THE WOODWORKER

The Charles H. Hayward Years: 1939-1967

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FOREWORD TO VOLUME III: JOINERY

It's difficult to overstate the importance of the book "Woodwork Joints" by Charles H. Hayward (1898-1998), which was first published in 1950 and reprinted many times and in several different editions of varying quality.

The compact 168-page book is beautifully illustrated by Hayward and contains the kind of spare prose that made him the best woodworking author of the 20th century. Like a good woodworking joint, Hayward's text contains nothing superfluous and lacks nothing important to the task at hand.

So when we began planning this third volume of "The Woodworker: The Charles H. Hayward Years," we used the 1954 edition of "Woodwork Joints" – a 5-1/2" x 8-1/5" folio printed by Evans Bros. Limited – as our guiding light.

Every illustration from "Woodwork Joints" had appeared in *The Woodworker* magazine, where Hayward was editor from 1939 to 1967. So as we culled every magazine issue from those years for the book you are holding, we marked and scanned every magazine article on joinery to make sure we captured everything that could have ended up in "Woodwork Joints." We almost succeeded.

The good news is that our efforts have produced a book that covers nearly all of Hayward's writing on joinery during the 28 years he was editor at *The Woodworker*. And because of the nature of the magazine format, we actually were able to plumb much deeper into the details of cutting and fitting joints to include things that never made it into "Woodwork Joints."

For example, Hayward wrote 20 pages on dovetails in "Woodwork Joints." This book has 90 pages on dovetails, and the pages are much bigger (8-1/2" x 11") than the 1954 edition. As a result, you'll find far more information on the secret mitre dovetail, stopped dovetailed housings, decorative dovetails and the double-lap dovetail. Plus details on how to correct faults in your joints, how to avoid crushing the end grain when chopping out and even a novel way to cut both the tails and pins simultaneously.

In addition to Hayward's take on joinery, this volume also contains the perspective of other British writers of the day that Hayward published in *The Woodworker*, including J. Maynard, Robert Wearing, K.J.S. Walker and C.A. Hewett.

So where did we fail? Despite our best efforts to find them, this volume does not contain a couple short sections from "Woodwork Joints," including hand-cut joints specifically for plywood and the use of metal fishplates with scarf joints.

Those faults aside, we think this volume is an admirable companion – if not a replacement – of "Woodwork Joints." I hope this book becomes as ratty and thumbed-through as almost every copy of "Woodwork Joints" I've ever seen. That would be the best tribute ever to Hayward as his work continues to inspire the next generation of woodworkers.

Christopher Schwarz
October 2016
Fort Mitchell, Ky.

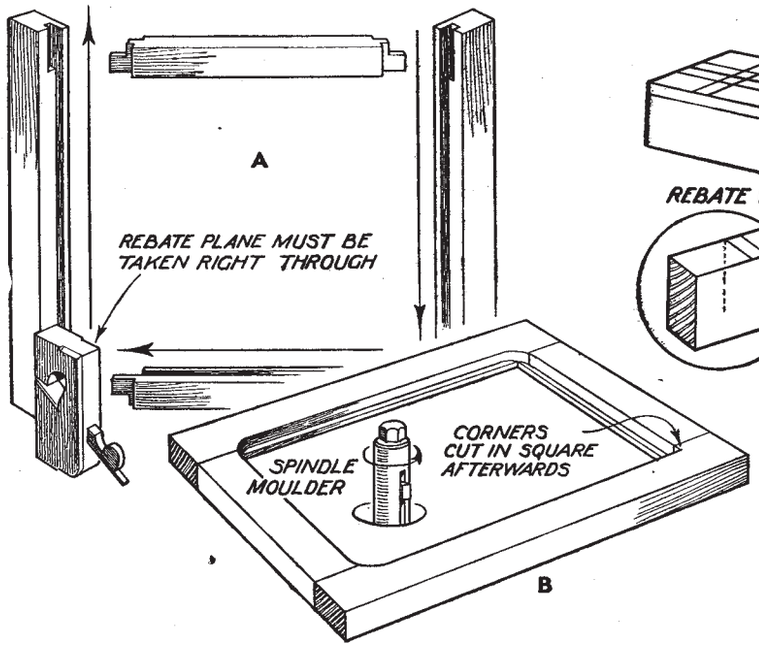


FIG. 2. A. HOW REBATING NECESSITATES LONG BACK SHOULDERS
B. REBATE MACHINE SPINDLED AFTER DOOR IS ASSEMBLED

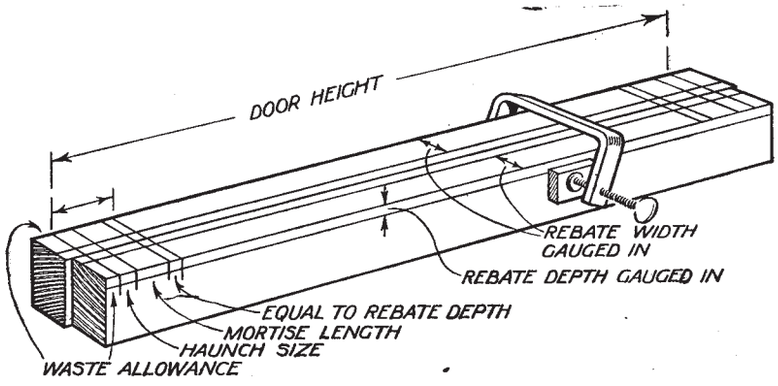


FIG. 3. STILES CRAMPED TOGETHER DURING MARKING OUT

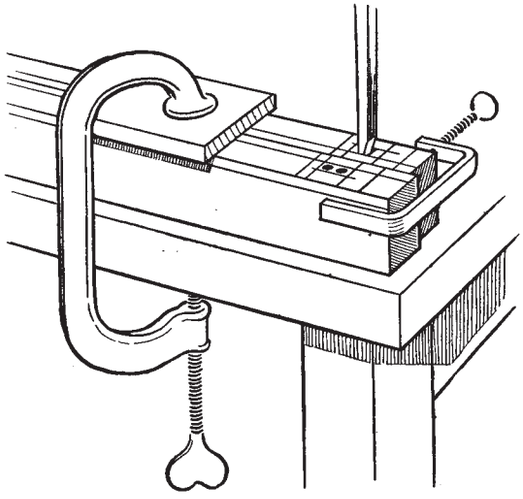


FIG. 4. MORTISES BEING CHOPPED

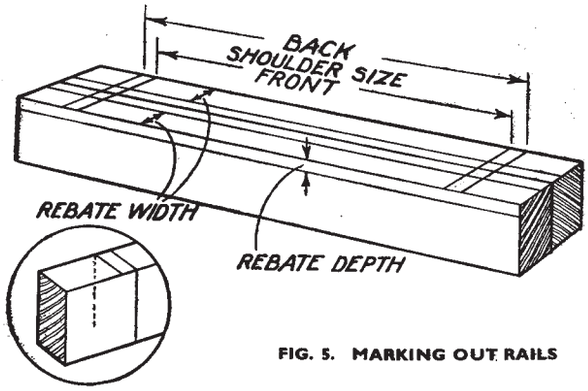


FIG. 5. MARKING OUT RAILS

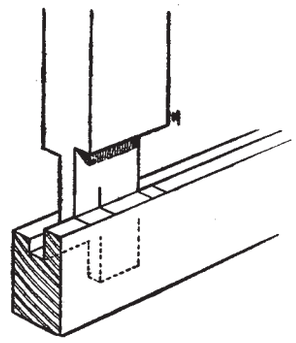


FIG. 6. MARKING SET-IN OF TENON FROM MORTISE

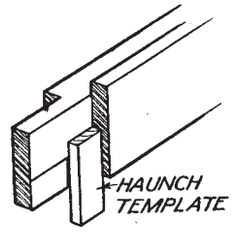
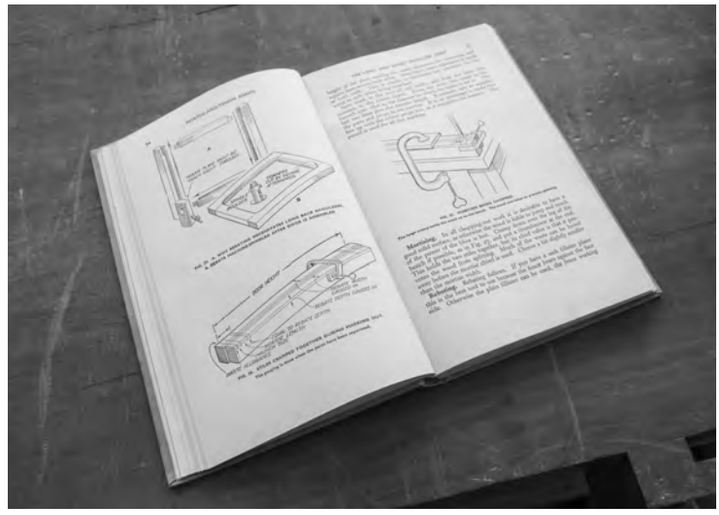


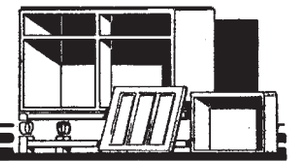
FIG. 7. HAUNCH LENGTH MARKED WITH TEMPLATE



WOODWORKER

JOINERY:
FRAME JOINTS

Chart titles are in italic.



JOINERY:
FRAME JOINTS

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WOODWORK JOINTS:
MORTISE AND TENON JOINTS

Some years ago We published a short article showing as a matter of interest that there were well over two thousand possible variations of the mortise and tenon joint. In practice, of course, no man needs to know about so many, and, except for small differences, the number one should be familiar with is nearer two dozen. It should be realised, however, that every joint owes its origin to definite practical reasons. Its particular form may be necessitated by this or that decorative or constructional detail; it may be the strongest form that could be devised for the job; perhaps it is the only form that would give practical working for hand or machine tools, as the case might be; at the same time there are probably other alternatives which would do just as well. Whatever the form one can be sure that the accepted types of joints have been found to satisfy the practical requirements of the general run of jobs. In this series of articles we are taking the chief joints and showing the main variations, pointing out the practical considerations affecting their use. For convenience We have referred to all uprights as "stiles," and all horizontal members as "rails."

A **Simple Stub-tenon.** Used for frames, doors, etc., when inner edges are square and plain. Tenon is usually full width of rail, as shown, when latter is set in from end of stile. When rail is level with top or bottom of stile the tenon is set in, as shown by the dotted line, though for a better job a haunch is cut to prevent the corner from twisting. Sometimes when rail is in middle of stile both sides of tenon are set in slightly so that all traces of mortise are hidden.

B. Haunched Tenon for Grooved Frame. Chief use is for doors, etc., which have grooved-in panel. Note how the haunch fills in the end of the groove, so avoiding a gap, and at the same time preventing any tendency for the corner to twist. See also how the mortise is set in at the inside by a distance equal to the groove depth, owing to the groove automatically cutting away the tenon.

C. Tapered or Secret Haunch. When rail is level with top of stile or leg this haunch is invisible and is rather stronger than the square haunch, since the wood above the mortise is not cut away so much.

D. Tenon for Moulded and Rebated Frame. Moulding is cut away locally at the mortise and is mitred. Rebate is level with bottom square of moulding so that shoulders are level. Haunch serves to prevent corner from twisting.

E. Joint for Rebated Framework. Back shoulder is longer than that at front by amount equal to rebate depth. Note also that mortise is set in at inside by same amount since rebate cuts aways the tenon. Haunch prevents twisting.

F. This is similar, but haunch is omitted and is thus quicker to cut.

G. Joint for Casement or Sash Window. Mortise is level with centre square of moulding. End of latter is left on as a spur, and rail is franked to fit over it. Moulding is scribed. Compare with joint at (D).

H. Rails and Leg Joint. Mortises meet so that tenons have maximum length. Ends of tenons are cut at an angle, thus clearing each other.

