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PREFACE.

Before printing another edition of this work it has been deemed advisable to revise and enlarge it. To this end more than thirty new illustrations have been added including some Angle Joints, Halving Joints, Mortice Joints, Dovetail Joints, Scarfing Joints and Joints for lengthening timbers, etc.

This book forms one of a series of popular and practical handbooks.

It describes clearly the construction of the principal joints used in carpentry and joinery, and shows not only how to set them out, but indicates for what purpose they are best suited.

The instructions given are by a practical joiner of many years' experience, and are worded in as simple a fashion as possible, consistent with the use of proper shop terms and phrases, which, however, are duly explained.

It is hoped that this little book will be of especial value to amateur woodworkers, as well as to trade apprentices and improvers, while it is possible that even the more advanced workman will find some wrinkles of value in its pages.

The publishers will be pleased to receive any suggestions that may prove of value for a future edition.

CAMELOT PRESS, 226-228 WILLIAM ST., NEW YORK, U. S. A.

WOODWORK JOINTS.

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MORTISE AND TENON JOINTS.

ALL STATES

There is no doubt that the weak point of the average amateur carpenter and joiner lies in the faulty way in which he makes his joints. No matter what he is doing, or however well it may look at the first glance, a close examination will usually reveal faulty joints, and, consequently, defective work. Now, the reason for this state of affairs is not so much the want of ability in the use of tools, nor the absence of constructive talent, as the want of knowledge as to the proper methods of making the various joints in common use, and the want of guidance in deciding the most suitable joint for the job in hand.

It is my purpose, in the present volume, to endeavor to help all lame dogs over the stile, by illustrating and describing the whole series of joints used in common carpentry and joinery, showing to what uses they can properly be applied, and explaining the technical names of each and every part in as simple a manner as possible. I would advise every one of my readers who wishes to be able to profit by my instructions, to make a small model of each joint shown, and label it with its proper technical term; these can then be

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kept for reference, and, if made carefully, they will form excellent practice, and sill serve the same purpose in carpentry as the continual practice of the scales in learning music.

Before commencing the explanation of the joints shown in the present chapter, I should like to impress upon everyone that, in woodworking, it is of first importance to prepare the wood properly. That is, it must first be planed straight, and out of twist on one side, which should in nearly all cases be the best side of the wood. After this is done, make a "face-mark" (as shown on many pieces in the present drawings) towards the best edge. This latter must then be planed straight, also to a right-angle with the face, testing it by means of a square. It is from these two sides that all marks are squared and gauged, and it will be readily seen that if these are not true the work will be sure to twist and turn in all directions. It is evident if it is necessary for the experienced woodworker to prepare his material properly, it is much more so with the amateur.

In Fig. 1 two pieces of wood are shown, joined at right angles by means of a mortise and tenon joint, or as a carpenter would say, "tenoned" together. A is wood with mortise, B wood with tenon. This is a very easy joint to make, the method being as follows: To set out the mortise take the piece marked A_i and square across on the "face" the two marks C, shown in Fig. 2, the distance between the two marks being the width of the piece B. These marks C must be squared across the two edges, where they give the width of the mortises in length. For the width of mortise, set a mortise gauge to about a third of the thickness of the wood, and make the



two marks D, taking care to use the gauge from the face side.

To make the mortise, remove the wood exactly to the marks, but not beyond. This is done much easier if holes of suitable size are bored first. Both in boring and using the chisel, half should be done from either side, and, if done properly,

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the mortise should be straight through when finished, both at the sides and end. It is very unlikely that it will be so at the first attempt, but this should be the aim of everyone, as it is really very easy to make it so.

To set out the tenon, square across the mark E on the face side, continue on the face edge, as



shown, and then again across the other *side*, not the edge; then gauge with the mortise gauge in the same way as before on the two edges, and also the end, as shown. In cutting the tenon (which is done with a saw), the cut is made just *outside* of the gauge lines, so that the tenon is left full size, and will just fit the mortise; likewise, in cutting the shoulders, the saw (a fine toothed one should be used) must cut up to the marks E, not on them. Shoulder marks, as E, should be cut with a knife or chisel, not marked with a pencil, as this ensures



a cleaner shoulder, and consequently a better fitting joint.

The joint shown in Fig. 3 ("Barefaced" tenon joint complete) is used in cases when one piece to be joined is less in thickness than the other; the mortise is then made in the middle, or nearly

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so, as shown in Fig. 4, and the tenon formed with a shoulder at one side only-this is called a "barefaced " tenon, and is usually found in tables and similar work. The only difference, in setting out, is that instead of the tenon being gauged with a mortise gauge an ordinary marking gauge is set





to the thickness of the required tenon, and this is used to gauge with. F, mortise for "barefaced " tenon; G, shoulder mark for ditto.

It is often necessary to join pieces at right angles, as shown in Fig. 5. This is done by curtailing the mortise in length, and the tenon in



FIG. 5.

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width to suit, as shown at H. The piece which is cut out at the back of the tenon is called a "haunching"; and it can be done in two ways. As at I it is run from nothing at the outside to $\frac{1}{2}$ in. inside, the mortise being cut to receive it, as shown at K. By this method the "haunching"



is out of sight when the job is finished. But a stronger way is shown at L, the mortise being cut as at M. This shows when finished, but it is easier to do, and is much stronger when done.

I have some more mortise and tenon joints to deal with, and then I will show how to fix them together by the various methods of pinning and wedging.

In Fig. 6 is shown the elevation of a wood partition, as framed for covering with laths and plaster, and my reasons for introducing it here are that its construction requires two different kinds of mortise and tenon joints, which have not yet been described. At the corners A the posts are fixed to the "sill" and "plate" respectively (B and C) by means of the "haunched" tenon, as described in a former page, and what I have to describe now is the method of fixing the diagonal "brace" D to the sill and post, also the "quarterings" or "studs" (they are known by both terms in various parts of the country) E to the sill and plate.

The method of forming the mortise and tenon for the diagonal is shown in Fig. 7. The tenon is first cut in the ordinary way, the correct bevel for the shoulder being obtained from a scale drawing, or by laying out the parts in the position they will eventually occupy. The top part of the tenon is then cut off at right angles to the shoulders, as shown at F.

The setting out for the mortise is shown on the face of the post; the bottom line G is the same bevel as the shoulder lines on the brace; but the top line H is at right angles to the face of the post.

By mortising in this way it is not only much easier to make a good fit, but the squared-off tenons at F form a firm abutment, which would

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be entirely absent if the tenons were inserted the full width of the brace. In cases where especial strength is required the shoulders are cut as shown by dotted lines, the post being cut away to suit, as also shown in the same way. In all cases where



FIG. 7.

timbers come together diagonally, they should be mortised and tenoned together in this way, whether for carpentry, joinery, or cabinet work, a good job cannot be made by any other method. In Fig. 8 is shown the method of fixing the "quarterings" in partitions. It is used for any timbers which have to withstand side thrust only, in which there is no necessity for holding the



two parts together. The technical term is a "stub" tenon, and it is simply a very short tenon



of the usual kind, seldom exceeding one inch in length. There is no need for me to describe the way to set the "stub" tenon out, as what I have

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stated previously will apply to this; therefore it would be needless repetition.

