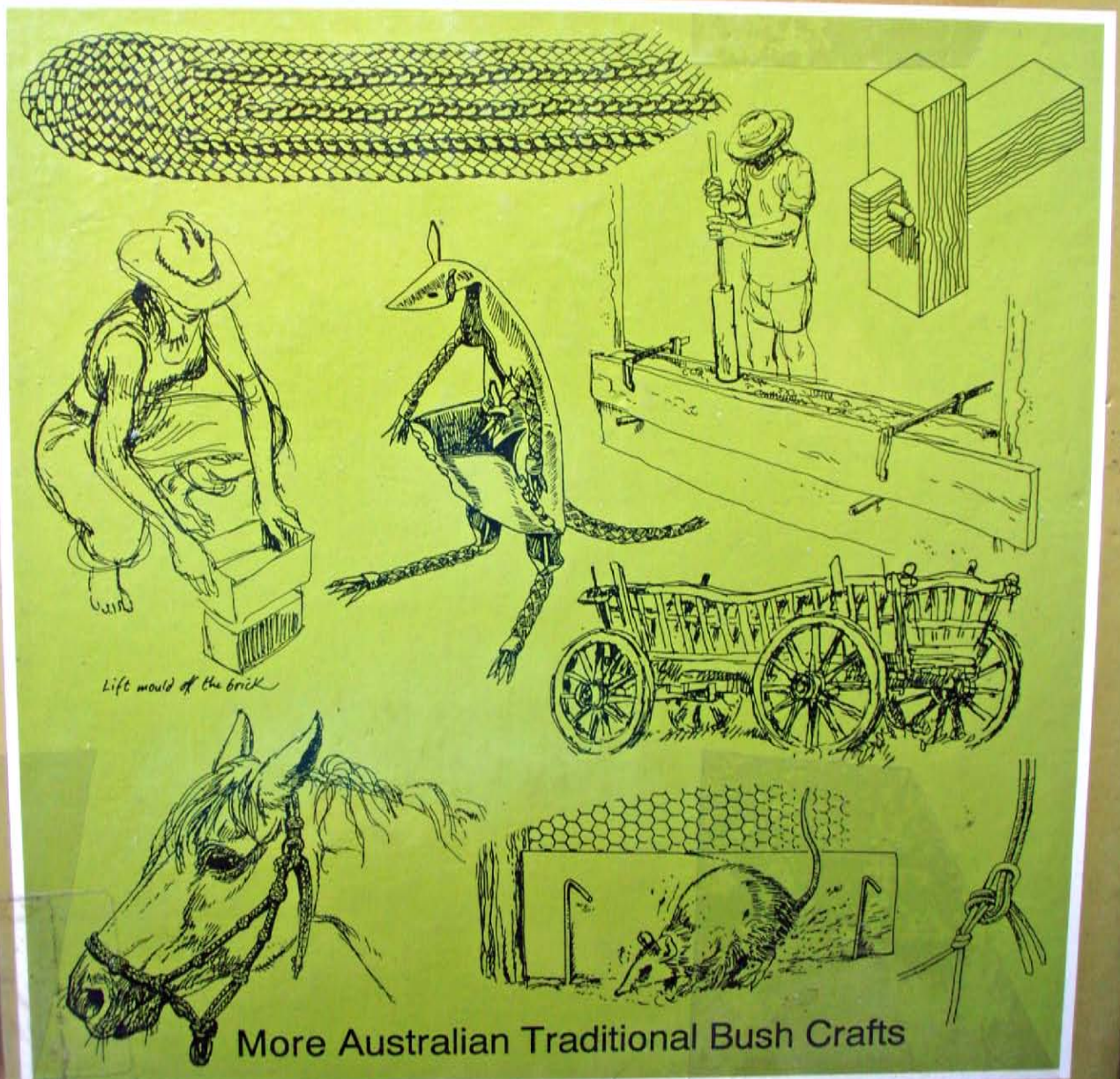
BUSHCRAFT 5

DEVELOPING YOUR SKILLS

Ron Edwards



More Australian Traditional Bush Crafts

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BUSHCRAFT 5

Developing Your Skills

written and illustrated by

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INTRODUCTION

This book differs from the first four in that in concentrates more on the skills of building your own home, in this case using earth as the basic material. Everyone in the world should have the right to build their own home. Not only build their own home but build it just as they want it and free from the interference and dictates of Big Brother.

