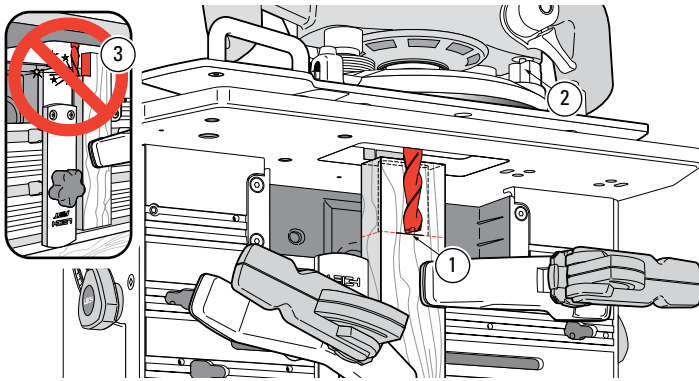
4-8 Make sure the two guide pins are turned up two full turns from the lowest position! Place the router on the jig table, the right hand guide pin in the right side track, the left hand guide pin in the near side of the guide recess.



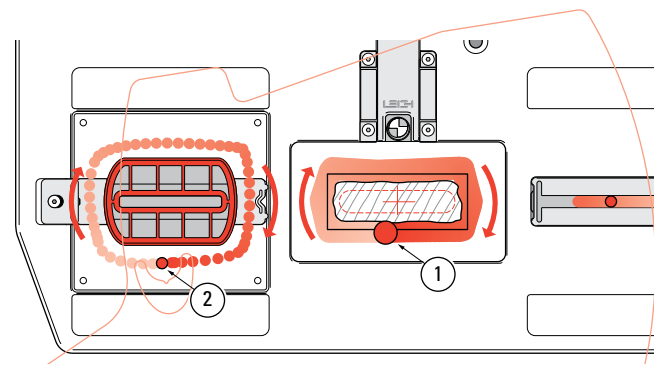
4-9 Adjust the right hand guide pin. Grip right hand pin knob and move sub-base back and forth to feel the “free play” of the pin across the slot width ①. Turn knob down $\frac{1}{8}$ of a turn at a time, to feel the “play” diminish ②. When the “play” stops, turn knob up $\frac{1}{8}$ of a turn until the slightest play can be felt ③. The router/sub-base should slide freely left to right. If right pin is a little “sticky”, turn it up a bit more.



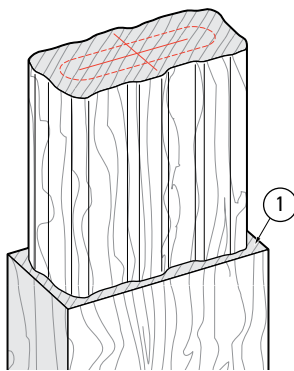
4-10 Check that the left hand knob is two turns up. From this setting the actual fit setting will be established by trial and error and the result recorded for each guide/bit combination. Note: The “steps” in the height “washer” indicate numbers of “turns up”; one turn ① two turns ② three turns ③. **Never turn the knobs up more than $3\frac{1}{2}$ turns in use.**



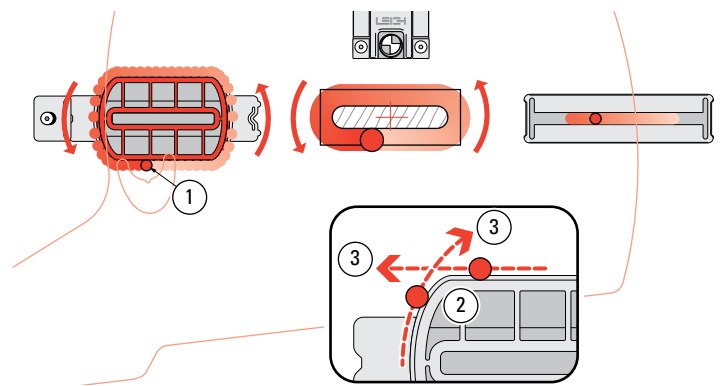
4-11 Plunge the router so the tip of the bit is level with the pencil mark of the tenon shoulder and lock the plunge ①. Set the plunge depth stop rod to its stop ②. *Generally, tenons are routed in one depth setting, it is not necessary to make multiple passes at different depths of cut.* **⚠ WARNING: Never rout tenons with the sidestop fence in the inverted position ③.**