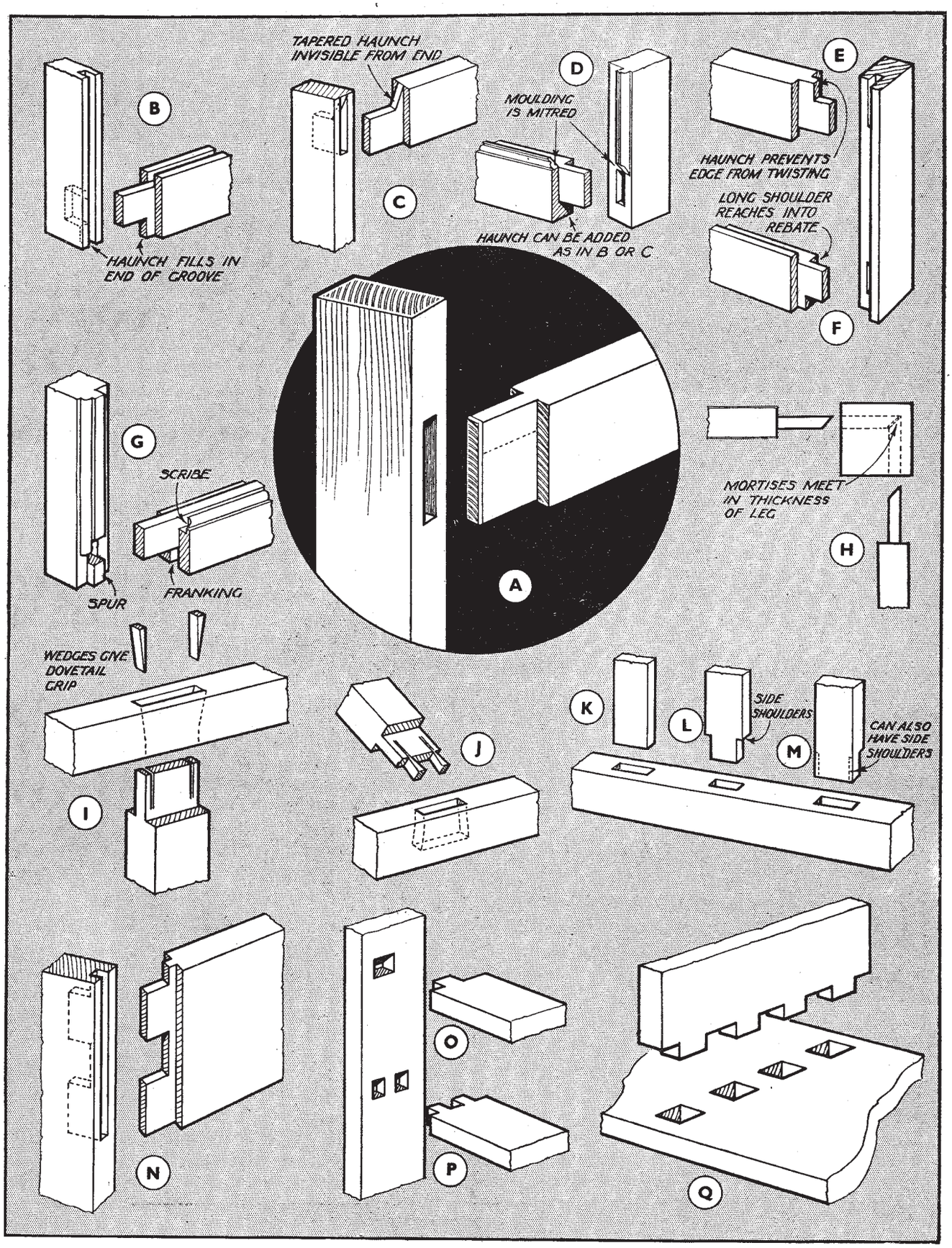
I. Wedged Through-tenon. Used when strength is essential, and when appearance of tenon outside does not matter. Note that ends of mortise splay outwards.

J. Fox-wedged Tenon. Application similar to (I), but used when it is undesirable for tenon to emerge at outside. Mortise is splayed outwards towards bottom, and wedges are inserted in saw kerfs before joint is assembled so that bottom of mortise presses them in. When this or joint (I) occur at corner the tenon is set in at the outside and is haunched.

K. Non-shouldered Tenon. Sometimes used when slat is too thin to be shouldered, but only when there are shouldered end uprights or stiles to give exact distance between members. Occasionally used in gates, mortise running right through to allow uprights to pass through in unbroken length.

L. Side-shouldered Tenon. Used when material is too thin for shoulder in thickness. More satisfactory than (K), in that shoulders give exact distance between members.

M. Bare-faced Tenon. Shouldered at one side only. Handy when material is not thick enough for two shoulders, or when the upright must stand in at one side. Advantage of end shoulders (dotted


TAPERED HAUNCH
INVISIBLE FROM END
B
C
D
MOULDING
IS MITRED
E
HAUNCH PREVENTS
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END OF GROOVE
HAUNCH CAN BE ADDED
AS IN B OR C
F
A
G
SCRIBE
SPUR
FRANKING
MORTISES MEET
IN THICKNESS
OF LEG
H
WEDGES GIVE
DOVETAIL
GRIP
I
J
K
L
SIDE
SHOULDERS
M
CAN ALSO
HAVE SIDE
SHOULDERS
N
O
P
Q

lines) is that they hide ends of mortise.

N. Double Tenon. For extra wide rails. Note haunch at top and web joining tenons. Latter prevents light being seen through joint in event of shrinkage.

O. Drawer Rail Joint. Single tenon cut full thickness of wood. Sometimes taken through and wedged.

P. Double-tenon Drawer Rail Joint. Similar use to (O), but more satisfactory in that tenons are nearer edges and ensure rail being square. This again can be taken through and wedged.

Q. Carcase Pinning. Frequently used for fixing intermediate division in wardrobes, etc. Generally the tenons are taken through and wedged.

SOME HINTS FOR THOSE WHO MAY NOT YET KNOW:
SIMPLE MORTISED & TENONED FRAMES

YOU can't muddle through the making of a mortised and tenoned frame and get a good job. If you are comparatively inexperienced, probably you are finding this out. For ensuring accuracy, squareness and freedom from twist, there is nothing better than the simple, systematic method of setting out carried on in the workshop. It is the key to easy success in frame making.

Setting Out. First, see that your stuff is trued up and taken to width and thickness.

Reject any piece that is twisted. Don't cut off the rails and stiles to exact lengths.

The stiles (the mortised pieces) should be about 2 ins. longer than the length of the finished frame, and, if the frame is to be through tenoned, the rails (the tenoned pieces) should be about 1 in. longer than the width of the frame.

We will assume that the frame to be made is a simple one on which ply is to be mounted to form a small flush door. Measure the length and width of the opening for the door, adding (say) 1/8 in. to each. Set off these measurements along the face edge of a rail and stile respectively, leaving spare wood at each end. Square the lines round the stile as shown by the end lines (A) in Fig. 3. From these end lines measure along the face edge the width of the rails, and square pencil lines (C, Fig. 3) across the face side to the back edge. From these measure along the face edge, towards the ends, two-thirds of the width of the rails, and from the points square more pencil lines (B, Fig. 3) across the face side and back edge. Next take up a rail, and from each of the points marked on the face edge (A, Fig. 4) measure inwards the width of the stiles and square lines all round with a marking knife (B, Fig. 4). These are the shoulder lines.

You now have a pattern rail and a pattern stile, and from each you can mark out another one or as many others as you may need. This is done by cramping the pieces together side by side with the pattern, squaring the edge lines on and then taking apart for squaring the lines

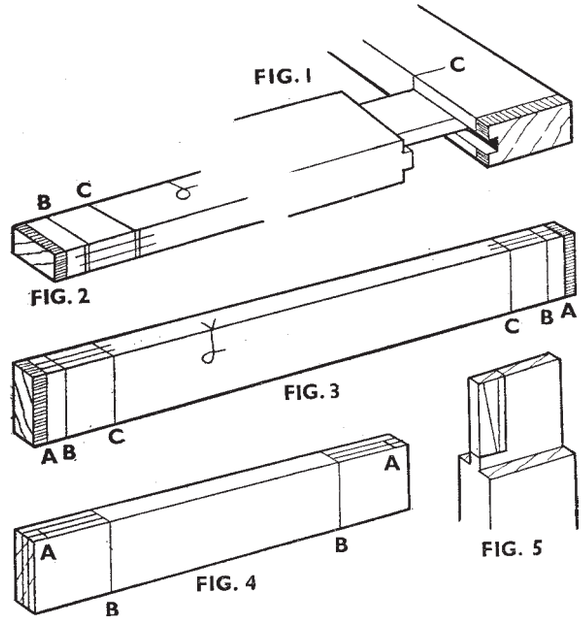


FIG. 1. MORTISE AND TENON JOINT WITH SQUARE HAUNCH
FIG. 2. BACK EDGE OF STILE MARKED FOR MORTISE AND WEDGEROOM
FIG. 3. SHOWING THE SETTING OUT OF A STILE
FIG. 4. SHOWING THE SETTING OUT OF A RAIL
FIG. 5. TENON MARKED FOR CUTTING HAUNCH AND WEDGES

on the sides. On the rails, the lines are for the shoulders and must be cut with a marking knife. On stiles, only the lines (C, Fig. 3) are squared across the face side so as to act as guides when fitting the rails. It will be understood that Fig. 3 is an illustration of the pattern stile on which both lines are squared across the face side. Fig. 2 shows the back edge of a portion of a stile. On this edge two further lines are seen each about 1/8 in. on the outside of lines B and C. These are for the wedge room which will be cut from the lines and sloping inwards at the final stage of mortising.

Gauging and Mortising. Gauging is the next step. This must always be done from the face side. Remember that the gauge must be set to as near one-third of the thickness of the stuff as the chisel you are to use for mortising will allow. The gauging is illustrated in Figs. 2, 3 and 4. It is presumed that you know how to cut the tenons and the mortises, but take care to mortise only between the lines (B) and (C) in Figs. 2 and 3. Between lines (A) and (B) on the face edge (Fig. 3) is the space for the haunching, which may be cut square, as shown in Fig. 1, or bevelled downwards from nothing at line (A).

For mortising, always use the chisel to which you have set the gauge. This will cut exactly between the lines. The use of a narrower chisel will create the need to pare the sides of the mortises, and this is bad practice, often resulting in unlevel joints.

Fitting the Joints. Work systematically. First, do all the mortising, cutting the wedgeroom and the haunchings. Then cut the tenons, follow on by cutting the shoulders, and finally, mark and cut out the waste piece of each tenon so as to leave the haunch. In the case of through wedged tenons, where two wedges will be needed for each joint, it is a good plan to cut them from the waste pieces which are removed to make the haunches. The idea is shown in Fig. 5, which illustrates a tenon marked out for cutting the haunch and the wedges.

Bear in mind that the joints should *push* together. Tight tenons driven in with the mallet almost always cause the frame to twist. If the tenons are too thick through faulty sawing, ease them down to the gauge lines with a rebate plane before marking and cutting for the haunches. Tenons tight in width should be eased at the back edge— that is, the edge adjoining the haunch. Never cut the inner edge of a tenon. This alters the position of the rail on the stile and throws the frame out of square. If the fitting has been done correctly, when the joints are together the inside edges of the rails will come exactly to the short line (C) on the stiles as Fig. 1 shows.

POINTS TO NOTE WHEN CUTTING A MORTISE AND TENON

WHEN cutting any woodwork joint it is essential that the material is planed up true in the first place. In a door made with mortise and tenon joint the face sides and edges must be square as otherwise it is impossible to mark out the shoulders square, and the wood must be brought to an even width and thickness. As a safeguard, however, the face edges of all parts are made to face inwards so that the mortises occur on these edges, and all marking out is done with the butt of the square resting against either face side or face edge.

In setting out the tenons, place the rails side by side on their edges, and hold them together with a handscrew while squareing across the shoulders with the cutting knife. Take off the handscrew,

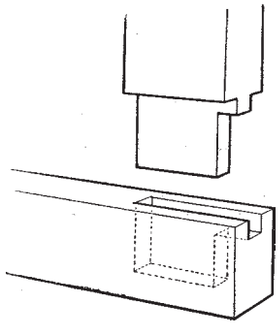


FIG. 1. COMPLETED JOINT SHOWING HAUNCH

and square each shoulder round all four sides with the cutting knife, using the square as described. Next arrange the stiles similarly, and square across where the rails are to be with a finely pointed pencil. A third line is needed to mark where the actual mortise begins, for this must necessarily be set in from the end (see Fig. 1).

The next step is the gauging, the tenon should be as nearly as possible one-third of the thickness of the material; thus, if the stuff is 7/8 in. thick, a 5/16 in. chisel is suitable. Set the points of the mortise gauge to the chisel, (a marking gauge could be used, but it means going over the work twice). Next set the gauge central to the thickness, and work it always from the face side.

CUTTING THE MORTISES

Fix the stiles for the mortising on the bench, keeping them over one of the

legs so that there is solid resistance to the blows. Bore a series of holes in each mortise to remove as much waste as possible, using a twist bit slightly smaller than width of the mortise. Now begin to chop with the face of the chisel towards you. Just strike the chisel once or twice, and then step the chisel along 1/4 in. or 3/8 in., according to the hardness of the material, until 1/8 in. short of the end of the mortise is reached. (The reason of this stopping short is that in the process of the work the mortises are liable to bruise.)

Having cut along the mortise, reverse the chisel, and work back again; this process must be repeated until the proper depth is obtained. This seems simple, but a difficulty will be to remove the waste during this process, for although the wastage is loosened, it will bind to the sides of the mortise; it is the best plan, therefore, to use a slightly narrower chisel for the one purpose, levering out the waste from time to time, in order to allow the mortising chisel to descend. When practically finished a cut can be made at both ends to the finished size. Before leaving the mortising, just a reminder: the chisel must be upright, or the work will be in winding. To ensure this the worker should stand at the end of the work, not the side.

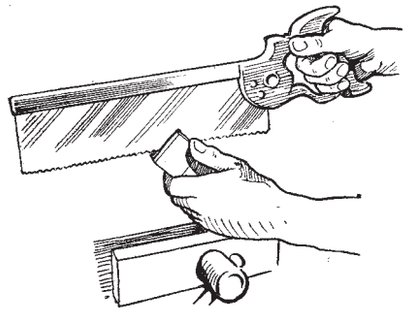


FIG. 2. FIRST OPERATION WHEN SAWING THE TENON

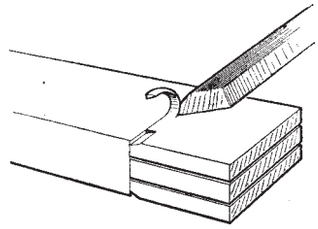


FIG. 3. MAKING SLOPING GROOVE AT SHOULDERS

To cut the tenons place the wood in the vice at an angle as in Fig. 2 and start the cut from the back. Once the saw has made its place, lower the handle gradually, until there is a straight line of cut between the back corner, and the front shoulder. Having cut to the first gauge line thus, cut to the second. Afterwards the wood is turned the other way round and held this time upright so that the cut can be completed. Always saw down on the waste side so that the gauge line is just left in.