Fig. 9 shows a double tenon, which is often used in framing together wide timber. It requires no description, being simply two ordinary tenons instead of one. The only point to remember about it is when setting out both the tenons and the mortises to gauge from the face edge only,



as if the tenons are gauged one from either side of the wood, which seems at first sight the proper way, difficulties will be encountered when putting the framing together, unless each piece is exactly the same width; and this is seldom what we find to be the case.

In Fig. 10 is shown another form of double tenon. This is used in the middle rail of panel doors, when mortise locks have to be inserted, as, if the ordinary single tenons are used, the mortise made for the lock cuts away all the strength of the door. What I said in reference to Fig. 9



applies with still more force to Fig. 10, therefore gauge both tenons from the face side of the rail.

Fig. 11 shows a method of forming a longitudinal joint, in upright timbers where a vertical



pressure only is to be borne. It is a species of vertical scarfing on the principle of mortise and tenon. The joints are kept short, as the main

object is to preserve the two pieces in the same line.

Fig. 12 shows a form of tenon which is met with in carpentry only; it is called a "tusk" tenon, and is used in framing for the joists of a building, where openings have to be left for stairs, fireplaces, etc., and Fig. 13 shows the corresponding mortise. It will be noticed that



owing to the method of cutting the tenon there is practically no weakening of the mortise, and yet the advantage of nearly the full depth of the joist is obtained in the tenon.

A section of the complete joint is shown in Fig. 14, so as to make it clear, as well as to show how the two timbers are fixed together by means of key I, which, passing through the tenon as shown, draws the two parts together tightly. In setting

out, all gauging must be done from the *top* side of the joints, as that is where they are required to finish level.

Hitherto I have shown only how to make the various kinds of mortise and tenon joints, nothing having been mentioned as to the means adopted to hold them together when made.

All joints in which the tenon is more than threequarters of an inch thick are, as a rule, pinned together. Also, in cases where the tenon only



reaches partly through the wood, the pin should be used for fixing. On the other hand, in putting together work made from comparatively thin wood, the wedges will hold it best. There are, of course, exceptions to these rules, and in some cases both pins and wedges are used; but when this is done, the pin is simply driven straight through after the work is wedged up, and it is not really "pinning" in the proper sense of the word.

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Fig. 15 shows two pieces of timber to be "pinned" together—A being mortised (see dotted lines), and B having the tenon. First bore the hole for the pin, as at C, nearest the side which has to fit to the shoulder, as shown; then drive the two pieces together, and with the point of the boring-bit mark the centre of the hole on the tenon. Now withdraw the latter from its mortise, and bore



the hole through; but instead of placing the point of the bit in the hole, as marked, it must be placed about an eighth of an inch nearer the shoulder. Thus, in the drawing, D is the point as marked, and E the place for the point in boring the hole.

Now, on putting the two timbers together, the holes will be as shown in section in Fig. 16, and it is evident that on driving a properly fitting pin through them, the shoulders will be drawn up to a tight fit, and held there securely.

In Fig. 17 is shown another kind of drawboring. F has a "slot" mortise in the end, and G a tenon to fit. The pinhole is bored through the mortise, as in the preceding example, and the position of the hole marked on the tenon in the same way; but in this case we have not only to draw up the shoulders tightly, but also the tenon up to the end of the mortise. To manage this, the point of bit is inserted *nearer* the shoulder, as



before, but farther away from the edge of the tenon, as at H and I, which are respectively the point as marked, and the point to be used.

Simple as the operation of draw-boring appears on paper, it has many pitfalls for the novice, which it will be as well to guard him against before dismissing the subject. Perhaps the most common error is in allowing too much draught. He thinks that if an eighth of an inch is allowed, and draws the joint fairly tight, double this amount will naturally draw it up so much tighter. This is a great mistake. With the smaller amount of

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draught the pin will pass through the holes comfortably, and will answer all purposes; but with more, the pin cannot pass through. Therefore, a portion only goes through, the remainder going as a rule along the surface of the tenon, and appearing at the shoulder, thus preventing a closefitting joint, instead of causing one. Therefore, allow a moderate amount of draught only.



Another common error is to allow the draught the wrong way, causing the pin to push the joint off, instead of drawing it up. This is easily guarded against by remembering that the hole in the tenon must be bored *closer* to the *shoulder* than is marked; while to push the tenon up tightly, as in Fig. 17, the draught must be allowed the reverse way. Fig. 18 is another method of securing this joint by using two pins instead of one.

For successful draw-boring it is necessary to make the pins properly. We often see them made as in Fig. 19 (K); and then the makers wonder why they will not act properly. Now, if the pins are made as at L, they will draw in easily at first, and gradually tighten up, filling the holes at both sides, and no danger of splitting the wood.



Do not be persuaded that cramping up and pinning is as good as draw-bowing; it is not. The latter makes a much stronger job, and really takes scarcely any more time if set about in the proper manner. I suppose I scarcely need say that straight grained wood only is suitable for pins.

We now come to the method of wedging mortist and tenon joints. When this method of fixing is

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adopted, the mortises are made about one-quarter inch wider at the back than at the face side, to give room for the wedges; and simple as this may seem, there are both right and wrong ways of



doing it. In Fig. 20 I have shown three sections of mortises, with the "wedgings" made in as many different ways. M is simply knocked down square—a very convenient way of doing it on a mortising machine; but a very bad plan for the



object in view, viz., to fix the tenon properly. At N the wedgings are cut at a very short angle. This can also be done in the machine by reversing the chisel and working the wrong way. It is bad for the fixing, and bad for the machine, being liable to strain it, or bend the chisels.

At O is shown the proper method of making the wedgings. They are sloped easily out to nothing—about half-way through the mortise, and the wedges will fit tightly the whole length, as shown at P, Fig. 21.

A very good method of wedging is shown at R, Fig. 21, the tenon being split, and the wedges



inserted and driven tightly in. This is not often adopted, as it is too much trouble; but it makes a good job, especially for fairly large work.

As with pins, so with wedges, they can be made right and wrong. A decidedly wrong method is shown at S, Fig. 19, and yet if we watch a dozen joiners at work we shall probably see quite half of them make their wedges in this way. At Tis shown the proper method of cutting wedges,

and a comparison of the two shapes will soon prove that this is so.

In Fig. 22, at U are shown two faults which often show themselves in wedging up tenons. On the right the wedge penetrates through to the face side, owing to the tenon being too small for the mortise, and accelerated by the use of too small a wedge; while on the left is shown a part of the face driven out by the use of a wedge of the same pattern as shown at S, Fig. 19. The remedy for each of these faults is obvious.



At V and W are shown two methods of what is called "fox wedging "—that is, wedging tenons which go only partly through the wood. The mortises have to be made larger inside than out, and the wedges sloped to the same extent, and a fairly strong job is the result. V shows the wedges at the sides of the tenon, and W shows the tenon split and the wedges inserted in it. The latter makes the stronger job; but it is rather a difficult matter to make a satisfactory job, and, taken on the whole, such tenons are better fixed with pins. Fig. 23 shows how to cut the wedges from the waste wood in the haunchings in such work as panel doors, sashes, etc., thus economizing both time and material.