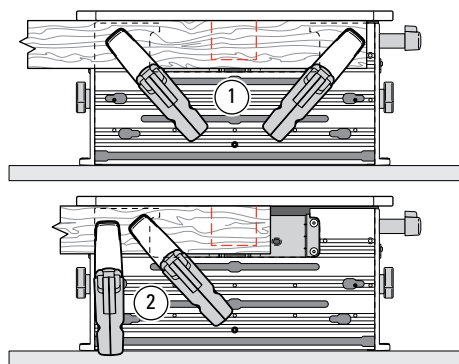
4-12 Read all of the next 3 instructions before routing. With guide pin in near side of guide recess, switch on router power and with firm control, move it in until the bit lightly touches the tenon workpiece. Very carefully, with bit very lightly engaging the wood surface, “climb rout” clockwise around tenon piece ①. Maintain very light bit contact. Do not run guide pin on guide yet ②.



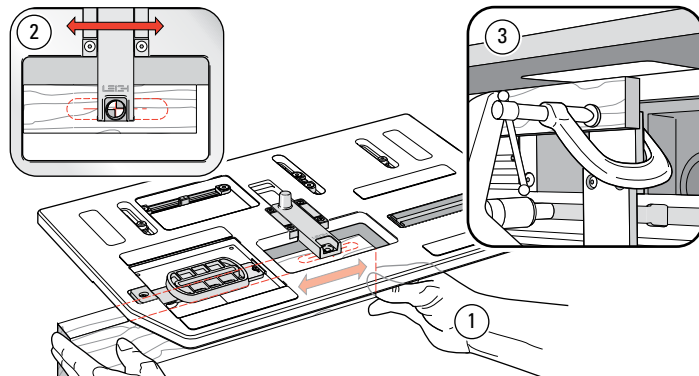
4-13 Control the router firmly, the router is driven clockwise by the bit rotation. This first shallow climb cut will leave a small but clean shoulder ①.



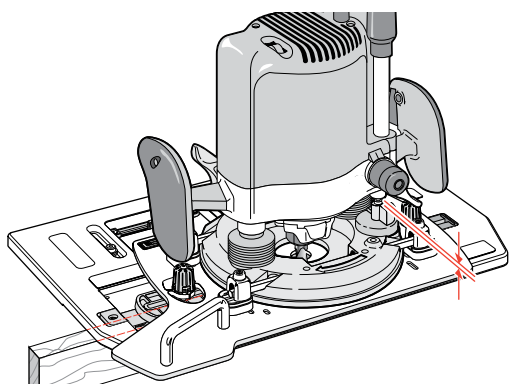
4-14 Routing counter-clockwise, run the guide pin around the tenon guide surface. Make sure the pin contacts the entire outer surface ①. In these first test cuts, check the tenon for a completely smooth cut before removing the piece from the jig. Until you are confident with this procedure, we recommend as a final clean-up, you run the guide pin “off” of each guide “corner” ② in both directions ③.



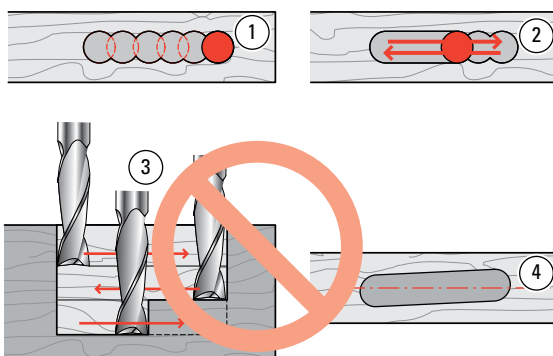
4-15 Remove the router and tenon workpiece from the jig. Position the two clamps so the mortise piece can be positioned for secure holding. Clamp to either both sides of the vacuum box ① or to one side ②. Note: Leaving a “horn” on the ends of mortise pieces as in ① not only makes for easy clamping, it’s good woodworking practice as the horns will be an aid in assembly gluing and clamping later.