Strange as it may seem people living under what the West regards as repressive rules, such as in China, actually have the freedom to build their own homes just as they want them while we, living in what we think of as a free country, are controlled by Government officials who have the complete power to tell us what we may and may not do. This lack of freedom is often carried to extremes such as happened in the area of Denmark in Western Australia, where the local council put a spy-chopper in the air to hunt out people living in isolated areas who had dared to try and put a shelter over their heads without the council giving permission.

Why do we let ourselves be ruled in this authoritarian manner? The answer is simple, Governments are by their very nature in the business of controlling the rest of the people, but they in turn are manipulated by other powerful pressure groups. Unfortunately home builders are in a minority and are scattered across the country and so provide a perfect target for officials who wish to show their power, or who think that we are incapable of running our own lives..

If our Government wished to get rid of homelessness and cut down on unemployment they could do so easily by allowing the homeless to purchase crown land at no deposit and low repayments and let them build whatever type of home that they could manage and afford.

Anyone can build a simple home, whether male or female, young or old, experienced or a beginner. All that is needed is a sound grasp of the principles, some simple tools and the will to work.

This book explains the principles of a couple of methods of basic home building, and tells you the techniques, but the will to work must come from yourself. If people in what we regard as poor backward countries can build themselves warm and attractive homes at very little cost then there is no reason why we cannot do exactly the same.

Ron Edwards
Kuranda, Queensland, August 1992.

A Karonda home
Sept 15 '82

There is no reason why any ordinary Australian of today cannot develop the same skills as the early pioneers, and in so doing enrich his or her own life.

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HORSE HEAD COOLER

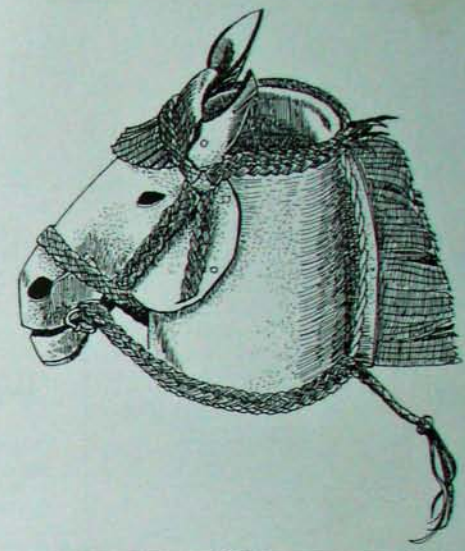
This design is worked around a foam cooler of the type used to hold small bottles or cans, but it can be equally adapted to fit around any sort of container or jar. We have a small version, 90mm high, in our shop which is used to hold pencils. I am not sure when bottle coolers were invented, but they began to be used a lot, at least in the north, in the late 1960s or early 1970s. People soon found that the foam coolers got easily damaged, and also very dirty, and before long some leatherworker hit on the idea of making a leather cover to protect them.

From here it was only one step to decorating them, and this soon turned into quite an art form. In 1975 I actually produced a strange publication showing a variety of designs used on coolers, but as this book had leather pages it was too expensive for anyone to buy and I later chopped up the remaining copies and wrapped them around foam coolers.

Although the original foam coolers were known as coolers, after a while people who make and sell the leather covers for them began to also call these covers coolers, and so today when people talk about coolers they may be referring to the foam liner or to the leather part. Most cooler designs are just impressed into the leather surface, but the one shown here is much more elaborate.

This is only the basic design, a keen plaiter could make a much more elaborate bridle, and a leather worker who enjoyed carving could work more design into the head. But most people will find that this is an interesting project and one that will certainly be commented on.

Fig.1. Cut a strip of leather to go around the container or cooler, the measurements given here work for the standard cooler used in our part of Australia. The height should be 6mm higher than the height of the foam cooler. This is to allow for the final band of stitching at the top and bottom.