Wedges must only be used abutting against end grain; if against side grain, the work will certainly split and be ruined; they must be the same thickness as the tenons—if thicker they will split the wood, and if thinner will turn round when driven, with the same result.



I have before shown only simple tenons, in which both shoulders are of equal length; but I will now proceed to show some more complicated joints, in which, owing to the framing having beads and mouldings worked on it, the shoulders require "mitring" and "scribing" to make them fit.

In Fig. 24 is shown one of the most simple of this kind of tenons, and in Fig. 25 is shown the corresponding mortise. As will be seen, a small

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"bead" is stuck on the edge of the framing at A. And this makes it necessary to allow the shoulder on that side the same distance longer than the



other as the width of the bead stuck on. For instance, if a quarter inch bead is used, the one



shoulder must be one-quarter inch longer than the other. This extra length of shoulder allows material sufficient to make the mitres at B, which,

when the frame is put together, intersect with each other, and make a joint, as shown in Fig. 26. In order to show more clearly my meaning, I have shown in Fig. 27 a section of the framing now described.

In Figs. 28 and 29 is shown another simple form of framing, which requires unequal shoulders to the tenons. No moulding of any kind is worked on this, but it is rebated (as a door frame for in-



stance), and the one shoulder must be the depth of the rebate longer than the other; it is simply sawn off square, no mitre being required in this case. A section of the frame is shown in Fig. 30.

Figs. 31 and 32 show the tenon and mortise respectively of what may be called a combination of the former two joints, the frame being both rebated and beaded. It consequently requires the depth of the rebate, plus the size of bead allowed

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on one shoulder more than the other. Thus, with one-half inch rebate and one-quarter inch bead, we require the long shoulder three-quarters inch



longer than the other; and, what requires thinking of, the bead (as shown in Fig. 31) must not be mitred close to the mortise, but the depth of the



rebate away from it, as at D. A section of this frame is shown in Fig. 33.

We have in Figs. 34 and 35 yet another form of what may be called compound tenon and mortise. It is such as is used in some parts for door frames, where the sills are bevelled through the greater part of the width, as in Fig. 36, and it follows that the shoulders must be beveled to fit. In such door frames the rebate is inside and the bevel outside, so that the shoulder at the rebate side is cut square, and the other one longer, to fit on the bevel of sill. The point to be careful of in setting out is to strike the beveled shoulder on



the tenon from the same point of the width as the bevel starts from on the sill. In the drawings this is at the rebate line, which is a good place to bring it to if possible; but it cannot always be managed.

In Fig. 37 is shown the section of a joint in which both shoulders are of equal length, although the framing is rebated. This is, however, balanced by the chamfer on the opposite edge at E; both shoulders, therefore, require cutting so much longer

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than when the framing was square in section, the one sawn in square to fit the rebate, and the other on the bevel as shown to fit the chamfer. This latter is one of the simplest forms of a "scribed" joint.

Another specimen of a "scribed" joint is shown in Fig. 38; in this case an ovolo is run on the opposite edge to the rebate. Thus the shoulders are both required the same length, as in Fig. 37, but they must both be sawn off square. The ovolo is then mitred, and the spare wood cut out with



chisel and gouge at right angles to the edge of the frame, so that it will fit as shown in the drawing. It is not usual to "scribe" the moulding through the whole thickness, but about half way, the moulding being cut away from the mortise, where it will not show in the finished joint.

Fig. 39 shows a section in which the shoulder at the moulded side would have to be longer than at the rebated side, according to the width of the ovolo. Otherwise it is the same as Fig. 38, and must be scribed in the same way. Fig. 40 shows a bead of the same size as the depth of the rebate, worked on the opposite edge, thus necessitating shoulders of the same length, but the one will be mitred, and in Fig. 41 the same is shown, but the rebate is a wide one, so that the mortise will come in it. Therefore the mortise is affected, and must be kept the depth of the rebate narrower, or if a slot mortise, it must be kept so much towards the end, and in mitring the head, this must be done exactly the reverse to what is shown in Fig. 32.

So far, I have given no reason why in some cases "mitres." are used, and others "scribing," and it



may perhaps be as well if I do so. Any moulding which finishes with a square member should be scribed at the angles; while such as finish with a feather edge, or die off to nothing, must be mitred, for the simple reason that it is difficult to scribe them. A glance at Figs. 42 to 45 will show my meaning. Fig. 42 is an "ovolo," and as it has a square at F, it is easy to scribe to it, as in Fig. 38, which is the same moulding, though of slightly different section. Fig. 43 is an "ogee" moulding. This can be scribed, but is far better mitred, not

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having a well-defined edge to fit up to. Fig. 44 is a "lamb's-tongue" moulding, and must be mitred, scribing to make good work being practically an impossibility. Fig. 45 is a "chamfer"



moulding, and can be scribed direct with the saw, when the shoulders are cut, or with a chisel after—the former method preferred.

In Fig. 46 is shown the section of a piece of



framing, rebated on each edge; this is dotted for double mortises, and the outside shoulder will require to be the depth of the rebates longer than the inner one at G; while if one or other of the edges were moulded, that one would require to be so much longer still, to allow for the necessary mitre or scribing.

In Fig. 47 is shown a "taper" tenon. This was very extensively used in olden times; but is now nearly obsolete. It is shown here more as what to avoid than as an example to be followed. The setting out must either be done from the centre, or two mortise gauges used, and great care is re-



quired or the wood is split when driving it together. Its holding power is weak, owing to its wedge-like shape, so that altogether it cannot be recommended.

It will be noticed that in the whole of the drawings the side of the tenon is brought to the edge of the rebate, where there is one, and where there are both rebate and moulding, as in Figs. 33, 42 to 45, the centre square should give the thickness

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of tenon. If this is always done, the work will come together much better and easier, and mistakes are less liable to be made. It is not always possible to arrange matters in this way; but as a rule it can be done, and, in such cases, it always should be so.

Another important point to remember is, if a moulding of any kind is worked on framing it should be on the face side or edge, so that there



will be no difficulty in making it intersect; and if both sides or edges are moulded, or even rebated, the stuff should be gauged to width or thickness or both, if necessary. If this is not done, it is impossible to make the joints fit, and this is often the reason why bad work is turned out. No time is saved in omitting the gauging to width, as what is gained in that way is usually thrown away in botching up the joints in the endeavor to make them fit, which is then an impossibility. When a bead or moulding is worked on framing of any kind, do not take the size for granted, as a quarter inch bead often works to five-sixteenths inch, and so on with other sizes. The correct way is to work the bead or moulding, as the case may be, on a waste piece of wood, and then measure correctly, and set out accordingly; the shoulder will then come up properly.

Fig. 48 illustrates a plain mitred mortise and tenon joint.



FIG. 50.

Fig. 49 shows a mitred secret mortise and tenon joint.

Fig. 50 gives two views of an angle lap joint half mortised two ways and secured with two pins. It requires a little extra attention in fitting but makes a good strong holding joint.

All mitres should be made by the aid of a template, the ends of which are cut to an angle of 45 degrees. A brass one is the best, but wood will answer the purpose.