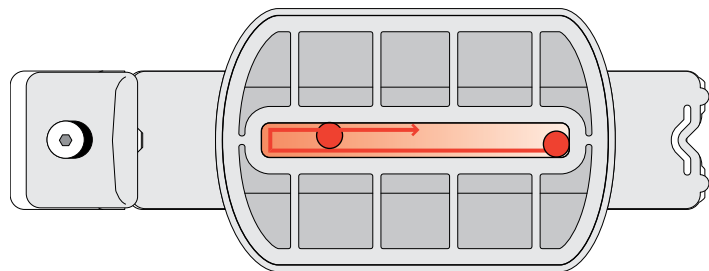
4-16 Extend the sight. With the marked side of the mortise piece toward the clamp plate, either move the board left and right ① to align the cross with the sight and clamp in place; or clamp in place first and move the table to align the sight ②. Remember, you previously set the $\frac{3}{8}$ FB limit stops to allow only left/right movement. For routing very small pieces ③, see 3-16.



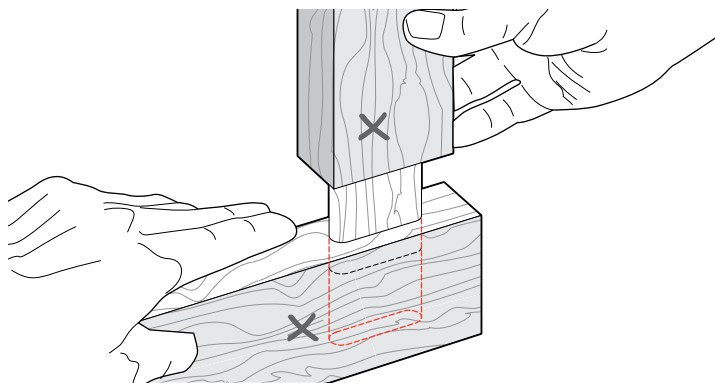
4-17 Place the router/Sub-Base assembly on the jig, the left hand guide pin in the mortise slot part of the guide. Now raise the plunge stop rod slightly, say $\frac{1}{32}$ - $\frac{1}{16}$ " [1-1,5mm] to allow the mortise to be routed slightly deeper than the tenon to ensure perfect tenon shoulder flushness on the finished joint.



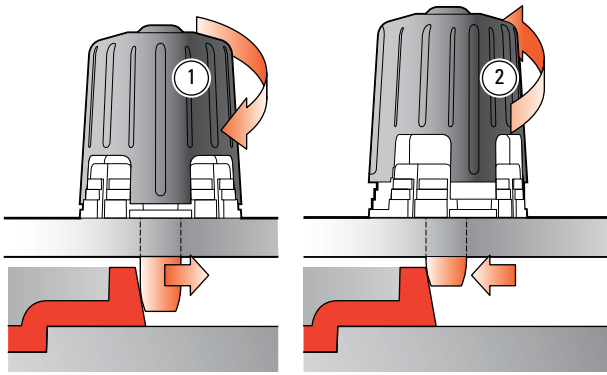
4-18 The best way to rout mortises (parallel to workpiece) is plunge full depth, slightly overlapping holes ①, then clean out left-right-left at full depth of cut ②. Do not rout left-right-left at progressively greater depths without plunging holes ③ ... the bit’s rotation will pull the bit off the intended mortise line with each pass ④ and the mortise may not be parallel to the workpiece.