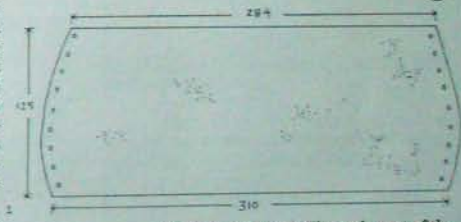
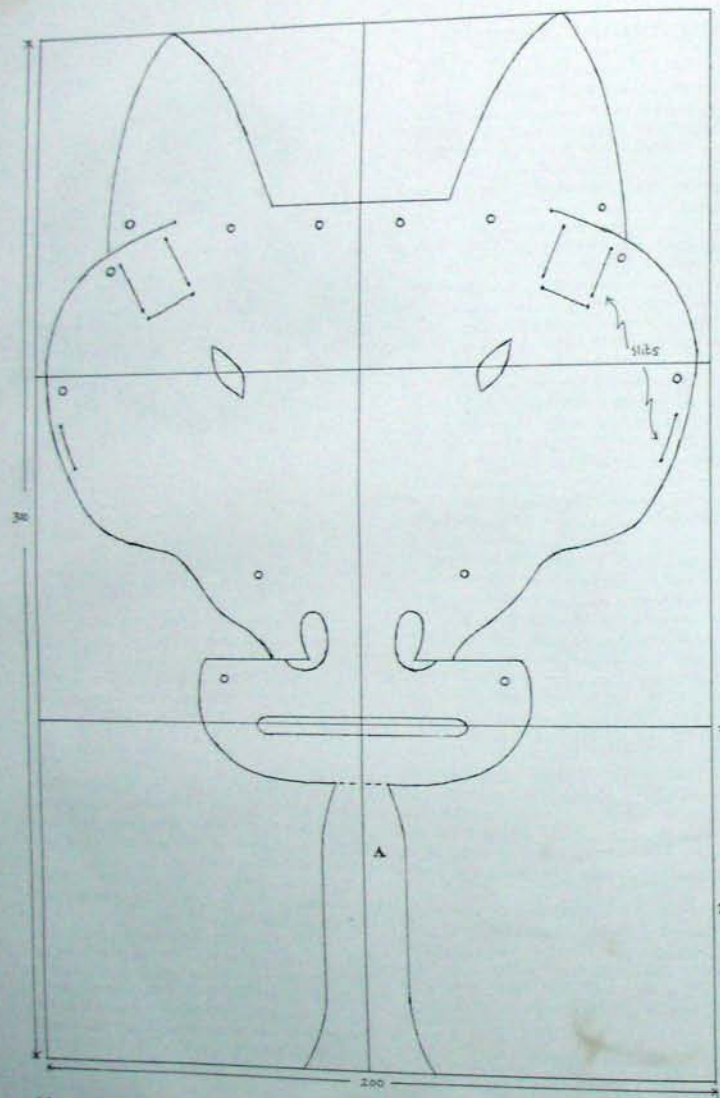


Fig.2. (next page) The main part of the head is cut from 2mm or 3mm leather. The patterns have been reduced in size of fit this page. To enlarge them draw up a set of 100mm squares and then draw in the design free-hand.

An even better idea is to put the patterns into a photocopier that will do enlargements and enlarge them to the correct size.

At the bottom of the pattern is a dotted line, and the section below this marked A can be left out if you wish. Its only purpose is to cover the underside of the chin and it is not normally seen.

If using light coloured leather it is a good idea to darken the edges at this stage, this makes the finished job look better It is also a good time to



2.

polish and wax the leather before you put the various parts together.

Whatever work you do in leather it is always a sensible idea to clean up the job as much as possible before assembling it. A part that has been well waxed and polished will not stain as easily as a piece of raw leather and accidental drops of dye can also be wiped off a waxed surface, but would permanently stain unwaxed leather.

Fig.3. Cut out two of these, one of them mirror fashion. Use kangaroo or similar thin leather. They are placed together to make the main part of the mane.