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There are many more shapes of tenon joints I could give, but I have shown enough to give anyone the correct ideas to follow, so that a little thought should enable my readers to make and fit correctly any form of this joint they may come in contact with.

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CHAPTER II.

LAP " JOINTS.

In the present chapter I am bringing before my readers a series of joints of an entirely different nature from those already described, although they are used for a similar purpose, viz., joining timbers at various angles. These methods of jointing are much more simple than those involving a mortise and tenon. They require less care in setting out, less skill in workmanship, and a smaller assortment of tools to carry them out successfully, and, as may be imagined, from a constructive point of view, the result is not quite so satisfactory. Nevertheless, lap joints are very useful in certain kinds of work, especially where cheapness is a consideration.

In Fig. 51, herewith, is shown two pieces of scantling joined to a third at right-angles—the one (A) at the extreme end, the other one (B) away from the ends. In Fig. 52 is shown the piece C, with the notches cut ready to receive the "laps" on A and B. In setting out lap joints the notches must be squared across at the required distance, and the depth marked with a gauge, which should as nearly as possible be set to half the thickness of the timber. All gauging should

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be done from the same side. Thus, on the piece C the part which is gauged from is cut away, and on A and B it is left intact, the other part being cut away. Correctness in this operation is very



much facilitated by marking the "face" side with a face mark, as shown on many figures accompanying this work, and by doing this or not, the difference between flush joints or otherwise—



FIG. 52.

or, more properly speaking, between good or bad work—is made apparent.

Fig. 53 shows one of the pieces (A and B) with the "laps" cut ready for fixing in the notches

in C, which is done by nailing or screwing, as the case may be. Sometimes the laps are cut as in Fig. 54; the notch to correspond being as shown by dotted lines at D, Fig. 52. This arrangement gives a stronger joint as far as the tendency to withdraw the one piece from the other at right angles goes; but otherwise there is not much to be said in its favor. The two gauges are required in setting out this kind of lap joint—one being set slightly less, and the other slightly more than



half the thickness of scantling; the one is used at the shoulder, and the other at extreme end of lap, as at E and F, the two points being then connected by a straight line. The above lap joints are used in framing up woodwork, in which the scantlings are all of one thickness and have all to come flush together, such as partitions to which lathing or boarding has to be subsequently applied.

Fig. 55 shows at G a scantling of greater depth lapped on to one of lesser depth, the latter not being cut away at all. The lap for this joint is

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shown in Fig. 56, and unless this scantling is supported independently, as in ground floor joist, this method is a faulty one. A better plan,



which has the same appearance when finished, is to notch the narrow piece, as in Fig. 57, and cut a double lap on the other scantling, as shown in

" LAP " JOINTS.

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Fig. 58. This gives strength to the one without weakening the other. The small notch in Fig. 57 is sometimes used for flush framing, the lap being as in Fig. 59. This is called "nogging," and is



to be found in floors in which short joists are lapped into main girders. It used to be a favorite method of framing in olden times. The finished "nogging" joint is shown at H, Fig. 55.

In Fig. 60 we have three different kinds of laps



I is a haunched dovetail lap, used only where a corner is to be framed together. The notch is shown at M, Fig. 61, and the lap in Fig. 62. At K (Fig. 60) is shown a dovetail lap proper. The

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shape of notch is indicated at N (Fig. 61), and the corresponding lap in Fig. 63. In setting out both of the foregoing joints, the laps should be cut first, and then laid on to the timber to be notched, in their proper positions. The shape of the dovetail is then marked, and the notches cut, a tight fit being ensured by sawing a trifle inside the marks.

Although I have shown the haunched lap (I) in a finished state, some spare wood must, in all



cases, be left on at the end of the notched piece until the joint is fixed together. Otherwise the "haunching" will stand a good chance of being split when driving in the lap. The joint L has the same appearance as the "nogging" (H), but it is made far different. It is called a "ship lap," and the notch is shown at O (Fig. 61), the lap being at Fig. 64. The method of setting out is obvious. The occasions in which this joint should be used are few, as, owing to the wedged shape of the lap, there is a tendency when fixing to drive the lapped timber off the shoulders. Therefore, this joint should only be used when framing-in scantlings at right angles between two others, and even then only when the latter are firmly fixed, so that it is impossible to drive them apart. An example for which "ship lap" joints are suitable is when the sides of a farm building have to be boarded uprightly, and when two or more rails have to be fixed to the existing posts to receive the board. These rails can better be fixed by



FIG. 65.

"ship lapping" than by any other method, as the posts will be found unyielding.

In Figs. 65-66 is shown another method by which the ends of timbers are firmly attached to beams or wall-plates on which they rest. The upper surfaces are shown as cut for the reception of an upper timber to further bind them together. This method though a little more complicated, has the advantages of bracing and holding together each timber, more firmly than in Fig. 60.

Fig. 67 shows scantlings framed together diag-

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onally the one (P) by plain, and the other (R) by dovetail lapping. The corresponding notches are shown in Fig. 68, and the laps in Figs. 69 and



70 respectively. In setting out these, the best way is to lay out the timber in its final position, and to mark the required bevels on each piece.



FIG. 67.

Thus the proper lengths will be obtained at the same time.

Fig. 71 shows a lap joint in which the scantlings

cross each other at right angles. This necessitates a notch in each piece, the one being shown at Sand the other at T (Fig. 72). This is often required in framing partitions, etc., and where braced the same kind of joint is used, but diag-



onally. and the same method of setting out is employed for each.

The dotted lines in Figs. 51, 55, 60, 67 and 71, represent the gauge marks in setting out, and are intended to emphasize my remarks as to the



necessity of always gauging from the face side. To mark out in this manner is the only way to obtain good work.

Fig. 73 shows a joint of a similar character, but more complex. It is not adapted for large

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works, being still more weakened by the cutting away of the pieces at the sides.

Fig. 74 shows the method of halving when the



timbers cross each other at any angle, and Fig. 75 is a separate view of one of the parts.



Fig. 76 is a method by which one timber is notched on to another. This is a good joint for the upper timber holdes as it were by a hook, which acts against a shoulder in the lower. The upper timber is thus prevented from being drawn inward by weight placed upon it, and the lower



is strengthened against any pressure which might tend to force it outward.

The joints which I have shown, so far, in this



FIG. 76.

series, have nearly all applied to carpenter's work only. In my next chapter I propose to change, and deal with dovetail joints, so that those who

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are devoted to joiner's work may benefit by these examples. But I shall revert later on to joints more especially for carpenters. which, in number, are not by any means yet exnausted.

CHAPTER III.

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DOVETAIL JOINTS.

I suppose it is needless for me to describe what a dovetail joint is like. They are seen, in one form or another, so frequently by every person that they are universally recognized; but owing probably to the very familiar form, which no doubt in some respects breeds contempt, dovetailing in a great many cases proves a pitfall for the amateur, and often for the budding professional joiner. There is, however, no piece of work in the trade which is simpler when it is set about in the right way.