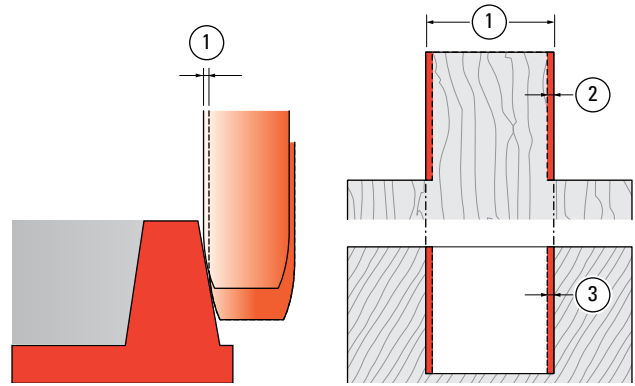
4-19 Make sure the guide pin is run clockwise against both the front and rear of the mortise guide slot on the final passes. The gap between pin and mortise guide slot is greatly exaggerated in this illustration.



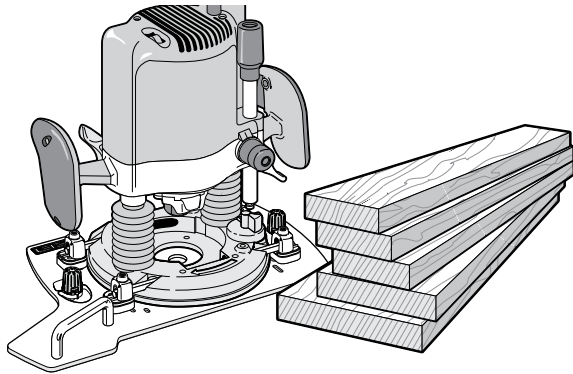
4-20 Remove the mortise piece and test the tenon for fit and (keeping the marked faces adjacent) for flushness. If the face sides are not flush, check the straightness of the two parts. If they are straight, the clamp plate may not be vertically parallel to the bit. See Appendix II, Jig Adjustments, A2-1 through A2-3.



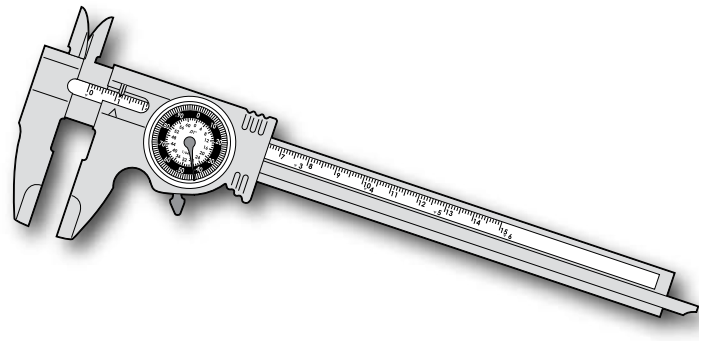
4-21 If the joint is too loose, turn the **LEFT** guide pin down ①. If it's too tight, turn the **LEFT** guide pin up ②. For how much, see 4-22. Rout a complete new joint. *Note: It's possible to adjust the guide pin and rout only one new mortise or tenon part and get a good fit, but on a project this would mean routing each part at different settings. Establish ideal pin height for both mortise and tenon at one pin setting.*



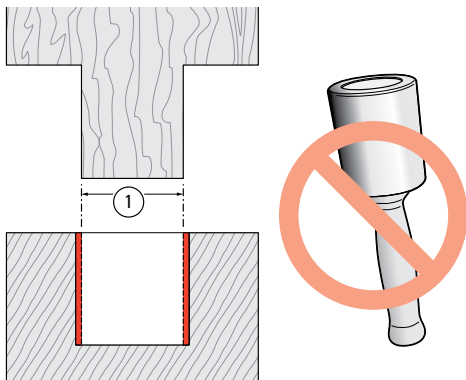
4-22 How much adjustment is required? One eighth of a turn of the guidepin knob will change the joint glue-line fit by 0.001" [0,025mm] ①, i.e. turn one-eighth up; the bit will reduce the tenon thickness by 0.001" [0,025mm] (half of that per side ②) and increase the mortise width by the same amount ③. Dimensions and angles shown here are exaggerated.