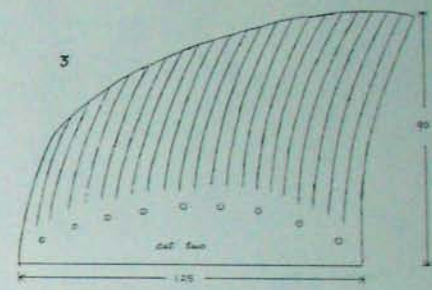
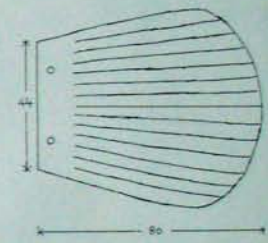


Fig.4. Cut this front of the mane out of the same thin leather. The job looks more attractive if you use dark coloured leather for the mane and bridle and light leather for the neck and head.



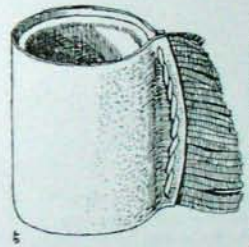


Fig.5. The two larger pieces of mane are put together and stitched into the neck section. The cooler is put inside while this is being done.

Fig.6. The Lazy S stitch is used, and the mane is put in place. The mane is not shown in the sketches as they come from Bush Leatherwork. Use 5mm lace. It takes about 5 times the length to be covered, according to the thickness of the leather.

Fig.7. The various parts can be sewn together, but in this example I have used speedy rivets. The mane is attached as shown.

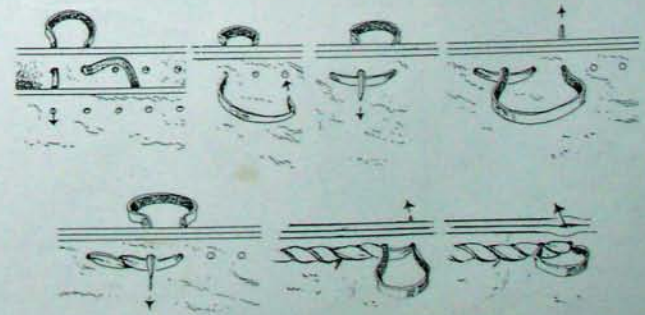


Fig.8. The mane is then bent forward. The ears are curved around and fixed with rivets.

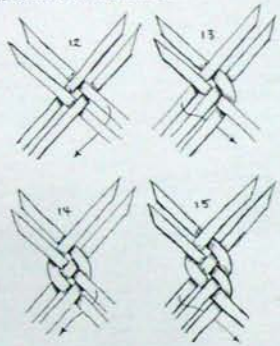
Fig 9. The nose is now bent into position and fixed with rivets.

Fig 10. Remove the cooler from the leather cover and rivet the head to the neck. Put in the top rivets first and swivel the head around to the desired angle before putting in the lower rivets. Replace the cooler.

Fig.11. You will need a bit and two rings for the bridle, all the rings are about 20mm outside diameter. In the example in the sketch at the start of this section the bit is made with Ds, but rings are really better. You may be lucky enough to be able to find some small rings, otherwise they will have to be made from wire. A small piece of wire joins two rings to make the bit.

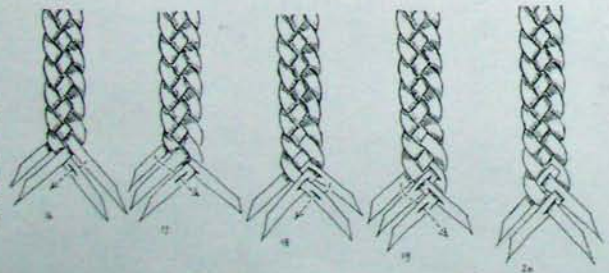
THE BRIDLE

AMOUNT NEEDED. Use 5mm lace, for the short section 4 strands each 1 metre, for the longer section 4 strands each 1.3m.



Figs.12-15. The sections for the bridle are now plaited. Take the four short strands and begin as shown, this is a normal flat 4 plait. Continue until almost all the lace has been used up.

Figs.16-20. The ends can be finished by cutting small slits in the lace and following the sketches.



Figs.21-25. **Changing from a flat plait to a round plait.** The four longer strands are begun in the same way as the shorter ones and a long section of flat 4 plait is worked. When there is enough to go around the horse's head and neck the last 60mm or so is worked as a round plait. The drawings show how the flat plait is changed to a round one.

Figs.25-31. Continue the round plait until almost all the lace has been used up and then tie a crown knot.