A dovetail joint, if made properly, requires no nails to hold it together, or to bring the parts down to a proper joint; but in order to attain perfection there are one or two points which must be attended to when making this kind of joint. First, the stuff must be faced up properly, using the trying plane on the flat surface. In passing I will just mention that in dovetailing, whether boxes, drawers, or whatever is being made, the face *side* is always the *inside*, and the face *edge* is the bottom *edge*.

Another point which is often neglected is to put in plenty of "pins" or dovetails. A very 53

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good rule for ordinary work in soft wood is to space them not less than $1\frac{1}{2}$ in., or more than $2\frac{1}{4}$ in. from centre to centre; for hard wood, or for small work in thin wood, they should be spaced closer still.

In setting out the pins, or rather the mortises in which the pins have to fit, a half dovetail should be placed at both top and bottom, as shown in



Fig. 77, and the intermediate "tails" should be brought to an extreme point, as shown at B in the drawings—that is, if neatness is an object; but if this has to give way to strength, then "tails" of the shape shown at C (Fig. 78) should be used.

The bevels of the "tails" should be as shown in the drawings, and in no case should they be shaped as at D (Fig. 78). If done in this way, there is great danger of the sides splitting off at E, and although this shape at first sight would appear to be stronger than the other, it is really



not so in practice. Also if one, two, or three, or even more articles of the same size are being made, the dovetails need or ly be set out on one piece. The whole should then be placed together in



pairs, as in Fig. 79, and the marks squared over, then screwed in the vice together, and all cut at once with a finely set tenon saw, first of all sawing all the pieces off to exactly the same length.

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To mark the pins, screw one of the ends (supposing those already cut to be the sides) upright in the bench vice, with the top end about half an inch above the bench top, as F (Fig. 80), taking care to keep the face side towards the bench. Then lay one of the sides on it, as G, so that the squared over marks on the edges of G coincide with the inside of F_i as at H. With the front



end of the same saw as was used to cut the "tails," used as shown at I, mark the position of each one on the end grain, and before removing the side board, number each piece as shown in the figure

All four corners of each job in hand must be done in this way, although taking particular notice that the face *side* of the vertical piece must be towards the bench, and of the horizontal piece underneath; and in addition remember that the face edges of both pieces must always come together. These are the edges which must be kept level while marking. Neglect of these points is the reason of failure to produce good work when making dovetailed joints.

In cutting the "pins" some regard must be paid to the kind of wood in use; soft pine requires more wood left outside the marks than hard oak, but taking ordinary work, in yellow or white deal, white wood, or anything similar, about a thirtysecondth part of an inch clear of the marks on both sides will suffice, leaving rather less at the two half-dovetails.

I should have stated before that in cutting off the stuff for the ends of the box (or whatever is in hand) about half an inch extra length should be allowed, and in squaring across, this extra length should be given to the pin at each end to be cut off when the job is put together.

Before the pins are sawn down, the marks on the outside (that is, where they come to a point) must be squared down as a guide for sawing parallel with the edges of the boards. This is a somewhat important part, and in Fig. 81 I have endeavored to show how they should and should not be cut. K is parallel from point to heel, and this is correct, but not easy to manage. L is cut wedge shaped, larger at the heel than at the point, which is bad, being liable to split the boards, and also to show a badly-fitting joint outside. M is cut slightly smaller at the heef

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than at the point, which is a good fault—there is no fear of splitting, and unless overdone, a good fitting joint will result. N is cut out of parallel, which is the worst fault of all, and must on no account be done.

All the pins being cut, the spare wood must be cut out, using very thin sharp chisels. Some workers use a bow saw to remove the spare wood between the pins, but I do not consider it any advantage—the chisel has to be used after, and it is quicker to remove all the wood with the chisel at one time.



I must not forget to emphasize the fact that it is necessary in setting out to use knife or chisel for all cross lines, both on the sides and ends. Pencil will not do at all, if good work is expected.

Before putting together, each pin must be slightly pointed on all three sides, as shown in Fig. 82, so that they will enter freely, without bruising the wood.

When putting together, the pins should be well glued, and the sides driven on at once, using a

block which is long enough to reach quite across, as O in Fig. 83; if this is omitted, splitting is apt to result. I have not referred to any fitting together, as I do not consider it necessary, because when dovetails and pins are cut properly, they



will be found to go together without any preliminary fitting; at least, this has always been my experience.

In Fig. 84 is shown a side view of lap dovetailing, which is familiar to all as being used in



making drawers. The method is the same as that described already as regards the sides, but the ends of the front are gauged on a certain distance, which should, if possible, be the same as the thickness of the sides, and the dovetails are

In Fig. 86 is shown what is sometimes called "secret," but it is really double lap-dovetailing. One part is done as shown in the figure, making the mortises the same size as the pins, and cutting



them as shown. The corresponding member is worked as in Fig. 85, the necessary marking being done by placing the one on the other, described in Fig. 80, and marking round with a marking



point, then cutting them out with saw and chisel. The side appearance of this when done is shown in Fig. 87, and the top edges show as Fig. 88, and as will be readily understood, very careful

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stopped at the gauge mark. The method of marking is the same as before, and the only difference is in cutting the pin, which has to be done



largely with the chisel, as the saw can only be used to start them with.

The appearance of the pins when cut is shown



in Fig. 85, and those who can do the ordinary dovetailing will have no difficulty in making the "lap" dovetail.

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work is necessary, in order to make a good job, and, presuming this, the joint is as strong as the ordinary dovetail.



FIG. 91.

By mitring the top edges, as in Fig. 89, the appearance of this part is as Fig. 90, and if done



properly is an improvement. It does not add much to the difficulty of making the joint.

Fig. 91 shows the end of one timber notched on

to another, at right angles. A dovetail being employed in this case.

Fig. 92 shows a method of notching the end of one timber on to another. A dovetail being employed and further security obtained by the addition of a shoulder.

Fig. 93 shows a combination of joints. A simple dovetail right angle joint; also a halving joint with



two dovetai's. Used in the construction of framing to prevent pulling apart.

Fig. 94 shows a simple dovetail joint used for lengthening timbers.

Secret dovetailing proper is a difficult job for any but an experienced man to undertake, but it makes a good strong joint if done well, and the appearance is the same as a mitred joint.

" GLUE " JOINTS.

CHAPTER IV.

" GLUE " JOINTS.

In the present chapter I intend to show how to make what are, in technical phraseology, called "glue" joints; that is, they are used in making up a wide board from two or more narrow ones. It is often stated that a properly made "glue" joint is stronger than the wood itself, and this is, to a certain extent, quite true; but to make it so, the joint must be a good one, and the two pieces of wood must be in contact at every point, so that practically no glue whatever is left in it, except what is forced into the pores of the wood. If such a joint as this be broken forcibly, it will be found that the wood is torn in many places. instead of the two boards coming apart intact. thus proving that the glue really is stronger than the wood itself.

There is no doubt that the jointing up of boards is the weak point of all amateur, and also of a good proportion of professional work. Failure is very often due to the bad order in which planes are kept; in many cases it is simply carelessness, and to the mistaken idea that "the glue will fill up where the wood does not touch." This

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must be dispelled at once, as good joints cannot possibly be made while this opinion is entertained.