When the sides of the tenons are cut, the waste has to be removed by cutting the shoulders. In doing this it is extremely important not to make the very common error of cutting into the actual tenon, for it is here that the joint needs its greatest strength; if the piece does not come away, put the rail in the screw again, and cut the extra bit that has been left undone. An excellent plan is to make a sloping groove on the waste side of the shoulder line, this forming a channel in which the saw can run. (see Fig. 3).

The last process is to cut the outer part of the tenon away for the haunching, and the reader is again referred to Fig. 1. It is a simple matter; just gauge for the width, mark the shoulders carefully, and saw. The counterpart of this will, of course, have been already done on the stiles; when this is done, fit the framework together, and do any easing that will be found to be necessary before glueing up.

* * * * *

ELEMENTARY WORKSHOP PRACTICE: ABOUT MORTISE AND TENON JOINTS

WORKSHOP practice is always worth following; it takes into account so many points of craftsmanship which, to the detriment of his work, often escape the home worker. In mortising and tenoning, for example, certain rules are always followed.

Apart from exceptional jobs, it is the custom to make tenons approximately one-third the thickness of the stuff. Thus in material 1-1/8 ins. thick, the tenons would be 3/8 in. thick. In the case of stuff 7/8 in. thick, 5/16 in. is the nearest practicable thickness to one-third. But if a 5/16 in. chisel is not available for mortising, it is better to employ a 1/4 in. thick tenon than one 3/8 in. thick. A 3/8 in. mortise in a stile 7/8 in. thick is too wide. Not only is the stile weakened, but the thickness of the remaining wood between the surface of the work and the inside of the mortise is so little (especially after cleaning off) that these areas tend to sink and so show hollow when the work is polished.

Haunched Tenons. Some less experienced workers may be hazy about haunched tenons. These are cut-away tenons at the corners of a piece of framing, or at the tops of table legs. A

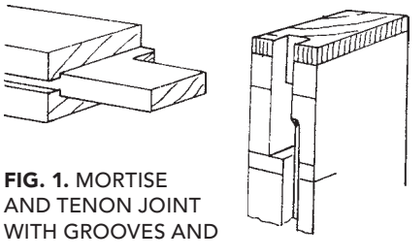


FIG. 1. MORTISE AND TENON JOINT WITH GROOVES AND SQUARE HAUNCH

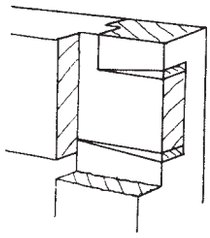


FIG. 2. SHOWING SQUARE HAUNCHED TENON WEDGED.

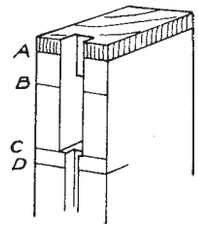


FIG. 3. HOW A GROOVE IS STOPPED ALONGSIDE A MORTISE

haunched tenon is illustrated at Fig. 1. It will be seen that, if the tenon were not cut away, the mortise would have to be taken right to the end of the stile. The joint would then become an open mortise or bridle joint, which is comparatively weak and cannot be wedged. The amount cut away from the tenon coincides with the amount of solid material left on the stile from the mortise to the end (Fig. 2). This must be strong enough to be wedged against, in the case of a through tenon; and so the common practice in cutting a haunch on a tenon is to cut away no less than one-third of the total width of the tenon.

Square and Bevelled Haunches. The workshop term " haunch " refers not so much to the cut away part as to the bit left on. This may be square (as in Figs. 1 and 2), or bevelled (as in Fig. 4). The square haunch is the stronger job and is more generally employed. It provides a greater area for glueing and for gripping than the bevelled haunch. It is the usual form not only for this reason, but because, in the case of stiles grooved for panels, the grooves are often worked right through from end to end, thus partly forming the haunchings (as the recesses for the haunches are called). The depth of a haunching usually coincides with the depth of the groove. Where there are no grooves, it may be taken that, with rails and stiles from 1-1/2 ins. to 3 ins. wide, the haunchings should be from 1/4 in. to 3/8 in. deep.

Bevelled haunches are sometimes used for the sake of appearance. They do not show on the edges of the framing. The grooves are stopped at the mortises, not worked right through. Although weak in themselves, there are instances in which bevelled haunches make for maximum strength. Take the case of the leg and top rail construction of a very light table, shown at Fig. 4.

The leg is 1 in. square. It will be seen from the diagram (A) in Fig. 4 that two square haunches come so close together that the wood between them would be likely to split, and so ruin the joints. Here bevelled haunches are preferable because they do not seriously weaken the end of the leg, and so they contribute to the strength of the whole corner.

Wedging a Tenon. A tenon is strongest when it passes through the stile and is wedged as shown in the partly cut-away view at Fig. 2. Note that the wedge-room is cut in the stiles —that is, on the back edge the mortises are widened about 3/16 in. at each end by a flat, sloping cut. Never make room for the wedges by cutting the tenons.

Sometimes during glueing up a wedge breaks off before it has been driven in sufficiently. If it cannot be coaxed out with a chisel straight away, bore it out with a twist bit of slightly smaller diameter than the width of the mortise. Then remove the remainder with a narrow chisel. The actual driving of the wedges is always carried out in the workshop with care and watchfulness. Too much driving of one wedge at the expense of the other may cause a rail to move from its true position on the stile. Always tap the wedges alternately and then this trouble will not occur.

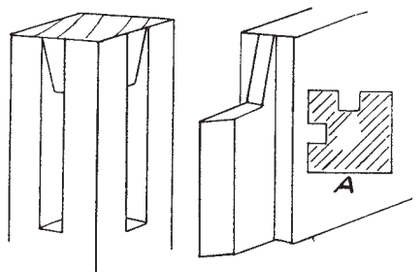


FIG. 4. BEVELLED HAUNCHES ARE STRONGER IN LIGHT TABLE LEGS

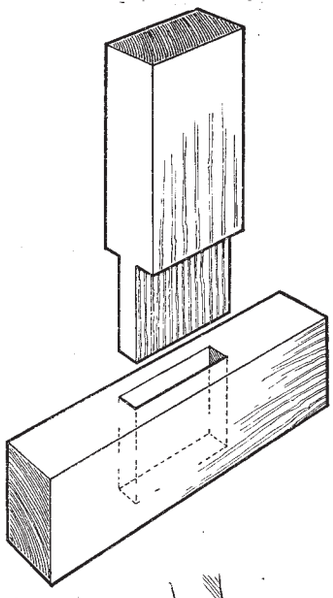
The Effects of Grooving on a mortise and tenon joint often form a stumbling block for beginners. As can be seen from the view of the tenon in Fig. 1, the inside edge of the tenon coincides with the bottom of the groove. This is easily arranged for during setting out. Look at the setting-out lines on the stile in the same figure. From (A) to (D) is the full width of the rail; from (A) to (C) is the width of the rail, less the depth of the groove; and from (A) to (B) is the haunching. The line (C), then, marks the bottom of the groove and the inner end of the mortise. The mortise must never be cut past this line.

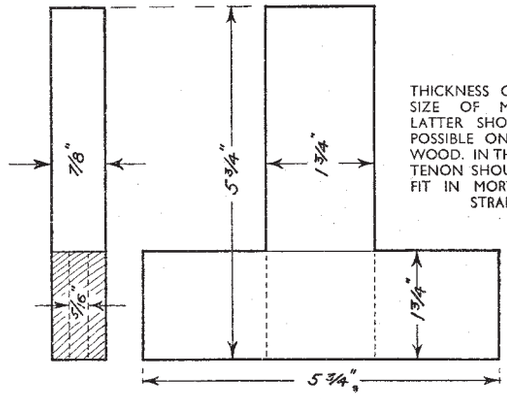
As regards the tenon, the inner edge is determined by the working of the groove, which is worked to the depth (C) to (D). The time for grooving is after the mortising and the cutting of the tenons. But be sure not to make the mistake of cutting the shoulders also (and so removing the cheeks of the tenons) at this stage. Do this *after* the grooving.

Usually the grooves are contrived to come more or less in the middle of the thickness of the framing (as in Fig. 1). Thus the grooves in the stiles when worked right through from end

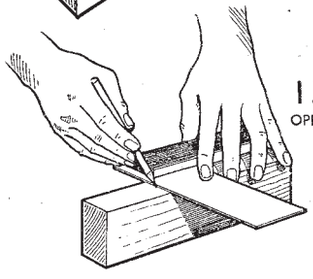
FUNDAMENTAL JOINTS IN WOODWORK

MORTISE & TENON JOINT



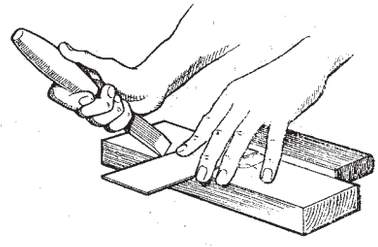


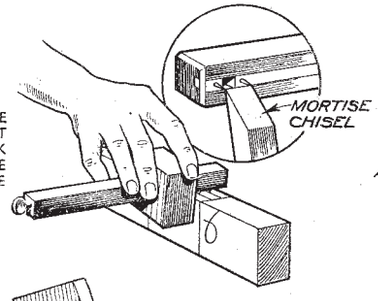
THICKNESS OF TENON IS FIXED BY SIZE OF MORTISE CHISEL. THE LATTER SHOULD BE AS NEAR AS POSSIBLE ONE THIRD THICKNESS OF WOOD. IN THIS CASE $\frac{5}{16}$ in. IS NEAREST TENON SHOULD MAKE HAND-TIGHT FIT IN MORTISE, AND SHOULD FIT STRAIGHT FROM SAW



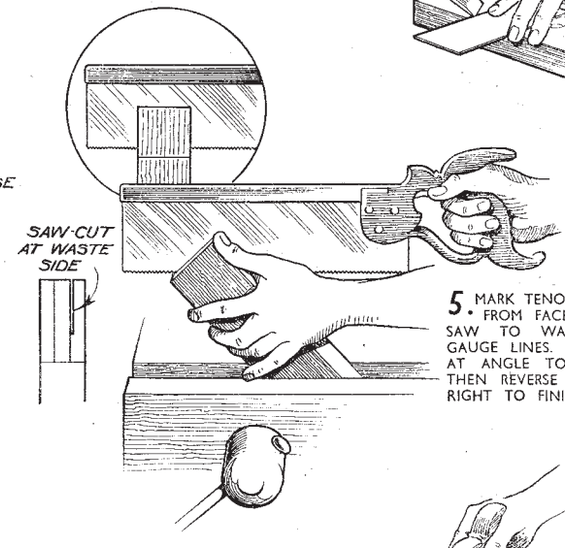
1. MARK WIDTH OF MORTISE AND SQUARE ROUND TO OPPOSITE EDGE, USING PENCIL

4. MARK SHOULDERS WITH CHISEL OR MARKING KNIFE. SQUARE ALL ROUND, USING SQUARE FROM EITHER FACE SIDE OR EDGE

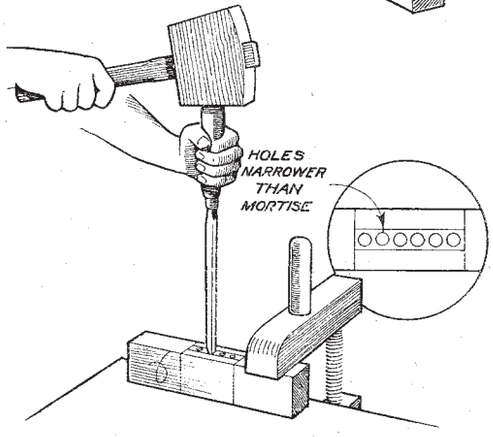




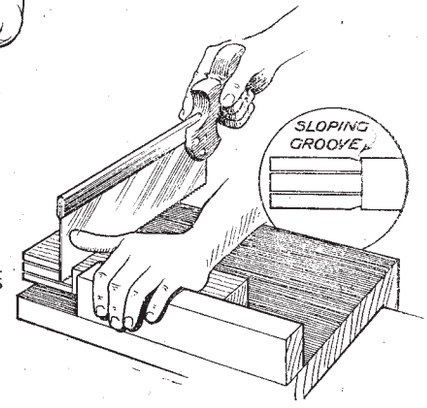
2. SET MORTISE GAUGE TO WIDTH OF MORTISE CHISEL ($\frac{5}{16}$ in.). SET CENTRE AND MARK BOTH EDGES. USE GAUGE FROM FACE SIDE ONLY



5. MARK TENON WITH GAUGE FROM FACE SIDE. WORK SAW TO WASTE SIDE OF GAUGE LINES. HOLD WOOD AT ANGLE TO START CUTS. THEN REVERSE AND FIX UPRIGHT TO FINISH (SEE INSET)