Figs.32-35. There are a number of ways of fixing the crown knot firmly, and this one is quite decorative. Each strand is taken around to the right, under the next strand and then up through the middle. Do not pull the first loop tight until all the other strands have been pulled through the centre. This helps when you are looking for the correct place to put the final strand.

Fig.36. When all the strands have been brought through the centre pull the knot firmly together.

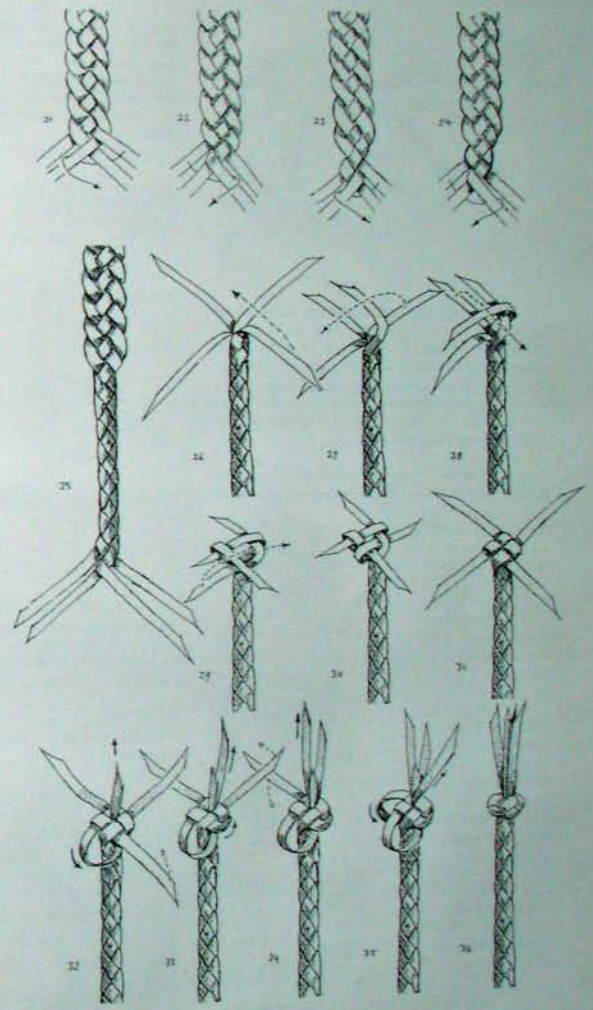


Fig.37. You will now have two lengths of plaited work, each with one end finished in a different way and the other end loose. Take the loose end of the longest piece and feed it through the bit and then through the two slits in the leather as shown, and the same on the other side. Make sure that you slip the bridle rings onto both sections when you are doing this.

Fig.38. Now take the shorter length of plaited work and feed it around the head as shown (the first piece has been left out of this drawing so as to make it clearer). Make sure it goes through the bridle ring in the proper way as shown in the next drawing.

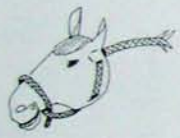
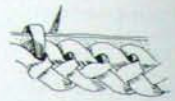


Fig.39. This drawing attempts to explain how the various parts of the bridle come in and out of the slits and then around the ring.

Fig.40. Punch a series of holes to match the rises along the plaiting.

Fig.41. The plaiting is now laced to the leather as shown. You can use an ordinary whip stitch if you wish, but a cordover stitch looks better.



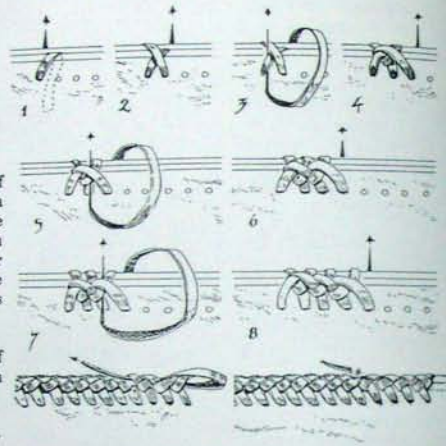
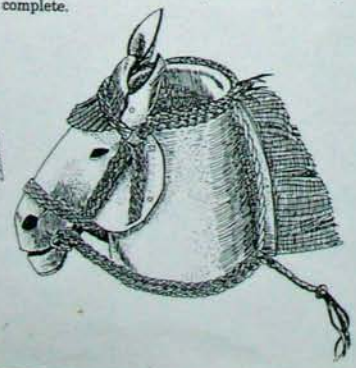


Fig.42. This is the double cordover stitch. The sketches are taken from *Bush Leatherwork* and so do not show the plaited work. It will take about one and a half metres to go around the top and the same for the bottom.