Glue joints are of various kinds, according to the job in hand. Thus, in Fig. 95 are shown the square joint A, the matched joint B, and the tongued joint C. The first is sufficient for most common work, such as shelves, etc.; and as the first stage of B and C is identical with A, I will describe the latter at length.

Boards up to three-quarters of an inch thick are usually jointed on the shooting board, this being the more convenient method, and they



" are bound to come upright " is an expression often heard and seen in print; consequently, when one tries his hand, and finds that the two boards do not come upright, he loses faith in his instruction, whether verbal or printed. Now, if the plane is quite true, as well as the shooting board, it will be all right; but this is very seldom the case. If in jointing, one board is laid on the shooting board face upwards, and the other face downwards, they will come right. This is shown clearly in Fig. 96, where D shows the two boards planed as they should be, one face up and the other face down, while E shows the effect when

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both are planed face upwards. Fig. 97 shows the position of the board to be jointed (F), and the plane, as in the act of jointing (G), on the shooting board (H).

When jointing thicker boards than mentioned above, they must be fixed in the bench vice at a convenient height, so that the plane can be handled casily, and be kept well under control. The usual method is to plane one edge straight and square first, and then plane the other until it fits closely on it. This way cannot be improved upon; but to be completely successful, the first board must



be made quite square and straight. And however easily this may be accomplished, by the experienced joiner, it is by no means a simple matter for the tyro, and therefore it is excusable for the latter to make use of square and straight-edge until he is able to do without them.

The trying plane must be set very fine for jointing, and the iron should be sharpened as near straight across as possible, only just round, so as to prevent the corners from projecting. The difficulty as a rule is to sharpen so that it is not too round; there is no fear of getting it too straight across. Now, supposing the edge of the board to be jointed is square across, but not straight, then the high parts must be removed by the plane in the position on the board indicated in Fig. 98, when a shaving of parallel thickness will be removed, so as to alter the edge in relation to the length of the board only. On the other hand, supposing that on trying the two boards together, the joint fits closely, but the top board leans over towards you, thus showing that the



bottom board requires more taking off at the back. To do this, a shaving should be taken off for the whole length of the board with the plane in the position shown in Fig. 99. When required off the front, the plane should be used as in Fig. 100. It is quite easy to guide the plane in any of these positions by means of the fingers of the left hand, which slide along the face of the board under the plane.

If the joint is twisting (or winding), then commence the shaving at the back end, with the plane

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as Fig. 99, and gradually bring it across, so that at the front end it finishes as Fig. 100, or *vice versa*, as required.

A practised hand can tell if the joint is a good one or not by the mere act of rubbing one board on the other; but the novice must be content to test them by trying to see through the joint, and they must not be passed if the least glimmer of light can be seen; for this reason artificial light is preferred to daylight by many persons when making joints.

Matched joints as B (Fig. 95) are only used for thin wood, such as drawer bottoms, etc. To ensure good work the planes must be in first-class order, and great care is needed in making the tongue, or the two shoulders will not come up together. In all cases a good square joint must be made first, and the matching done after.

All boards of a thickness of three-quarter in. and over, which require extra strength, or are to be exposed to changes of the atmosphere, should be tongued, as shown at C (Fig. 95), which materially adds to their strength. The grooves to receive the tongues can be made with the notching plane, if a plough is not available; and the sharp corners should always be run off with the rebate plane, as at I(Fig. 101). Neglect of this is the cause of many well-made joints refusing to fit closely together.

Tongues for jointing are of three different kinds —the "slip" tongue, which is made from a strip of wood of suitable thickness and width to fit the grooves, the grain running parallel with the boards; this is shown in Fig. 102, inserted in the groove made for its reception. The other kinds are the "cross" tongue and the "diagonal" tongue; in the former the grain runs directly opposite to that of the boards, while in the latter it runs diagonally. Figs. 103 and 104 show pieces



of thin boards marked off for diagonal and cross tongues respectively. In fitting slip tongues, they simply require "mulletting," so that they are a fairly close fit, without being tight enough to prevent the joint being rubbed when glued. In glueing up this joint, the tongue is first glued along one edge and partly on the sides, then the glued part is driven into its groove, after which

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the two edges forming the joint are coated liberally with hot glue, including the projecting tongue, and rubbed well together to expel the glue, when it can be placed on one side until dry.

The cross and diagonal tongues are a little more trouble to prepare; they must be planed to a certain thickness, so that they can be pressed into the groove with the fingers only, using a block, as Fig. 105, to plane them on. When the groove is full throughout the length, the sides of the pro-



jecting tongues must be planed off with a rebate plane until they are shaped in section, as K(Fig. 106), otherwise it will be difficult to rub the joint. When glueing up, the tongues must be removed one by one, and laid down in rotation, so that they can be replaced, after the thick edge is glued, in their proper order, after which the glueing and rubbing is proceeded with, as previously described.

This is no place to discuss the respective merits of "slip" as opposed to "cross" and "diagonal" tongues. Some workers advocate one and some the other. The "slip" are certainly the least trouble, and I can say from experience that a joint made properly with a slip tongue will never break; at least, I have never known one to do so during thirty years' experience.

Matched or tongued joints should never be glued until they have been fitted together to see that the tongues are not so wide as to prevent the joint from coming together, or failure is certain.



The numbering of the joints is an important matter, as, if not done in an easily seen manner, the chance is that wrong boards will come together. A good way of numbering (which should be done before the jointing is commenced), is shown in Fig. 107, where it will be noticed that the numbers on both boards show alike, making mistakes impossible.

Some care is necessary in making the grooves

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for tongued joints, as, if not made parallel with the sides of the boards, the result is as shown in Fig. 108—the joint refuses to come together at one side, owing to the tongue being bound by the imperfectly made groove.



When three or more boards have to be glued up at one time, the steel cramp shown in Fig. 109 is a very handy appliance; it pulls joints tightly together, and holds them stiffy. The method of using is shown in Fig. 110 at L. The clamp Mshown in use in the same figure is also useful, especially when glueing up long, narrow boards, which have a tendency to spring or twist.

After glueing up, the boards should be stood carefully on edge in a slanting direction, as in Fig. 111, placing one or more strips of wood between them, according to the length. In the figure the shaded portions represent the jointed boards, and the open portions the strips between them.

Instead of tongues, dowels are sometimes used



to strengthen glue joints, and a very good job they make. The joints are first made in the usual way, and the boards are then laid on top of each other, the position of the dowels being squared down across the edges and also squared across and down on the opposite edges, so that all will intersect. Gauge marks are then made on the edges of each board, crossing the squared across marks, as shown in Fig. 112, and the dowel holes are bored at the point where the two marks cross.

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The dowels should be placed 6 or 8 inches apart, according to the strength required.

Each hole should be slightly countersunk, as shown in Fig. 113 and in section in Fig. 114. Dowel rods of birch should be cut off to the length wanted (from two to two and a half inches) and the ends pointed, as in Fig. 117.

The diameter of the dowel is (as the thickness of tongues) regulated by the thickness of wood in use. Neither should exceed one third of the finished thickness; thus for one inch boards



(finishing seven-eighths) one-quarter inch should be used, and so on in proportion.

Dowelled joints cannot be rubbed together, but must be tightly cramped up after glueing; the dowels must be well glued as well as the joints.