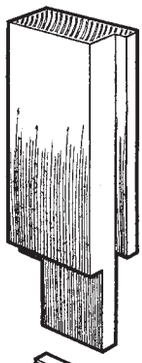
3. BORE HOLES WITH $\frac{1}{4}$ in. BIT TO REMOVE WASTE. CHOP OUT WITH MORTISE CHISEL. STAND AT END AND, STARTING AT CENTRE, WORK TOWARDS ENDS. CUT HALF THROUGH, THEN REVERSE

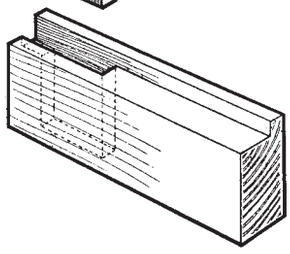


6. CUT SLOPING GROOVE WITH CHISEL AT SHOULDERS. THESE FORM CHANNELS FOR SAW WHEN CUTTING SHOULDERS

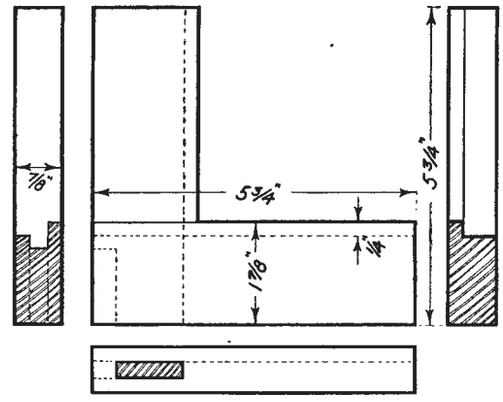
FUNDAMENTAL JOINTS IN WOODWORK

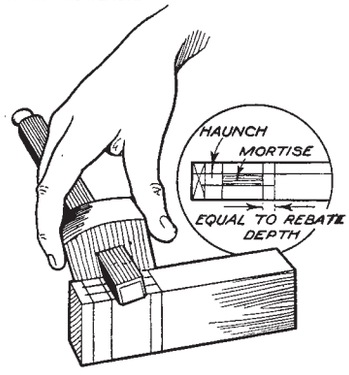
MORTISE AND TENON WITH LONG AND SHORT SHOULDERS



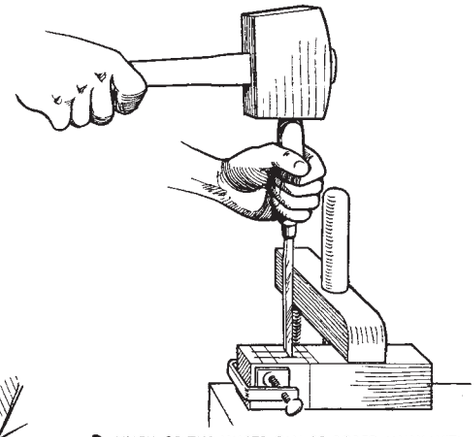


A USEFUL JOINT FOR A FRAMEWORK WITH PANEL FITTING IN A REBATE. THE BACK SHOULDER IS CUT LONGER THAN THE FRONT ONE BY AN AMOUNT EQUAL TO THE REBATE DEPTH. IN THIS WAY IT FILLS IN THE REBATE WHICH CAN BE TAKEN RIGHT THROUGH. NOTE THAT THE MORTISE HAS TO BE SET IN AT THE INNER SIDE ALSO BY AN AMOUNT EQUAL TO THE REBATE DEPTH AS THE REBATING AUTOMATICALLY CUTS AWAY THE TENON.

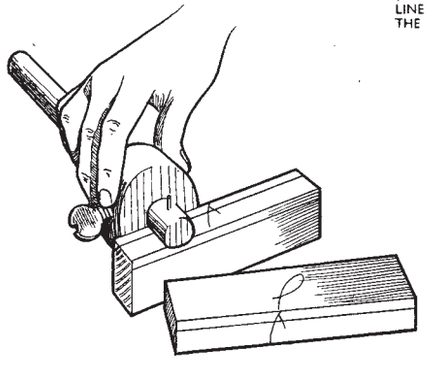




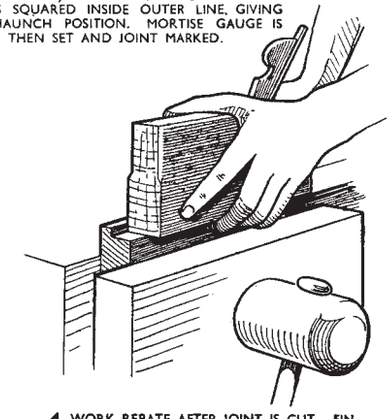
2. MARK OUT MORTISE. FIRST SQUARE OVER-ALL RAIL WIDTH, AND ADD THIRD LINE ¼ IN. (REBATE DEPTH) INSIDE INNER LINE. A FOURTH LINE IS SQUARED INSIDE OUTER LINE, GIVING THE HAUNCH POSITION. MORTISE GAUGE IS THEN SET AND JOINT MARKED.



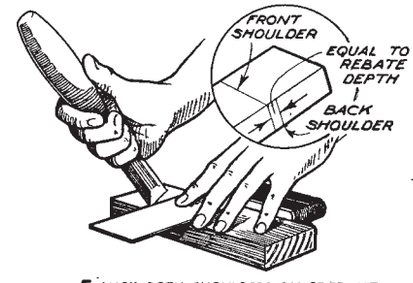
3. MUCH OF THE WASTE CAN BE BORED AWAY WITH BIT SLIGHTLY SMALLER THAN MORTISE WIDTH. THUMBSCREW ON END HELPS TO PREVENT WOOD FROM SPLITTING WHEN MORTISE IS CHOPPED WITH CHISEL. CHOP MORTISE HALF THROUGH FROM EACH SIDE.



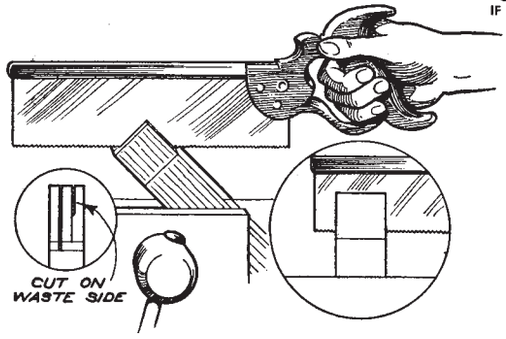
1. HAVING SQUARED UP THE WOOD GAUGE IN THE DEPTH AND WIDTH OF THE REBATE, USING THE GAUGE ALWAYS FROM EITHER FACE SIDE OR FACE EDGE OF WOOD.



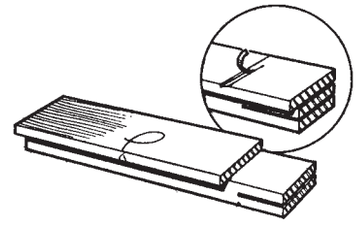
4. WORK REBATE AFTER JOINT IS CUT. FINGERS HELD BENEATH SOLE ACT AS FENCE IF A FILLISTER PLANE IS NOT AVAILABLE.



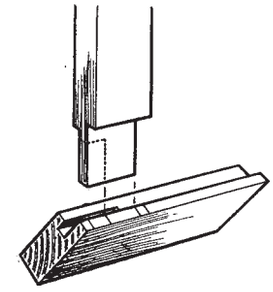
5. MARK BOTH SHOULDERS ON EDGE WITH PENCIL. AFTERWARDS SQUARE EACH ACROSS ITS SIDE WITH THE CHISEL



6. WHEN SAWING TENON FIX WOOD IN VICE AT AN ANGLE. AFTER MAKING CUT AS FAR AS DIAGONAL, REVERSE IN VICE, THIS TIME UPRIGHT, AND COMPLETE CUT. NOTE THAT CUTS ARE MADE AT WASTE SIDE OF GAUGE LINES.



7. AFTER WORKING REBATE CUT THE SHOULDERS WITH FINE SAW. IF SLOPING GROOVE IS CHISELLED AT WASTE SIDE OF LINE, A CHANNEL WILL BE FORMED IN WHICH SAW CAN RUN.

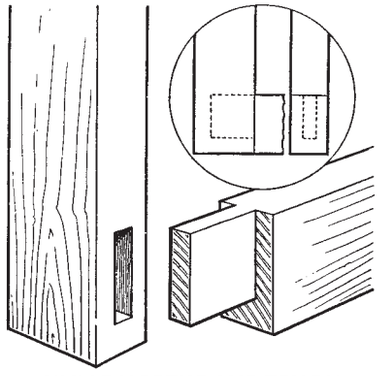


8. FINAL STAGE IS TO CUT GROOVE FOR HAUNCH AND MARK OUT PART OF TENON TO BE CUT AWAY. JOINT SHOULD FIT HAND TIGHT.

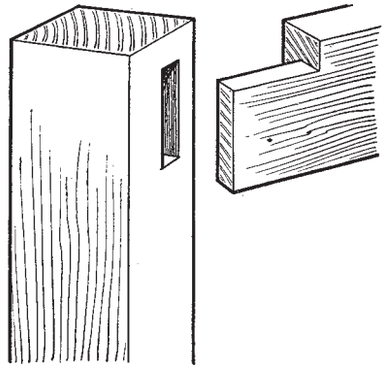
FUNDAMENTAL JOINTS IN WOODWORK

TYPES OF

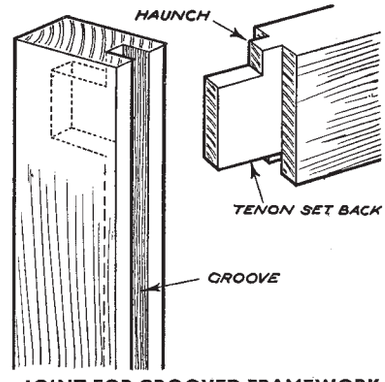
MORTISE & TENON JOINTS



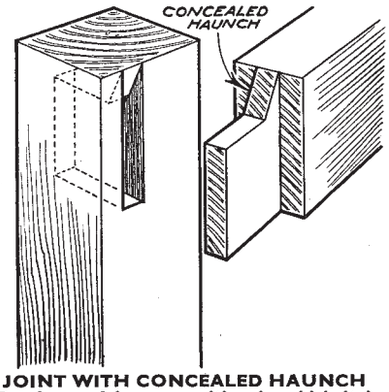
SIMPLE MORTISE AND TENON
Used chiefly for frames of various kinds, such as doors.



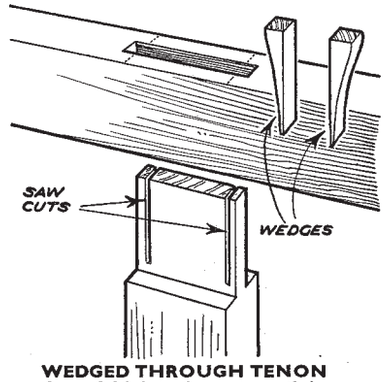
BARE-FACED TENON
Mainly used when rail with tenon is thinner than that with mortise.



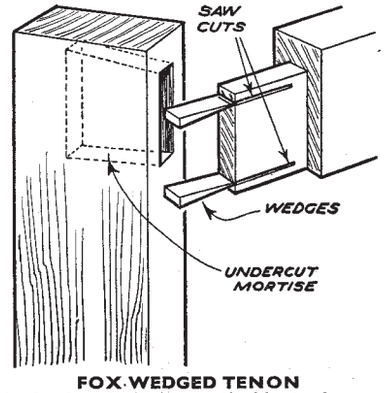
JOINT FOR GROOVED FRAMEWORK
The haunch fills in the gap made by the groove which runs through.



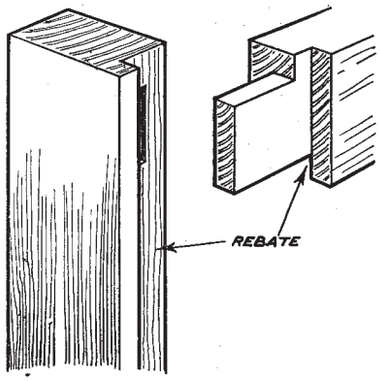
JOINT WITH CONCEALED HAUNCH
Can be used in any position in which it is desirable to hide the haunch.



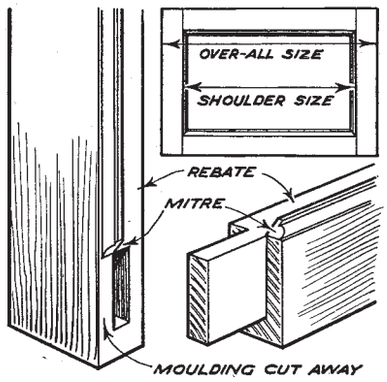
WEDGED THROUGH TENON
A useful joint where strength is essential.



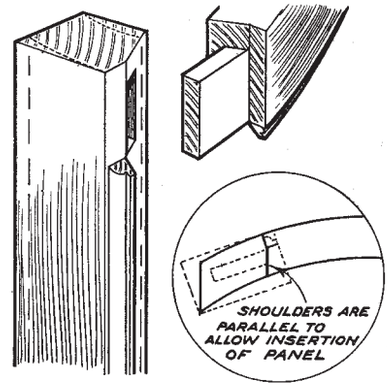
FOX-WEDGED TENON
Used when it is impracticable to have a through tenon.



UNEQUAL SHOULDERED TENON
The framework is rebated, and the back shoulder projects by an amount equal to the rebate depth.