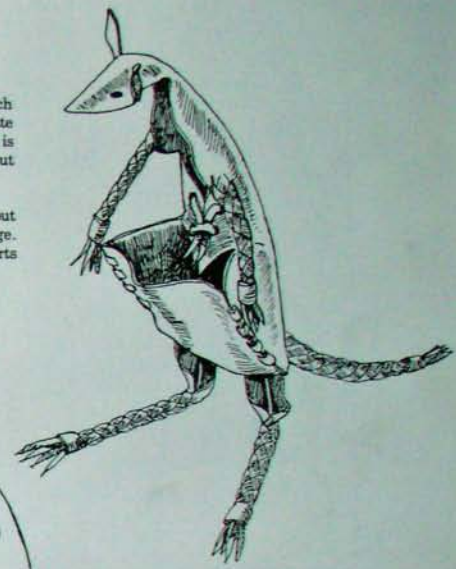
Fig.43. With the plaited work now fixed to the leather both at the top and bottom the job is complete.

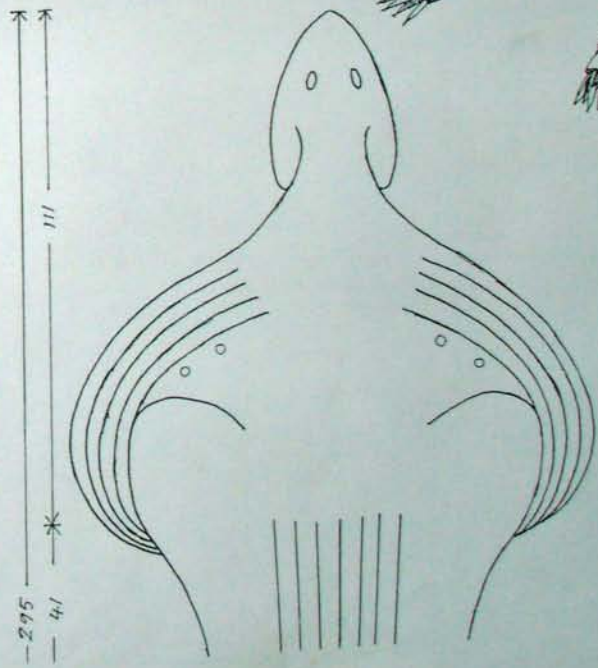


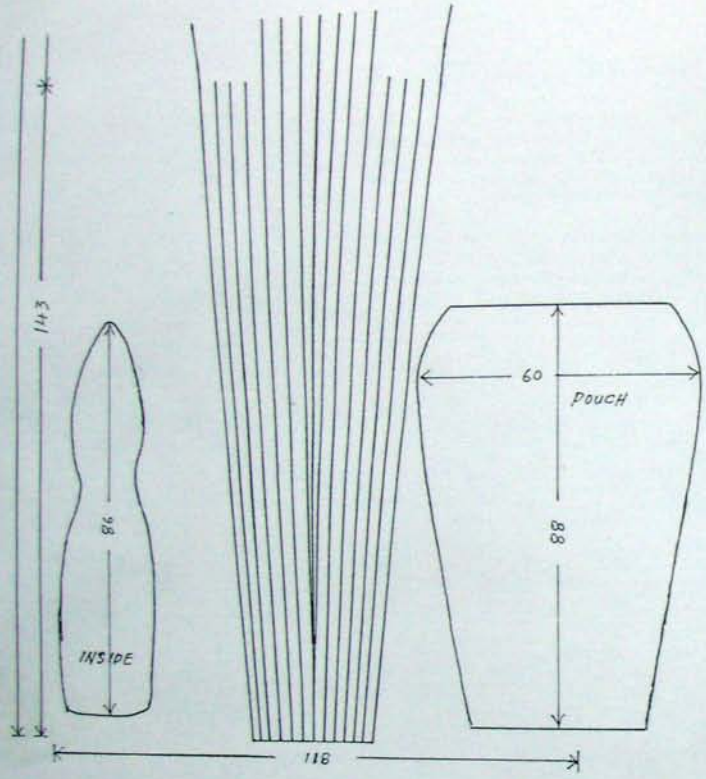
THE CARRY KANGA

This funny little kangaroo has a pouch which can be used to hold paper clips or a cigarette lighter, or it can just be used as an ornament. It is made of kangaroo skin, and once the pattern is cut out it is fairly simple to put together.

Fig.2. This is the pattern, actual size but cut into two pieces in order to fit on the page. Photocopy or trace off both pages and glue the parts together to make a full size pattern.







Figs.3-10. Plait the arms using a simple round 4 plait. Tie the ends together with a piece of strong thread.