Fig. 115 shows the two prepared halves of a drawing board, laid on top of each other and mortised for three tongues. The figure shows only a centre cross gauge mark for each mortise but there should be three marks for each mortise (centre and width). In addition to these three marks a gauge line should be made in the centre of the edge of each board from end to end. Fit the tongues and glue up, placing the board in clamps to dry. When thoroughly dry, the ends of the



board should be marked out and cut, as in Fig. 2 B. The two cross pieces grooved to the proper width and depth with a matching plane, and fitted.



Glue up and place in clamps to dry. The finished board is shown in Fig. 116.

In some cases double tonguing is resorted to (see Fig. 118). It is suitable for very thick wood,

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being stronger than one thick tongue. The procedure is the same as before described, but it is necessary to plough both grooves from the same side of the board, or if owing to the possession



of a match plane only, this is not practicable, the boards must be gauged accurately, to the same thickness, or the result will be (as shown in section in Fig. 119) the grooves not coming together will make it impossible for the joint to come up when the tongues are inserted, however good it may be before.

In Fig. 120 is shown an angle joint, dowelled



together as shown by dotted lines. The only difficulty in such a joint as this lies in forcing it together tightly. One way of doing this is by



FIG. 124.

FIG. 123.

screwing on the blocks N and using the cramps. If this is not practicable dovetail keys may be inserted, as shown in Fig. 121. A small space for clearance must be allowed at the ends O, and

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the edges of the keys beveled so that they draw in tightly, when they will force the parts together, and make a very strong job, while even if they are seen when finished, if put in properly, there is nothing unsightly about them. One of the dovetail keys, ready for insertion, is shown in Fig. 122.



Fig. 123 shows the two parts of a mitred secret mortise and tenoned angle joint.

Fig. 124 shows a mitred dovetail angle joint.

Fig. 125 is a mitred secret mortise and tongued angle joint. The tongue is made of hard wood.

CHAPTER V.

SCARFING JOINTS.

In the present chapter our readers are introduced to various methods of splicing heavy timbers as used in carpentry proper as well as for timber structures.

Fig. 126 is the ordinary halving joint as used for splicing wall plates, bonds, etc., which, being supported throughout their entire length, no severe



strain is put upon the joint itself; it is always made flatways of the timber as shown, and is fixed together by nailing only. For some special work each piece is cut at an angle, as shown by dotted lines; this strengthens it somewhat, but it is still only fit for the same purposes as before.

The joint in Fig. 127 is a variation of the former. It is sometimes called a dovetail halving; its object is to resist any tendency to pull the two (or more)

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pieces apart endways, which it does effectually when firmly nailed together, and the weight of a roof is upon it. Failing this, it is very little, if any, stronger than Fig. 126.

In Fig. 128 we have the ordinary splay joint,



which is used for splicing purlins, etc.; also in repairs, such as door-posts, etc.; where, on account of the frame being in position, the splay is the easiest joint to make. This joint is fairly strong when used in suitable positions, such as those mentioned; but must not be used where it will be



subject to great stress or strain, either vertically or horizontally, or it will give way.

One of the most useful joints found in carpentry is that shown in Fig. 129, one only of the parts being shown in Fig. 130. Both pieces are exactly alike, each having both a mortise and tenon, and it is fixed together by draw boring. This joint cannot be used on timber less than 4 in. in thickness, but is suitable for any sizes above this. The complete joint must not be less than 18 inches long



from end to end, and for stout timber it can with advantage be made much longer than this. It is sometimes made so that the tenons are vertical, and at others so that they lie horizontal when



fixed. Which is most suitable must be decided by circumstances; but the width of the tenons should always run the narrow way of the wood—thus, if the latter is placed *edgeways*, the tenons will be horizontal, and if *flatways*, they should be vertical.

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A variation of the above joint is given in Fig. 131; the only difference in the two is the lug A, which is left on the one piece, as in Fig. 132, a corresponding recess being made in the other piece for the lug to fit into. It will be noticed in



Fig. 131 that the recess is made longer than the lug. This is done to admit of a pair of folding wedges being used to tighten up the joint edgeways, as at B. These wedges assist the pins,



both in tightening up the joint and holding it in position when finished.

Both of the foregoing joints are extensively used to splice timbers which are supported at intervals only, such as open-fronted farm buildings, or workshops with open stores under, etc. Figs. 133 and 134 are simple methods for lengthening timbers, such as wall plates or joists when supported by columns or walls.



Fig. 135 is slightly different, the joint being held firmly together by the square hardwood pin which should fit tight when driven in.



Fig. 136 shows another form of joint for the same purpose. The points given to the corresponding ends of the two joists are to resist lateral pressure.



FIG. 136.

This joint is also tightened up by driving in a square hardwood pin.

Fig. 137 is another method of lengthening a wall plate, making a joint that will not pull out.

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Figs. 138 and 139 are joints more suitable for heavy timbers. The joints being secured with long iron bolts and nuts.

Fig. 140 is a joint effected by a tenon in the one part fitting into a mortise of similar width in the



other. This is considered a very good joint when the beam so joined is supported by a column underneath the joint. In such case it may be placed on its narrow side, so that the width of the tongue may be vertical. The pointed part



then strengthens the beam against lateral strain. This method, too, is found very effective when used vertically, there being no possibility of the parts slipping over each other. In this case the sally at the end must be formed by a very obtuse angle, and the edge of the points, and of the parts which receive them, must be worked very true, or there will be a chance of the wood being split by vertical pressure. As an additional safeguard, two bolts and nuts are used.

Fig. 141 shows two pieces of timber butt-jointed and keyed together, while one part of the joint made ready for fitting is given in Fig. 142, and the key is shown in Fig. 143. This should be used for large timbers only, where they are subject to a stretching stress. They will, to a certain extent, withstand side strain, but are liable to



give way, sooner or later, under it. It will be noticed that the heads of key fit loosely endways in their mortises; this gives room for wedges at E, which draw the joint up very tightly endways, and also allow it to be tightened up again at any time.

Fig. 144 shows how to splice an upright post. It is, of course, likely to be useful in repairs more than in new work; but the writer has used it in the latter on some occasions with success. It can only be put together by driving one part on the other sideways, and is fixed with pins.

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the dovetail. This latter is called a "corking" joint, and is set out the same as any other dovetail; that is, the tie is first cut to shape—shown in Fig. 148—then laid on in position, and the plate marked to receive it.



When the tie is "corked" into the plate, and the latter—as well as the tie—tightly pinned to the "teazle" post, we have one of the strongest joints which can be found in the trade.

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The joint shown in section in Fig. 145 will be quite unknown to many carpenters; but it is a very familiar one to those whose work lies in rural districts, and who are used to farm and estate work. F is the top end of a "teazle" post, such as is used to support the plates in



open-fronted buildings. It is tenoned into the plate G, and also into the tie H, one tenon being at right angles to the other, as shown more distinctly in Fig. 146. This is rather a ticklish job for a novice; but when once the principle is mastered, it will be plain enough to understand.