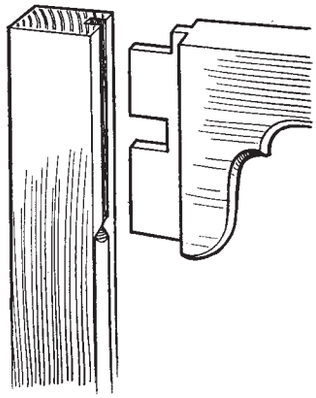
MOULDED AND REBATED FRAME JOINT
The moulding is worked in the solid, and is mitred. The shoulder size is taken from the rebate.



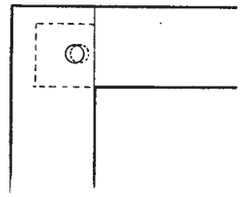
JOINT FOR BOW FRAME
The mortised stile is thick enough to allow the curve to be worked in it.

FUNDAMENTAL JOINTS IN WOODWORK

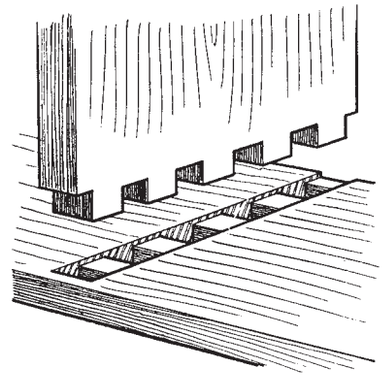
TYPES OF MORTISE & TENON JOINTS



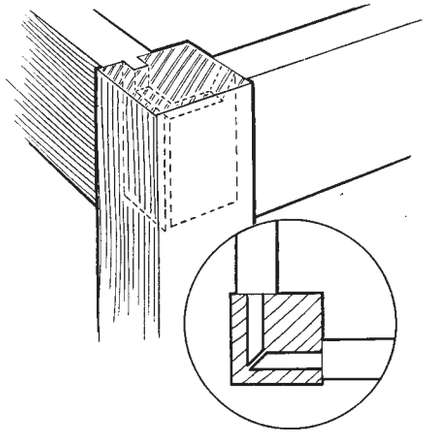
WIDE RAIL JOINT
Used chiefly for doors having a wide top rail.



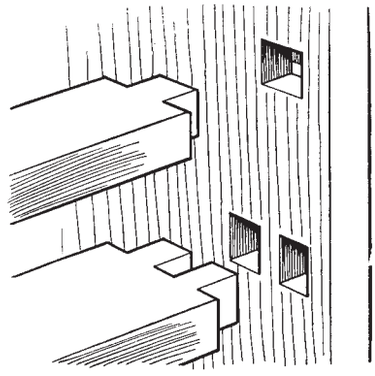
DRAW BORING
The holes being slightly staggered, the joint is drawn tightly together.



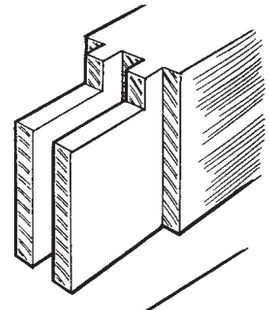
CARCASE JOINT
Often used for jointing partitions to the top and bottom.

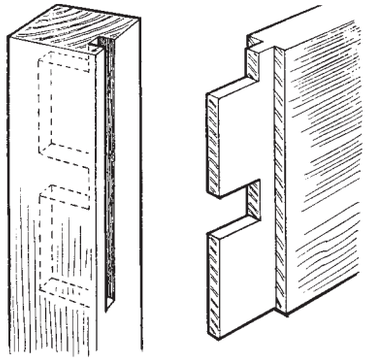


JOINT FOR TABLE LEG
The mortises meet in the thickness of the leg, and the tenon ends are cut at an angle to give the maximum length.

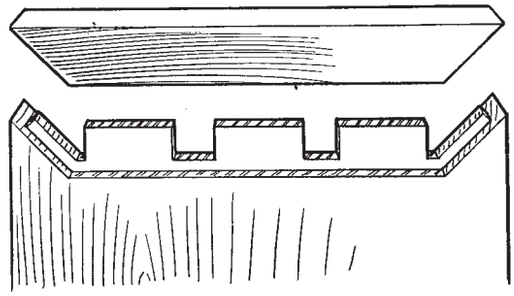


DRAWER RAIL JOINTS
The double tenon is more satisfactory as it resists any twisting tendency.

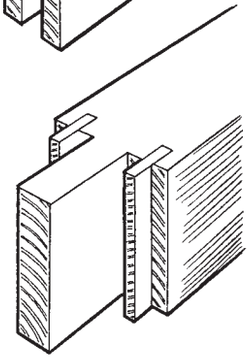




WIDE RAIL JOINT
Useful for the framework of a table with wide rails.



STRONG JOINT FOR CLAMP
Often used for bureau falls, table tops, etc. It is essential that the wood is perfectly seasoned.



DOUBLE TENON AND TENON WITH TONGUED SHOULDERS
For joints needing great strength.

to end will partly form the haunchings, as referred to above. Of course, the grooves could be moved to or from the face within the limits of the width of the mortises and still be taken right through.

When it is necessary to groove so near to the face or back as to bring the grooves partly outside the mortises, the obvious thing to do is to bring the mortises nearer to the face or back to suit. If this is a matter of only 1/16 in., well and good; if more, with ordinary framing, it is bad practice. The usual procedure is to stop the grooves alongside the mortises, as Fig. 3 shows. Of course, this refers solely to the stiles. Whatever the position of the grooves in the rails, they are worked right through.

* * * * *

WORKSHOP FOLDER

A WOODWORKER SUPPLEMENT:
BLIND MORTISE AND TENON

Thickness of tenon is determined by size of mortise chisel which should be approximately one third thickness of wood. The tenon should make a hand-tight fit and be straight from the saw.

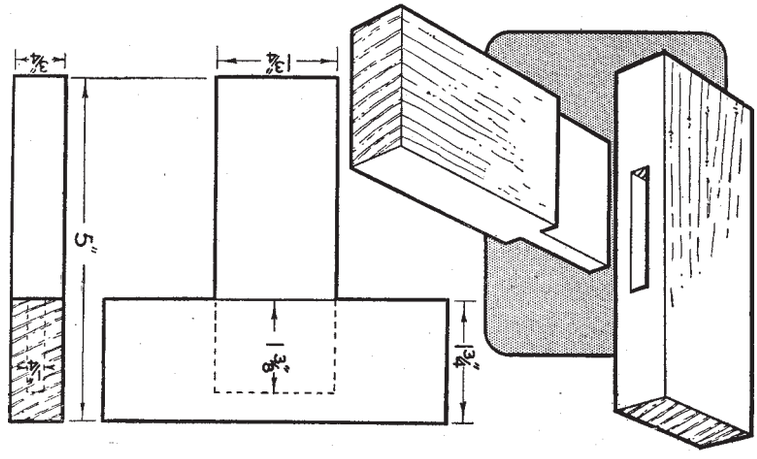
1. Prepare timber and mark length of mortise using pencil; knife lines for waste and shoulders of tenon.

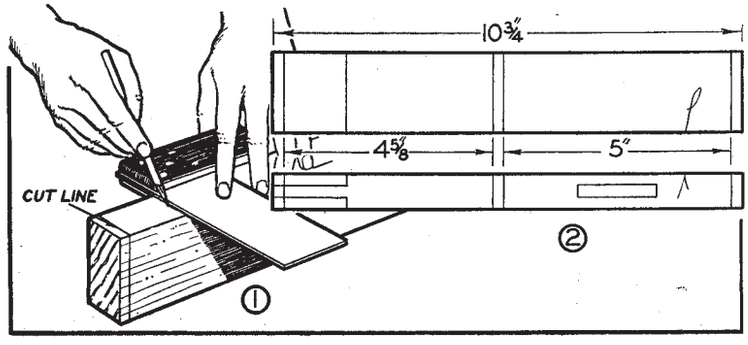
2. Sizes of timber if in a single length for practice.

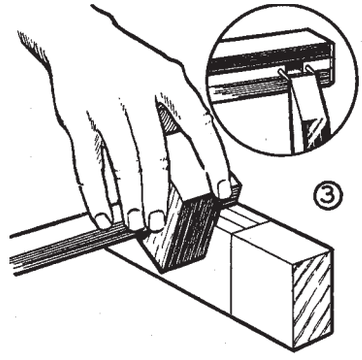
3. Set mortise gauge to width of mortise chisel (1/4 in.). Use gauge from face side only.

4. To remove bulk of waste bore holes with 3/16 in. bit, standing at end of work. Clamp to bench. Stick strip of gummed paper to chisel to serve as a depth gauge. Again stand at end and, starting at centre, work towards ends.

5. Mark shoulders with marking knife or chisel. Square all round working from either face side or edge.

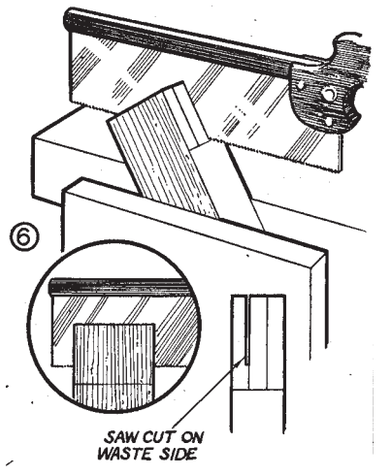


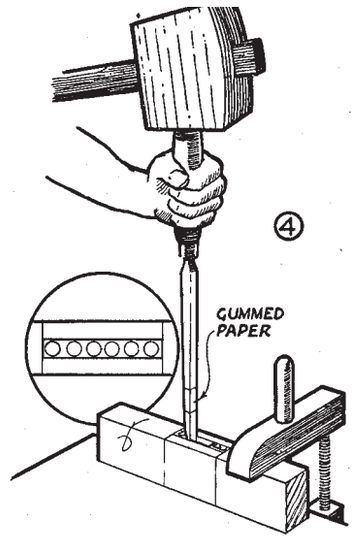


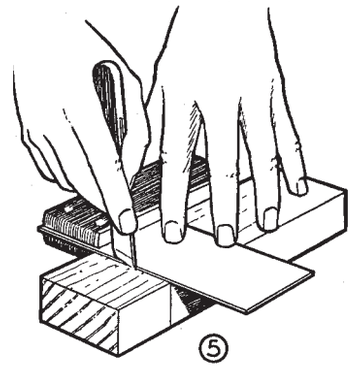


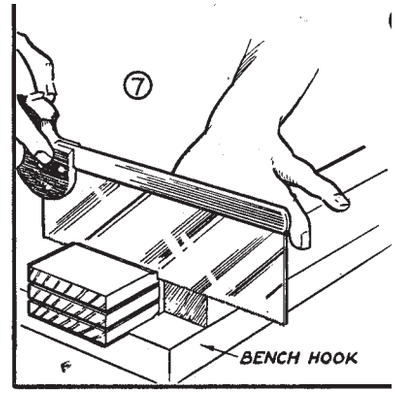
6. Mark tenon with gauge from face side. Fix wood at an angle to start cuts and hold saw to waste side of gauge line. Reverse and fix upright to finish (inset).

7. Cut sloping grooves with chisel at shoulders to form channels for the saw when cutting.







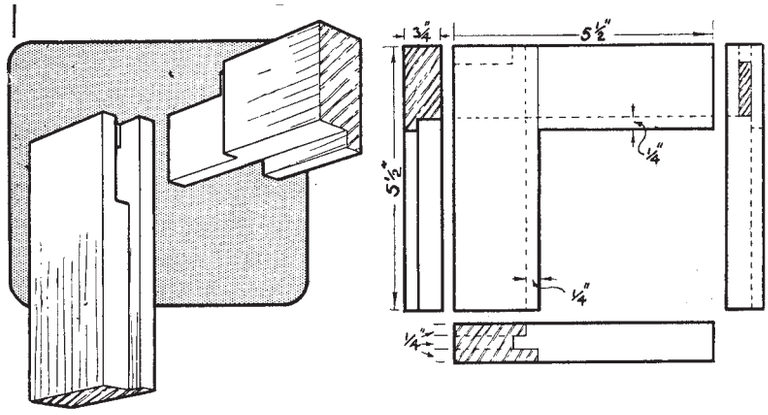


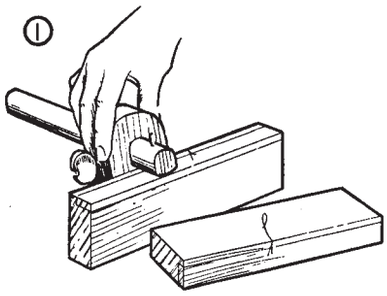
WORKSHOP FOLDER

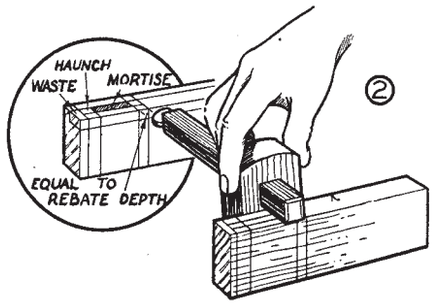
A WOODWORKER SUPPLEMENT:

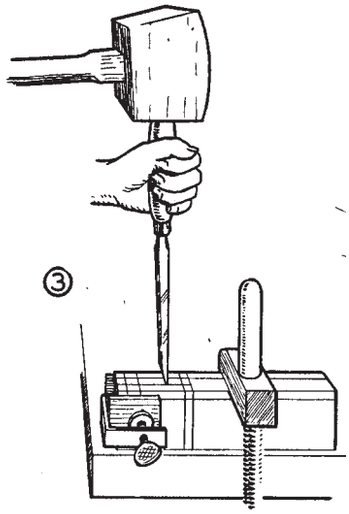
MORTISE AND TENON
LONG AND SHORT SHOULDER

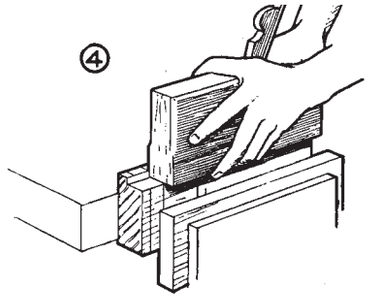
Basic joint for a frame having a rebate to hold a panel. The back shoulder is cut longer than the front by an amount equal to the rebate depth. When finished the joint should be a hand tight fit.