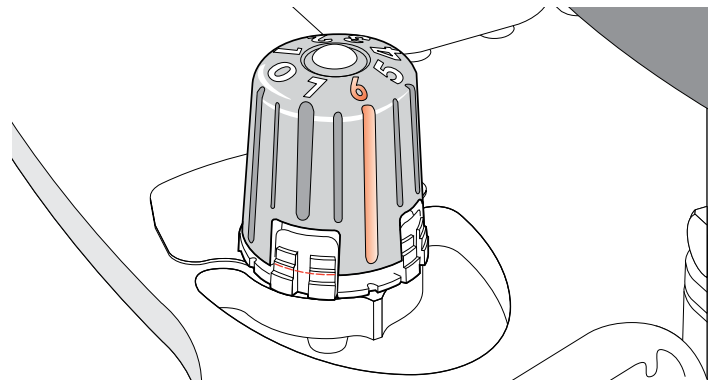
4-23 The FMT Pro can provide this accuracy for settings but remember, you're working with wood and a hand-held router, with lots of movement tolerances; it's not a computer-controlled milling machine. Nevertheless, the FMT Pro will allow you to do very precise and consistent work.



4-24 If you have a dial or digital calliper (every shop should have one) you can literally measure the tenon and mortise and adjust accordingly. Every 0.002" [0,05mm] of difference in mortise to tenon size (that's .001" [0,025mm] on the glue line) should require one eighth of a turn; down to tighten, up to loosen.

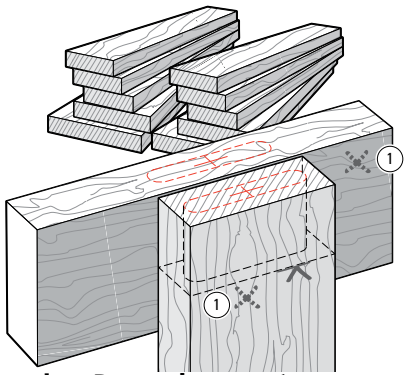


4-25 Generally we have found the best fit differential to be 0.005" [0,13mm] "loose". Basically, the dry joint should "push" together fairly easily, but not fall apart under its own weight. If a mallet is needed, it's too tight.

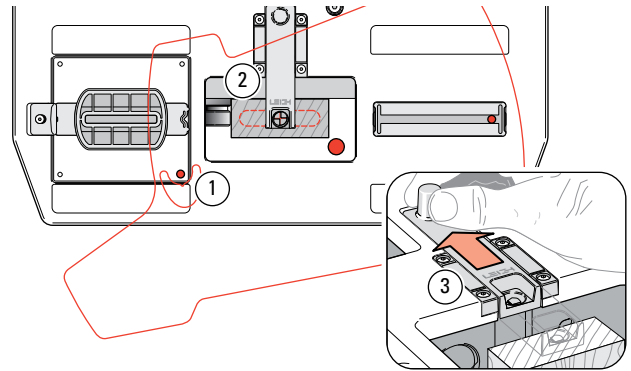


4-26 Once you have established the guide pin setting for a specific bit/guide combination, record the setting. For example: $\frac{5}{16}$ "x $1\frac{1}{2}$ " [8x35mm] "up $1\frac{3}{4}$ turns". **Using the same bit and guide next time**, use the recorded setting for a good fit first time. *Note: As with all joinery, different wood species do not necessarily rout precisely to the same fit.* ■