Briefly speaking, the shoulders of the longer tenon I must be the thickness of the plate G longer than those of the tenon K, less the depth which the tie enters the plate. This brings us to Fig. 147, which shows the dovetail in the plate to receive the tie; while Fig. 148 shows the tie cut to fit in

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Fig. 149 shows a three step scarfing joint bored, to be secured with 4 iron bolts.

Figs. 150 and 151 are simple scarfing joints secured with one bolt.



Fig. 152 shows another form of scarfing joint secured with two bolts.

Fig. 153, scarfing joint with three bolts.



Fig. 154, scarfing joint with eight bolts. Fig. 155, scarfing joint with two bolts and two straps.



Figs. 156 to 161 show the joints used in the construction of water-tight bulkheads, cassions, and cofferdams. For deep excavations, the laying

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of foundations for bridge piers and such like work where watertight joints are necessary.

In setting out such joints as the foregoing, or any others when the timber is used direct from



the saw, it is not convenient to use the gauge for the thickness of mortises and tenons. A better plan is to use the iron or steel square, as shown in Fig. 162, as the lines are much straighter than a gauge line on rough timber—consequently, the joints fit better. The squared across lines Cin Fig. 162 show the setting-out of the mortises and tenons in Figs. 129 and 131, and the lines Dshow the thickness of same. The wide part of the square being used in the figure, gives the width of the timber at six inches; if the latter were four inches only, the narrow arm of square would have to be used. While if the timber were five inches, a 14-in. square would be suitable; or, the shoulder could be made one inch only, the tenons being 14 inches.

CIRCULAR WORK.

CHAPTER VI.

CIRCULAR WORK.

We propose in the present chapter to deal with circular work of various kinds, and as this often forms a puzzle for both amateur and professional.



FIG. 163.

we trust that the information given will prove useful to both.

In Fig. 163 is shown a circular frame made up in two thicknesses, the segments being screwed 92 to each other, and the joints crossed in the two layers. This is a very strong method, and has been used by the writer for making circular frames and curbs from two feet to 30 feet in diameter, and from one inch to four inches finished thickness. It is thus applicable for a great variety of work.

The segments can be either short or long, the only important condition being that they must be struck to the proper radius, and cut out truly.



FIG. 164.

Each will then find its own position, as it is screwed to its fellow, until the whole circle is complete.

Fig. 164 shows a board marked out into segments for this kind of work. The longer the boards are the better they will cut up, as it gives more opportunities of cutting one out of the other, as at A.

Fig. 165 shows one of the segments cut out, and Fig. 166 shows how to begin to put the circle together. To continue this, fit another segment to B and C, and screw them to D and E respectively. Then turn the whole over, and fit the

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WOODWORK JOINTS.

next two segments to the ends F and G, screwing them again, and so on until the circle is finished; when, if the segments have been cut out truly, and kept level with each other in screwing them



FIG. 165.

together, the circle will be as true as though struck out and cut in one piece.

When screwing the segments together, do not forget the old maxim, "fasten the ends securely, and the middle will not move far away." That



FIG. 166.

is, keep the screws near the ends of each segment and the space between will take care of itself. Whereas if the ends are not screwed, the wood is apt to curl up, and spoil the work. Fig. 167 shows a circular rim, or curb, made up of segments halved together. This method is suitable for heavy work, where the timbers are of considerable size, no matter if the circle is small or large. The method of building up the circle is somewhat similar to the former one; the halv-



FIG. 167.

ings are cut on the ends of the segments to any shape or bevel, each one being marked so as to fit its fellow, thus making no waste wood. The halvings should be screwed together from both sides, and the result is a strong curb, although not so strong as Fig. 163, owing to the grain of the wood not being crossed in so many places.

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When extra strength is required, circles are sometimes built up of three or even four thicknesses of wood, but the method is the same; the object to have in view is to cross the grain of the wood in the separate layers as much as possible, and to screw together firmly.

Fig. 168 shows one of the segments of Fig. 167 halved ready for screwing together.

In Fig. 169 we have a circular head door frame, square in section, keyed and dowelled together. In forming this, the segments for the head must be fitted together correctly to each other, and



FIG. 168.

also to the straight jambs H. A hardwood key as Fig. 170 is then made for each joint, the parts of which must be slotted and mortised correctly to receive them, allowing space for wedging up at one side of each. Four dowels should also be inserted in each joint, as shown in Fig. 171; these should also be of hard wood, but need not be very long; an inch in each part is sufficient. The position of the dowels can be found by gauging from the face and inside, boring where the gauge marks cross, as already described for dowel joints. A longitudinal section of the joint, as completed, is shown in Fig. 172, the tightening-up wedges being shown. As will be seen in the latter figure, the keys must not be allowed to go through to the face of the frame.



Moulded and rebated frames can be jointed up by the above method, if care be taken in the dowelling; otherwise the moulding will not intersect, and the appearance will be spoilt.





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FIG. 170.

FIG. 171.

It is as well to insert a pin through each thick part of the key (as shown in Fig. 169), to ensure them against withdrawal owing to strain or shrinkage.

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In Fig. 173 we have another method of building up the circular head of a door frame. This is done in three thicknesses, which are arranged to suit the rebate, square, and moulding respectively, as in section Fig. 174. The method of fixing together is the same as for the circle in Fig. 163 in segments, the grain crossing in each case.

The joints K run up straight, so that the two outside segments fix to them at the springing; but as the end of the middle segment would run off to a feather edge if the joints ran up the full thickness, they should be cut back as in Fig. 175, thus allowing a good thickness at the springing.



FIG. 172.

One disadvantage of this method of forming a circular head is the necessity of the screw heads showing, otherwise it is a stronger and easier method than the former one; thus this should be taken into consideration when deciding upon which method to adopt.

Fig. 176 is a small circular head formed in segments, mortised and tenoned together, and fixed by draw-boring. The mortises are of course slotted, and this method is only admissible in small work—that is, when the radius of the circle is small. The larger the timber is in section, the stronger the work. A variation of this last method is to dovetail the segments together, instead of mortise and tenon; but this requires careful work



to get a good fit, and there is great risk of splitting off the corners.

Fig. 177 is the top of a circular head panel door, built up in three thicknesses of board in seg-



FIG. 174.

ments; the middle board of the three is kept narrow, so as to form the groove for the panel (see dotted line) also in section, Fig. 178.

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The top inside segment is cut away to form a mortise for the door mounting and the stiles can be run up in a similar manner to those in Fig. 173, to fix the outside segments to, or the latter can be halved on to the stiles below the springing.

This method of forming a circular head panel door is open to the same objection as the frame in Fig. 173, that is, screws are necessary for



Fig. 176.

fixing it together; otherwise it is a very convenient and ready method.

If the screws are objected to in this connection, door heads can be put together in the same way as the frame head in Fig. 169, using thin keys, and dispensing with the dowels, which will not be reuired, as the keys can be allowed to go through. 7 preferred, dovetail keys can be used instead of those shown; but if they are, do not make them too tight, or the sides of the door will be split, and all holding power will be destroyed.

We think that enough has now been described in connection with joints to enable anyone to



FIG. 178.

know how to proceed in any branch he wishes, although the subject is not exhausted. It would, however, be somewhat complicated to carry it further, and probably not of general interest.

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