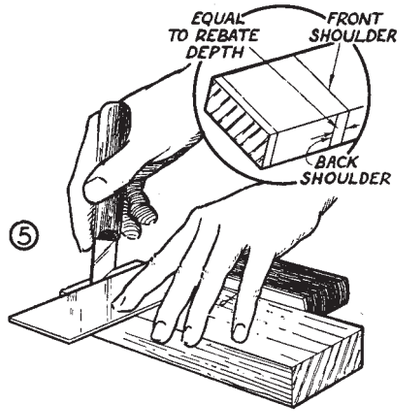


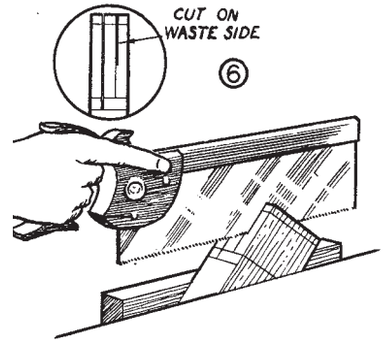


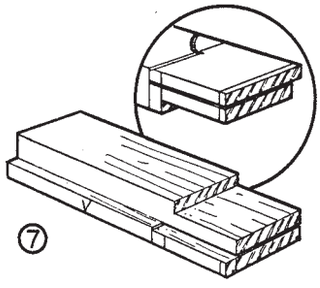


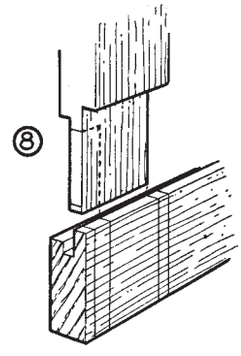












MORTISE

1. From the face side and edge gauge width and depth of rebate.

2. Mark mortise, squaring total rail width and adding rebate depth and haunch lines in pencil. Set mortise gauge to width of chisel used, and mark the joint. Cut in mortise ends with knife.

3. Chop the mortise half through from each side. A thumbscrew clamped on the end prevents splitting.

4. Cut rebate. Fingers of left hand act as fence. If plane used is not fitted with a depth gauge check depth of rebate when cutting.

TENON

5. Mark both shoulders on edge in pencil then square in appropriate lines on sides with a knife or chisel.

6. Fix wood in vice at an angle. Cut down on waste side of line to shoulder line. Reverse wood and repeat. Fix upright to finish.

7. Work rebate as in 4. Chisel a sloping groove on waste side of line for saw and cut shoulders.

8. Cut haunch and mark out part of tenon to be removed.

JOINTS IN EVERYDAY USE: MORTISE AND TENON FOR REBATED FRAMEWORK

When a door or similar framework has to be fitted with a rebated-in panel the mortise and tenon joints which join the comer need to have longer shoulders at the back than at the front. This is because the rebate plane must be taken right through in both stiles and rails, as shown in Fig. 2. Thus, the back of the stile is cut away, hence the necessity for the back shoulder of the rail being longer than the front one. In machine work the moulding spindle is generally used to cut the rebate. If the parts are machined before assembly the joint will be the same as in hand work (Fig. 1). If, however, the door is put together first the tenons have equal shoulders since the material has square edges. The spindle (which revolves as at B) scoops out the rebate, leaving rounded corners, as shown. These are finished square by hand afterwards. If, therefore, you come across a framework in which the back shoulder line does not line up with the rebate but is as shown to the right at B, Fig. 2, you can be sure that the rebate was not worked by hand.

AS in all work of this kind, the opposite parts should be fixed together whilst the joints are being marked so that they are exactly alike.

Marking Stiles. Take the stiles first. Plane them to the finished over-all size, and mark with a gauge along the face edge the rebate width, as in Fig. 3. The depth of the rebate is marked on the back (also shown in Fig. 3). Cramp them together temporarily with the face sides touching, and the face edge upwards, as shown. Mark in the over-all height of the door, making the usual allowance for trimming, and square lines across both stiles. Note that a waste allowance is made at both ends. This is chiefly to minimise any tendency for the wood to split when being mortised.

Now mark in the over-all rail width, and from the latter line measure in the rebate depth. From the outer line mark in the haunch size—that is, the distance by which the tenon is set in. The last two lines give the mortise length. It remains only to separate the parts and gauge in the mortise. It is an advantage to make this line up with the rebate gauge line as it simplifies the haunch. The pencil is used for all this marking.

Mortising. In all chopping out work it is desirable to have a good solid surface as otherwise the wood is liable to jump

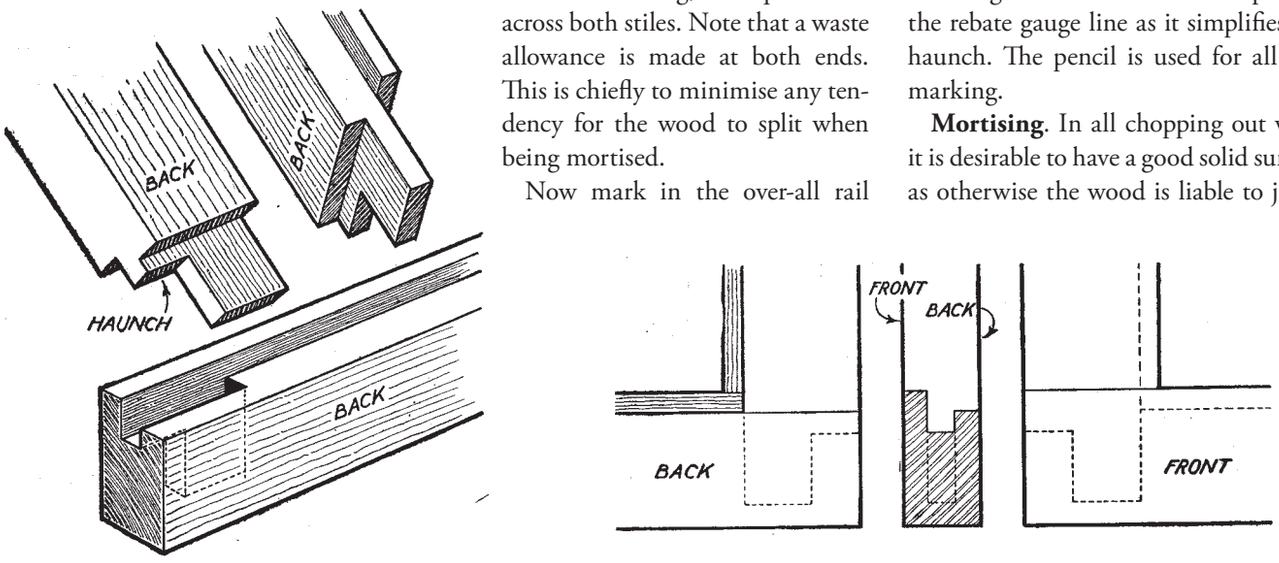


FIG. 1. PERSPECTIVE VIEW OF JOINT, AND ELEVATIONS SHOWING ITS PROPORTIONS
The long shoulder at the back is necessary because the rebating automatically removes the wood on the stile. In some cases the haunch is omitted, but it makes a stronger joint

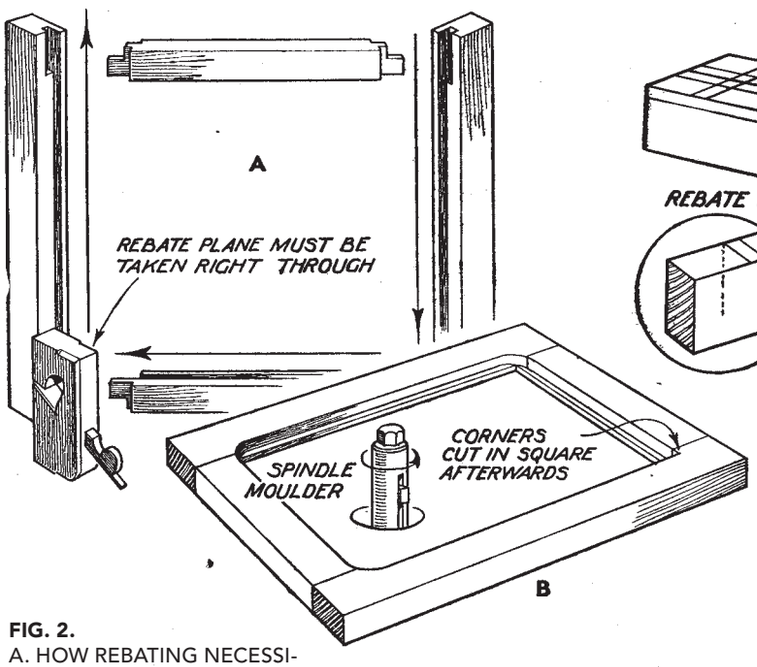


FIG. 2.
A. HOW REBATING NECESSITATES LONG BACK SHOULDERS
B. REBATE MACHINE SPINDLED AFTER DOOR IS ASSEMBLED

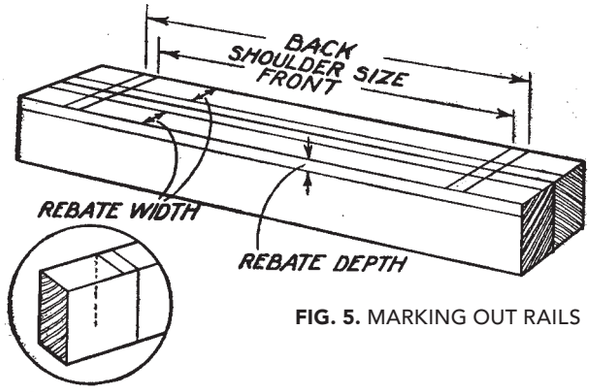


FIG. 5. MARKING OUT RAILS

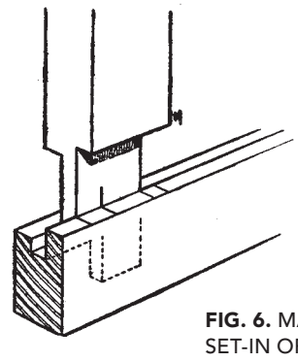


FIG. 6. MARKING SET-IN OF TENON FROM MORTISE

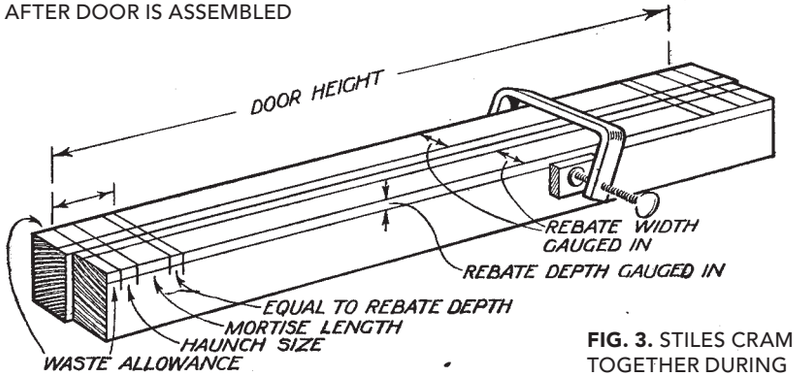


FIG. 3. STILES CRAMPED TOGETHER DURING MARKING OUT

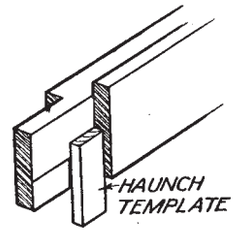


FIG. 7. HAUNCH LENGTH MARKED WITH TEMPLATE

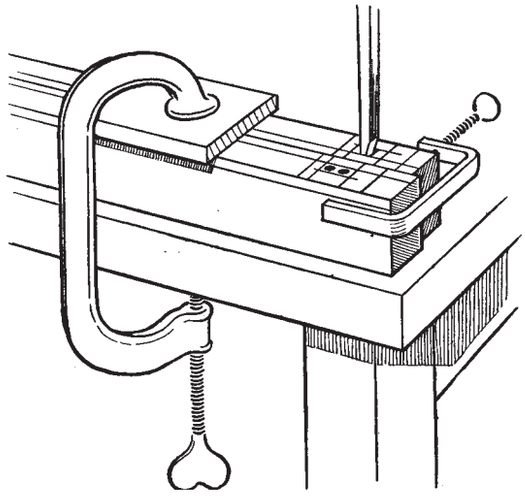


FIG. 4. MORTISES BEING CHOPPED

and much of the power of the blow is lost. Cramp down over the leg of the bench if possible, as in Fig. 4, and put a thumbscrew at the end. This holds the two stiles together, but its chief value is that it prevents the wood from splitting. Much of the waste can be bored away before the mortise chisel is used. Choose a bit slightly smaller than the mortise width.