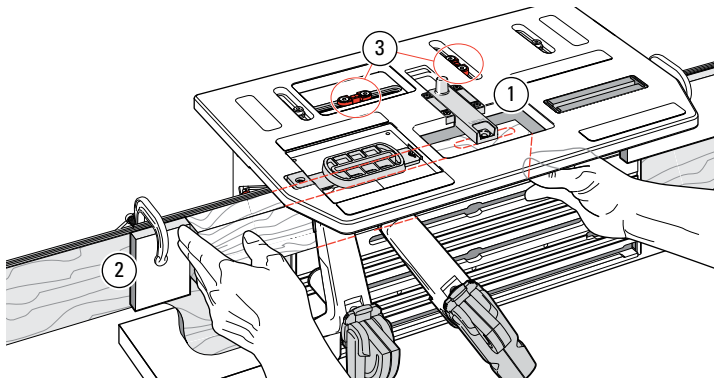
Production Procedures



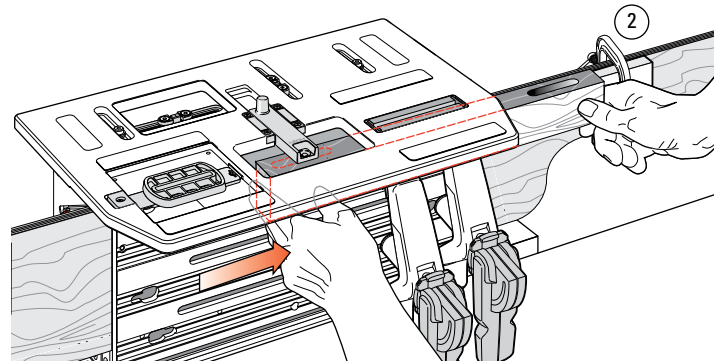
4-27 Production Procedures When routing frame joints it is only necessary to mark and sight a single tenon and perhaps two mortises. Once the side stop fence or outriggers are set and the table sighted for one joint, any number of similar joints may be routed without marking and without removing the router from the jig. We recommend marking the finished face which goes against the clamp plate (shown here from operator view) ①.



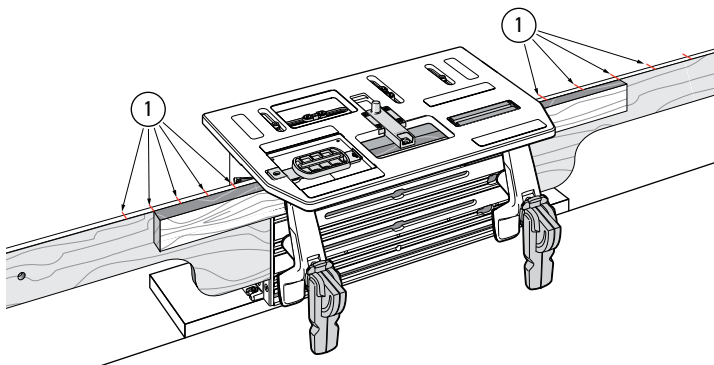
4-28 Tenons The router is “parked” with the guide pin in near front corner of recess ①. Extend sight and use only as a tenon stop ② when clamping successive (unmarked) tenon pieces against side stop. Retract sight ③ and rout any number of tenons without removing router. **Note:** If you forget to retract the sight, the Sub-Base will push it out of the way as you move it rearward, but we do not recommend this.



4-29 Mortises: Sight one mortise ① and set a stop block at the end of the mortise board ②. Set **LR** limit stops and **FB** limit stops to prevent unintentional table movement ③.



4-30 Sight the second mortise by moving the mortise piece (not the table) and set the second stop block ②. Rout any number of successive (unmarked) mortises without removing the router from the table.



4-31 Successive mortises in “ladder” type construction are quick to rout. Mark all mortises on only one piece (only one needs a front-to-back mark!). Sight the first mortise (cross) to set the table and mark the top of one outrigger in line with the workpiece end. Table locked, move the workpiece, sighting each successive mortise line, marking the outrigger(s). To rout, align the unmarked board ends with the outrigger marks ①. ■

See Production Procedures Video



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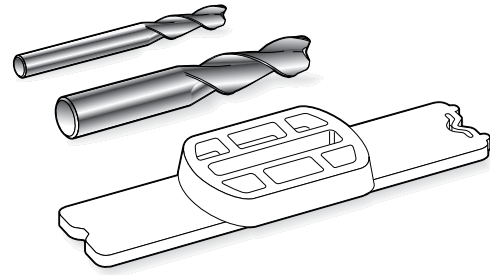
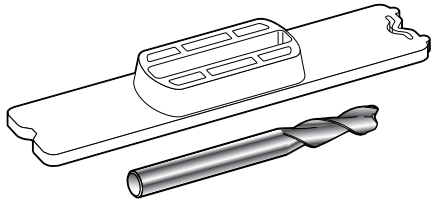
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See next page for Production routing of Small Joints.