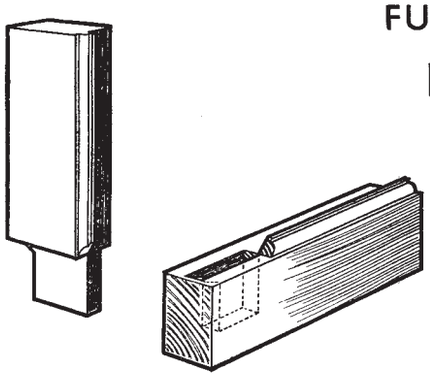
Rebating. Rebating follows. If you have a sash fillister plane this is the best tool to use because the fence bears against the face side. Otherwise the plain fillister can be used, the fence working from the back. There is not likely to be any inaccuracy if the wood has been properly thicknessed. In any case, as a safeguard, the plane can be set bare so that a finishing shaving can be taken with the plane laid on its side.

At this stage you can either cut in the sockets to take the haunches, or you can leave it until the joints are fitted. The simplest plan is to cut a slip of

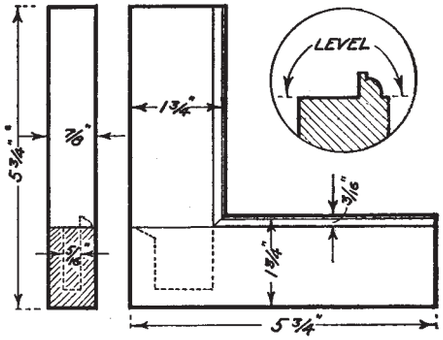
FUNDAMENTAL JOINTS IN WOODWORK

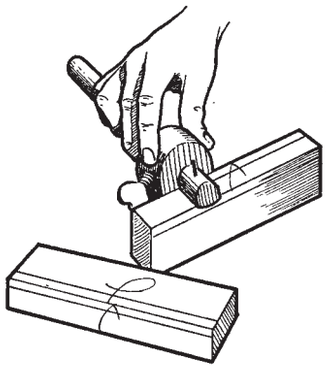
MORTISE AND TENON JOINT

For Moulded and Rebated Framework

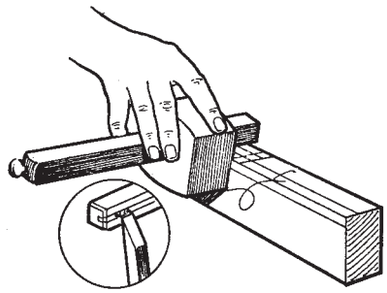


USEFUL JOINT FOR MAKING DOORS AND FRAMES OF ALL KINDS. THE MOULDING IS WORKED IN THE SOLID AND IS MITRED. NOTE THAT THE BOTTOM MEMBER OF THE MOULDING IS LEVEL WITH THE REBATE SO THAT THE SHOULDERS OF THE TENON CAN BE LEVEL. THE MORTISED PIECE SHOULD BE EXTRA LONG, AS THIS MINIMISES RISK OF SPLITTING AND ALLOWS FOR TRIMMING.

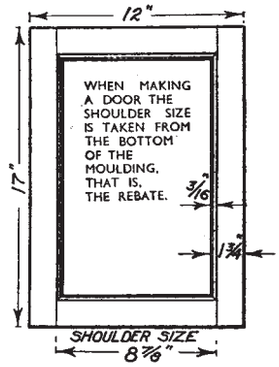


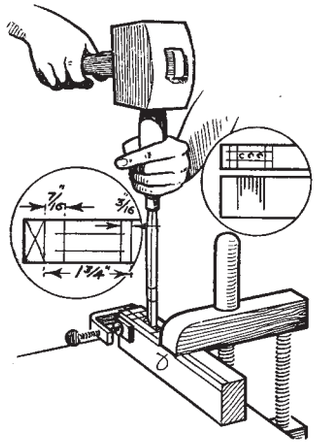


1. SET GAUGE TO $\frac{3}{16}$ IN. (MOULDING AND REBATE DEPTH) AND MARK BOTH SIDES FROM FACE EDGE. RE-SET GAUGE TO DISTANCE IN OF REBATE AND MARK FROM FACE SIDE AS ABOVE.

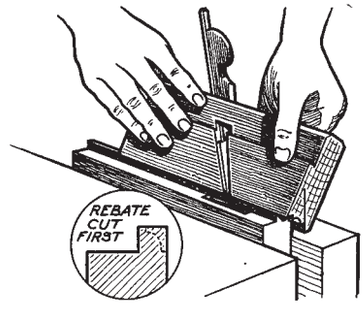


2. SQUARE ACROSS MORTISE POSITION (SEE INSET NO. 3) SET MORTISE GAUGE TO CHISEL WIDTH ($\frac{3}{8}$ IN.). SET TO CENTRE OF WOOD AND MARK FROM FACE SIDE.

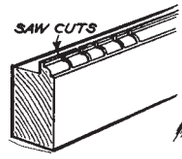




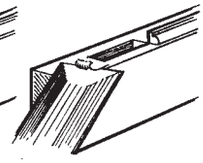
3. FIX WORK TO BENCH, AND PUT THUMBSCREW AT END TO PREVENT SPLITTING. BORE AWAY PART OF WASTE WITH $\frac{1}{4}$ IN. TWIST BIT, AND CHOP MORTISE. PAPER STUCK TO CHISEL ACTS AS DEPTH GAUGE



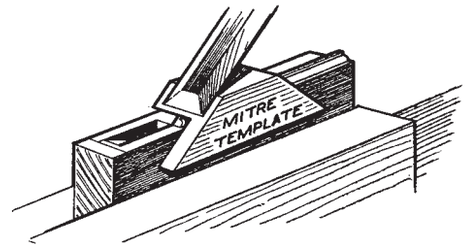
4. CUT REBATE FIRST, USING REBATE PLANE, THEN WORK MOULDING. IF A PLANE IS NOT AVAILABLE, THE SCRATCH CAN BE USED.



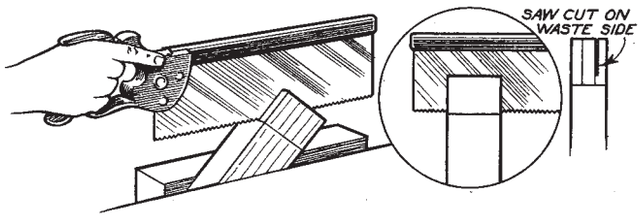
5. TO REMOVE MOULDING AT MORTISE MAKE SERIES OF FINE SAW CUTS



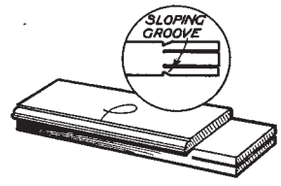
6. WASTE IS PARED AWAY WITH CHISEL, SO THAT FRONT IS MADE LEVEL WITH REBATE.



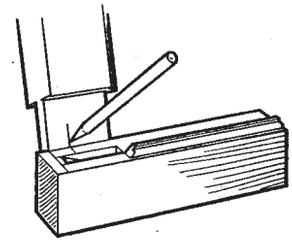
7. TO CUT MITRE ON MOULDING USE THE WOOD MITRE TEMPLATE, HOLDING CHISEL *FLAT* ON BEVEL AND CAREFULLY PARING. WOOD CAN ALSO BE CUT AWAY AT MORTISE END TO FORM SLOPING RECESS FOR HAUNCH.



8. SQUARE ROUND SHOULDER MARKS OF RAIL WITH CHISEL, AND GAUGE IN POSITION OF REBATE AND MOULDING. SAW TENON, HOLDING SAW AT WASTE SIDE OF GAUGE LINES. FIRST CUT AT ANGLE IN VICE, THEN REVERSE WOOD, THIS TIME UPRIGHT.



9. WORK REBATE AND MOULDING (SEE 4), AND SAW SHOULDERS, FIRST CUTTING SLOPING GROOVE TO FORM CHANNEL FOR SAW.



10. MARK PART OF TENON TO BE CUT AWAY, ALSO HAUNCH. MITRE MOULDING (AS IN 7) AND FIT UP JOINT.

wood, the thickness of which equals that of the tenon and of a width the same as the haunch length and use this as a template. Then as you cut the socket you can try it in. When it fits in flush without a gap you know that the haunch will do the same. The simplest way of cutting is to saw down the sides with a dovetail saw and chisel away the waste.

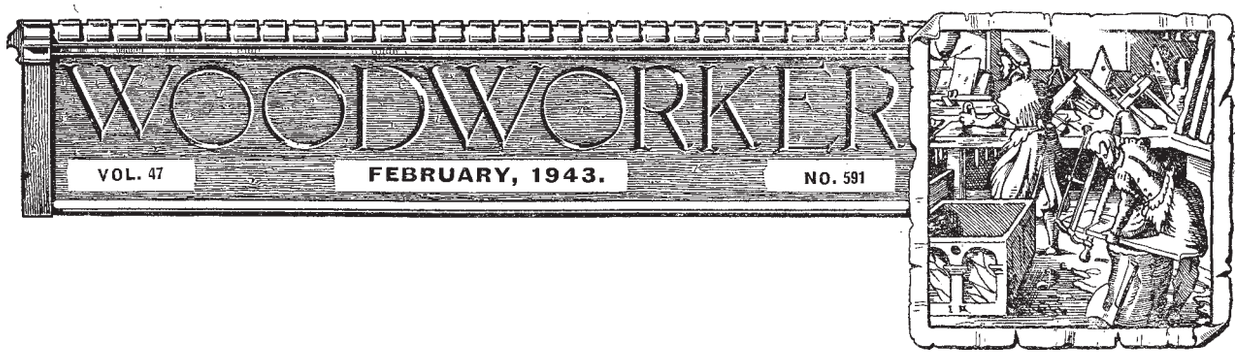
Marking the rails. This is shown in Fig. 5. Once again the parts should be cramped together temporarily after the rebate has been gauged in (the latter would be done at the same time as the stiles). Mark first the over-all door width, less the width of the two stiles, and lightly square in the marks with chisel or knife. This gives the front shoulders. *Outside* these measure the rebate depth and again square in the lines lightly. These give the back shoulders (see Fig. 5).

Separate the rails and square the marks around on to their relative faces. Be careful about this because a mark made in error at the back means an unsightly blemish which may be too deep to clean out (at the front it would not matter because it is the shorter shoulder which is required). Square in the lines deeply as this enables little sloping channels to be chiselled in which the saw can run when the shoulders are sawn. Note that if the outer edges are marked, light marking is necessary because the two lines are taken right across and a lot of cleaning up will be needed to take out the unwanted mark. In the case of the inner or face edge marks it does not matter because the marks are taken out automatically. Generally, however, it is not necessary to mark the outer edges.

Tenons. Sawing the tenon follows. Keep just to the waste side, and be careful not to cut past the shoulder line. One side will obviously be deeper than the other. Before sawing the shoulders the rebates should be worked. Unless the cheeks are left on the rebate plane is liable to round over the ends. As it is any rounding over occurs on the cheeks themselves, and since these are sawn away it does not matter. A sloping groove cut on the waste side of the shoulder line provides a channel in which the saw can run on when cutting the shoulders.

Fitting the Joints. This involves cutting the tenon width, leaving the haunch at the side. Place the rail in the position it will occupy and mark the extent of the mortise from the pencil line still remaining at the edge, as in Fig. 6. The rebating has automatically cut away the tenon at the inside. To mark the haunch a template is advisable, and it can be similar to that used for the haunch socket, except that it is wider by the extent of the rebate. Fig. 7 shows the template in use. It is scarcely practicable to use the same template because this would have to mark from the back or long shoulder, whilst the tenon width is marked from the front, Fig. 6.

Finally check the tenon length by dropping a pencil into the mortise, noting the depth by placing the finger nail against it, and offering up to the tenon. Make sure, too, that the haunch does not prevent the shoulders from pressing home.



THOSE WRETCHED TENONS!

The other day a reader sent us an oddment of wood to identify. It was a piece of English oak, but the point of interest about it was that it happened to have a tenon cut in it—an amazingly poor tenon, crooked and ill-shapen. We began to consider some of the ways in which the maker had gone wrong. Some were common pitfalls, whilst others were rather more subtle. Do you ever come across any of them?

WHEN next you examine a piece of furniture, open the door and look at the top rail just where it meets the stile. If you see two marks as shown at A, Fig. 2, you can be reasonably sure that the man who made it was careless, and yon will automatically look round for other faults. You see what has happened! The maker has sawn down past the shoulder line when cutting the tenon sides. Either he has forgotten to look or he just hasn't bothered.

Various Faults. Or maybe you will find a gap at the joint, a gap which does not extend right round the shoulders, however. Here again the fault is clear. He has probably marked out the shoulders with the chisel, and has properly chiselled a small sloping groove against it in which the saw can run. When it comes to cutting the set in of the tenon at the end he hasn't bothered. The positioning of his saw is therefore guesswork and it cuts into the wood as shown at B.

The fault at C is usually found in the work of the man who lacks confidence. He doubts his ability to cut his shoulders perfectly square, and, rather than risk a joint which will not pull together owing to shoulders which are fuller at the tenon than at the surface, he deliberately undercuts them. The set-in of the tenon at the end is naturally level with the outside since the saw is held level with the latter, and the result is the unsightly gap at each side of the tenon.

You cannot detect a loose tenon (unless it has dropped apart), but the opposite fault is just as bad and often shows itself in a split at the end of the stile as at D. Probably the maker, in an endeavour to avoid a loose joint, has gone to the opposite extreme and has tried to force a tight tenon into its mortise. Yet he could have avoided the split by the simple precaution of putting a thumbscrew just by the joint as at A, Fig. 5. Of course, the tenon would have to be trimmed down with the file in any case, but the thumbscrew would resist the split.

Another possible cause of such a split

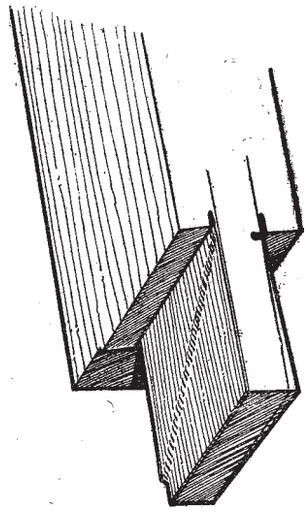


FIG. 1. BAD FAULTS IN A TENON. Note how the saw has been taken beyond the shoulder and the tenon lines, the crooked sawing of the sides, the gap at the back, and the unnecessary gauge lines.

is that no extra allowance was made in length beyond the mortise. Considerable strain is set up when the latter is being chopped and it is as well to allow at least 1/2 in. at each joint beyond the finished size. If for reasons of economy this cannot be done the thumbscrew should be put on as in Fig. 5.

The over-zealous worker often has the blemish at E. It is known as a cramp-bound joint and is due to the cramp having been tightened too severely. The shoulder has been so forced against the rail that the substance of the latter has given under the pressure. Only moderate pressure is needed; just enough to bring the shoulders well home.

Open shoulders (F) are a poor sight, and may be caused in various ways, and it is invariably due to either faulty marking or cutting. Possibly one shoulder is longer than the other (the result of bad marking), in which case the shoulder at the opposite side will probably be home. Another cause is that the shoulder slopes outwards towards the tenon and thus shows a gaping joint. This will probably give open joints at both sides.

Concealed Faults. So much for visible

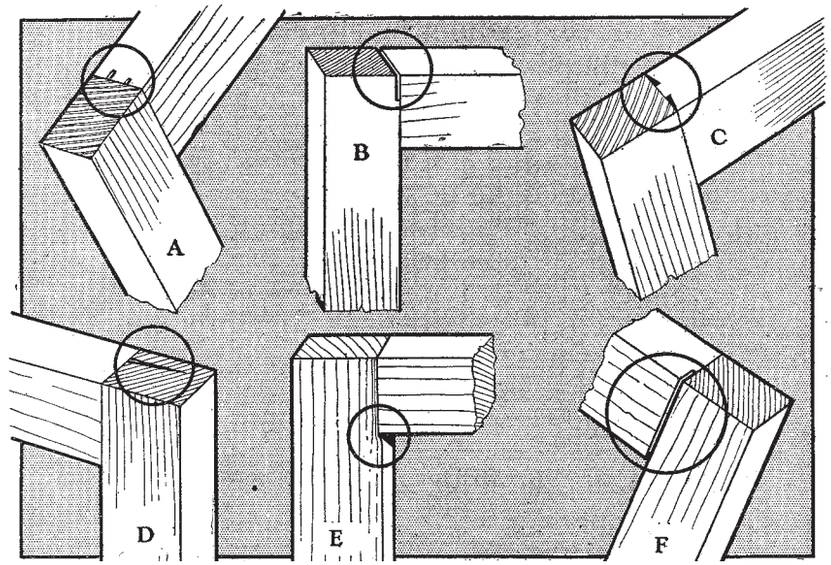
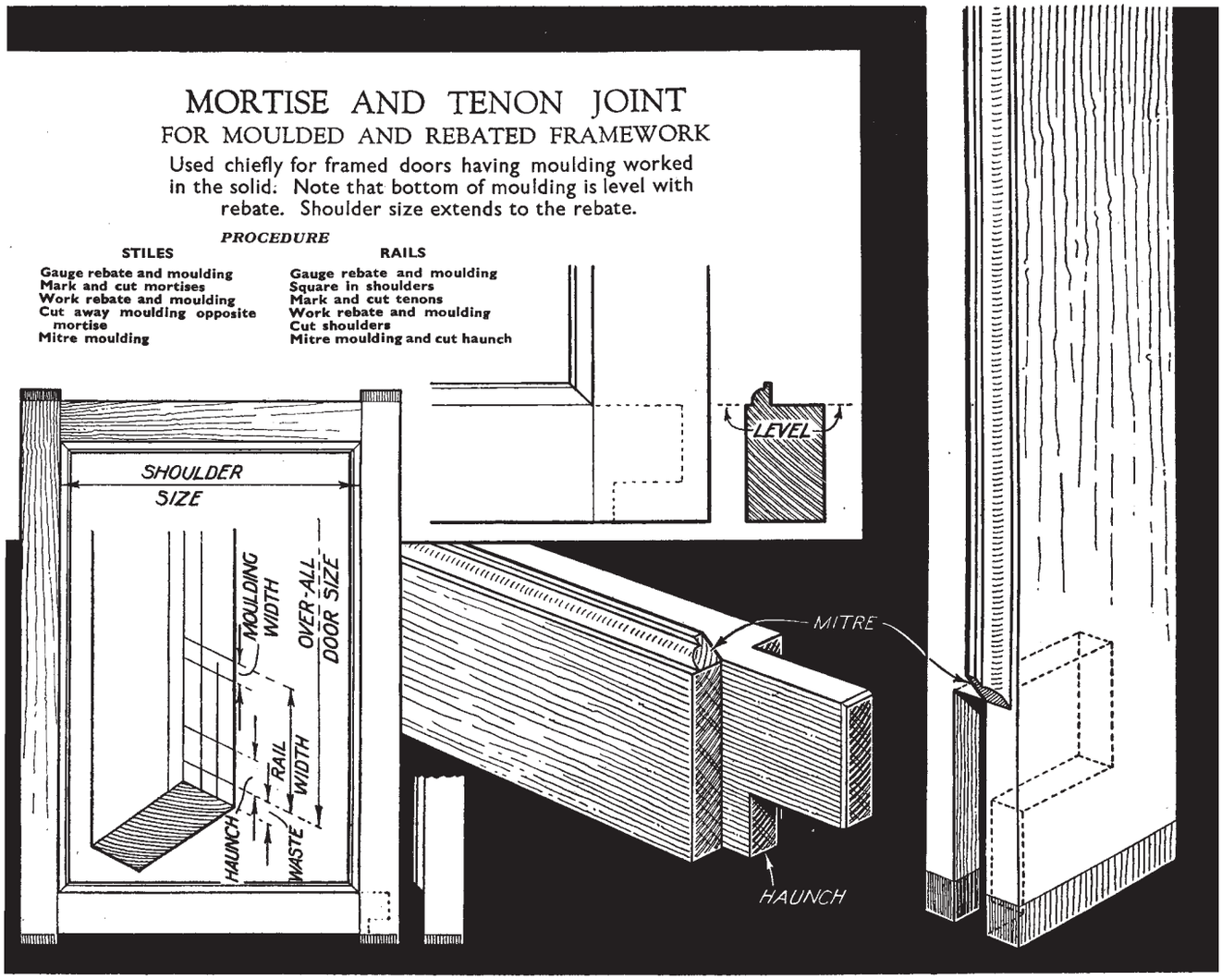


FIG. 2. THINGS TO AVOID WHEN MAKING THE MORTISE AND TENON JOINT.
A. Tenon sides sawn beyond shoulder lines.
B. Set-in of tenon shows.
C. Shoulders undercut.
D. Tight tenon causes splitting.
E. Cramp-bound joint.
F. Uneven shoulders.

WOODWORKER INSTRUCTION CHART NO. 10

When marking out the rails should be put together in a pair and the marks squared across both. They are then separated and the marks squared round each individually. The stiles are also marked together in a pair. Saw the tenons but do not cut the shoulders until after the rebate and moulding have been worked. Chisel the mitre, using a mitre template to give the correct angle. Mark haunch width on tenon from the mortise, and cut both the haunch and the notch to receive it. The mortise gauge at its original setting can be used to mark the stile and to show the haunch position. The waste pieces or horns left at the stile ends are sawn away after the door has been assembled. Their purpose is to lessen any liability for the wood to split when being mortised. Clean up the moulding before assembling the door.



faults. We now come to those which are hidden. Fortunately they mostly come to light when the joint is being fitted, and have to be put right. Possibly you have tested the tenon and found that it is just about right in thickness yet it will not go home. A, Fig. 3, shows a likely cause. The ends of the mortise may either slope inwards or be stepped. The remedy is obvious. If it is a through mortise the sides may not be flat owing to the chisel having been held over at an angle and the result will be that at B.

A sloping tenon or mortise (or both) will cause open shoulders and a winding frame. C, Fig. 3, is an example. To enable the parts to go together in alignment one side of the tenon will have to be filed down, though this does not make a really sound job because there will be a gap at one side as at D (it is shown on the opposite side here). Short of making a new part there is no alternative, however. If both mortise and tenon slope you may be lucky enough to find that they lean the same way and so go together true as at E! You cannot rely on this, and if they are opposed you will have the unfortunate result shown at F.

* * *

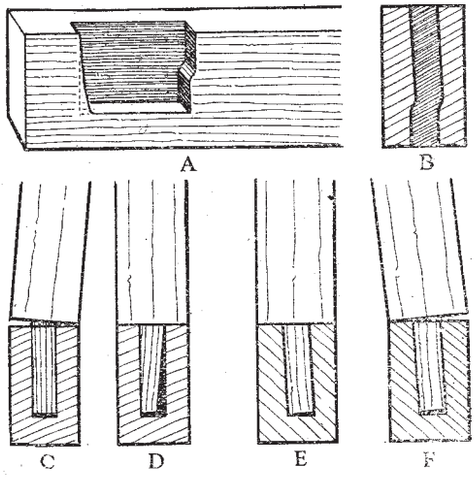
Test joints individually in a framework

* * *

Winding in a framework can be due to a rather more subtle cause. Either mortise or tenon (or once again both) may be twisted. This is shown at A and B, Fig. 4. Here again the two *may* cancel each other and the joint go together straight, but the reverse is just as likely to happen and the winding will then be increased. Correction with file to the tenon or chisel to the mortise is necessary, but this will of course unavoidably leave a gap which will weaken the joint.

This sounds a rather formidable list of faults that may occur, but it is as well to know the pitfalls beforehand. In the meantime here are one or two positive hints on fitting. First fix a thumbscrew to the side of the joint with a waste piece beneath to prevent the surface from being marked (Fig. 5). Having cut the set-in, test the tenon length by putting a pencil in the mortise and marking the length with the thumb. Test this against the tenon. If correct (with a *slight* allowance) make a slight chamfer with the chisel all round the tenon end as in Fig. 6. This will enable it to enter its mortise more easily and clear any slight obstructions.

Possibly the tenon is tight and you want to know where to ease it. Putting a straight-edge across the joint is a general indication for winding, but when you withdraw it note whether the tenon is shiny or possibly darkened. The friction of pushing in invariably causes a shine and this indicates the full parts. Use a file to correct a tenon. This leaves a rough surface for the glue to grip.



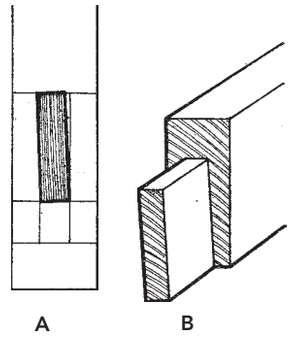


FIG. 4 (ABOVE) TWISTED MORTISE AND TENON.

FIG. 3 (LEFT). VARIOUS FAULTS IN THE JOINT

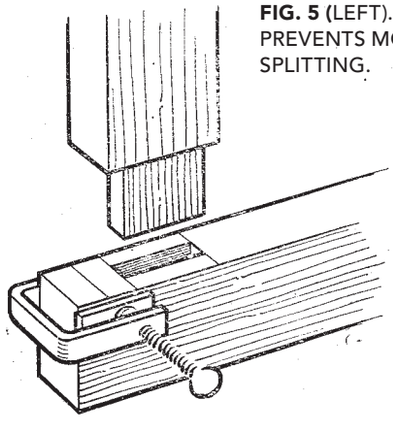


FIG. 5 (LEFT). THUMBSCREW PREVENTS MORTISE FROM SPLITTING.

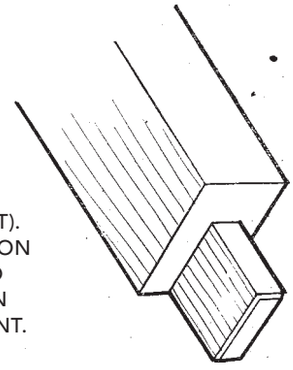


FIG. 6 (RIGHT). TOP OF TENON CHAMFERED HELPS WHEN FITTING JOINT.