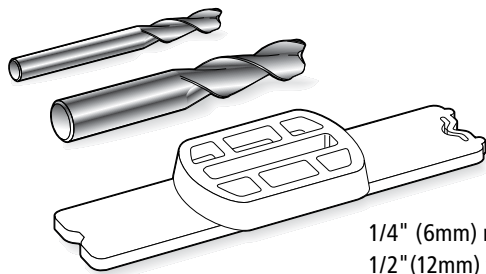
Production Procedures for Small Joints



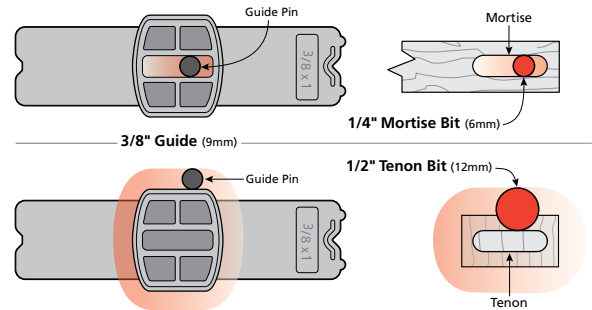
4-32 The FMT Pro is designed so that both mortise and tenon of a particular-sized joint may be routed with the same sized bit. So if you are making say, a single frame with a 1/4"[6mm] guide and bit, this works very effectively. However, it is much more efficient to rout small tenons with a **larger** bit, and particularly useful for production routing. This involves using two bits instead of one.

4-33 Two Bit Combination If you want to rout many 1/4"[6mm] mortises and tenons, the tenons can be routed much more quickly with a 1/2"[12mm] bit*. The Guide and Bit Selection charts in Appendix I show how different bit combinations can crank out such extraordinary joints just as quickly and precisely as larger ones, and with adjustable joint tightness.

*Note: The maximum bit diameter used on the FMT Pro is 1/2"(12mm).



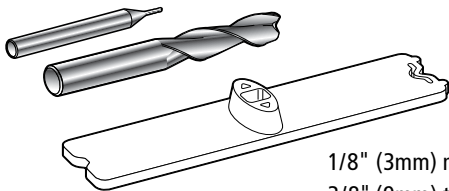
1/4" (6mm) mortise bit
1/2" (12mm) tenon bit
3/8" (9mm) guide



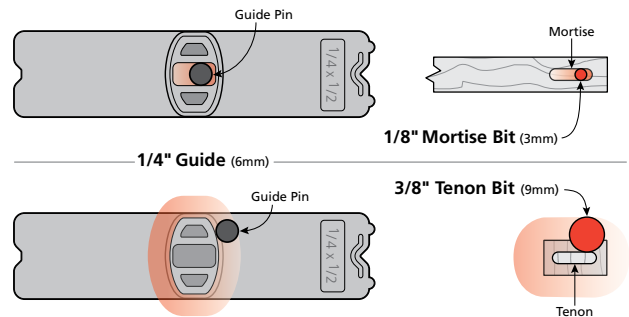
4-34 Example: 1/4" (6mm) Mortise & Tenon Joints with a 3/8" (9mm) Guide Using the two bits and guide shown above, you can rout a 1/4" (6mm) mortise and tenon. The resulting joint is 1/8" (3mm) smaller than the 3/8" (9mm) guide size. **Note: Any two bit diameters that add up to twice the guide size will produce a joint size of the smaller bit.**

4-35 For example:
3/8" guide x 2 = 3/4"
1/4" mortise bit + 1/2" tenon bit = 3/4"
(9mm guide x 2 = 18mm)
(6mm mortise bit + 12mm tenon bit = 18mm)

Routing Joints Smaller than 1/4"

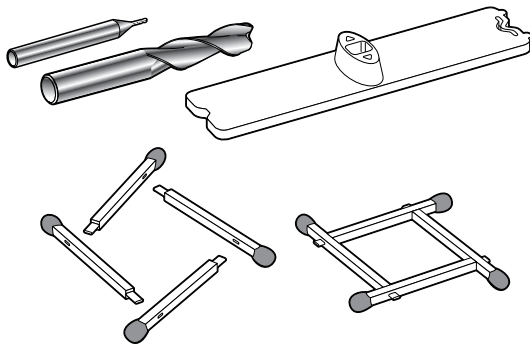


1/8" (3mm) mortise bit
3/8" (9mm) tenon bit
1/4" (6mm) guide

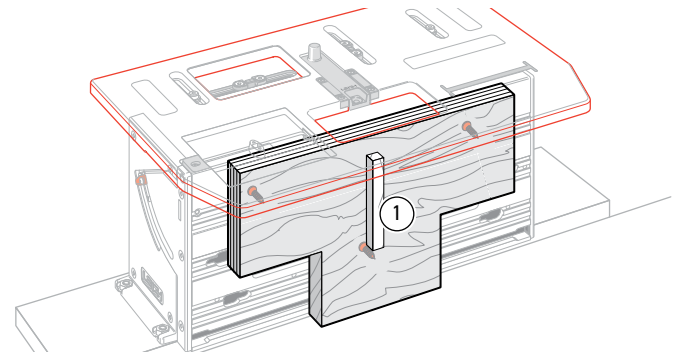


4-36 Example: 1/8" (3mm) Mortise & Tenon Joints with a 1/4" (6mm) Guide Using the two bits and guide shown above, you can rout a 1/8" (3mm) mortise and tenon. The resulting joint is 1/8" (3mm) smaller than the 1/4" guide size. **Note: Any two bit diameters that add up to twice the guide size will produce a joint size of the smaller bit.**

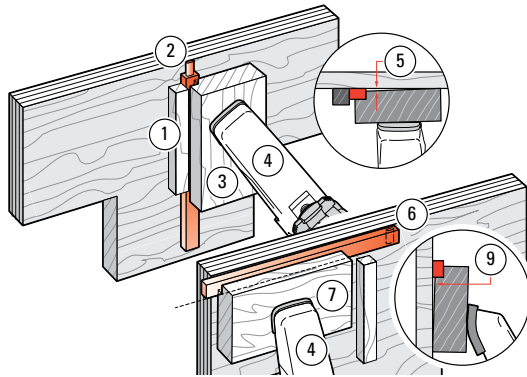
4-37 For example:
1/4" guide x 2 = 1/2"
1/8" mortise bit + 3/8" tenon bit = 1/2"
(6mm guide x 2 = 12mm)
(3mm mortise bit + 9mm tenon bit = 12mm)



4-38 The tiny $\frac{1}{32}$ " x $\frac{3}{32}$ " [0,8 x 2,4mm] mortises and tenons on this "match frame" were formed (with machine tool bits) on a $\frac{1}{4}$ " x $\frac{5}{16}$ " guide. The $\frac{1}{32}$ " tenon bit is $\frac{7}{32}$ " larger than $\frac{1}{4}$ ". The $\frac{1}{32}$ " bit is $\frac{7}{32}$ " smaller than $\frac{1}{4}$ ". A similar metric set: 6mm guide; 1mm mortise bit, and 11mm tenon bit to produce 1mm joints. Machine tool bits as small as 0.010" with $\frac{1}{4}$ " shanks and similar metric are available from machine tool suppliers.



4-39 For very small joints we recommend attaching a rigid piece of ply or MDF minimum $\frac{3}{4}$ " [20mm] to the clamp plate, using the through screw holes in the plate. This should have its own mini side stop fence attached for tenons ①.



4-40 To hold very small workpieces ②, make up a rabbeted holder ③ with the rabbet slightly shallower than the workpiece thickness, leaving a gap at ⑤ and ⑨. i.e. For Tenons: Side stop ① Tenon Piece ② Holder ③ Clamp ④ Gap ⑤. For Mortises: Mortise Piece ⑥, Holder ⑦, Clamp ④, Gap ⑨. ■

See *Small and Minature Joints Video*



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