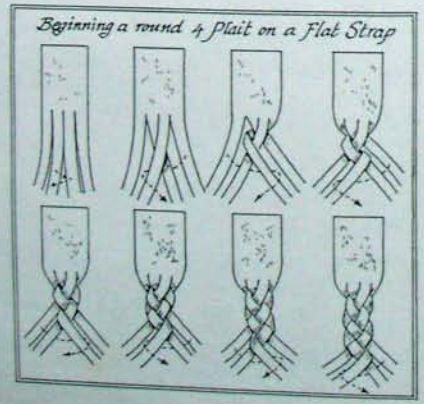


Fig.11. The project will now look like this. At this stage my wife said that it looked like the sort of kangaroo you see in the middle of the road.

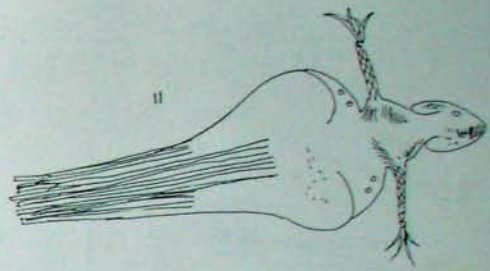
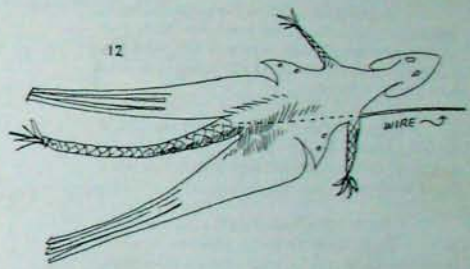


Fig.12. Plait the tail.Get a piece of thin wire and plait around this. Begin with a 6 plait, and then when about half way down let the two shorter strands hang in the middle and continue with a 4 plait. Tie the end up with a thread.



Figs.13-22. This is the 6 plait.

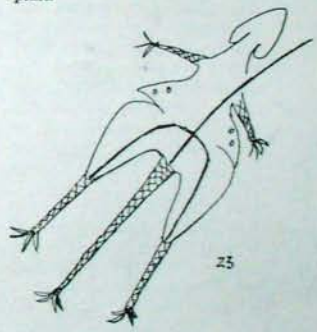
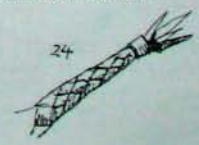
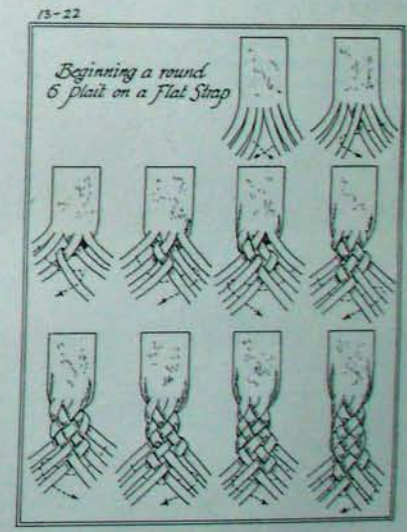


Fig.23. Bend another piece of wire and plait the legs around this with a 4 plait.

Fig.24. Cut some thin strips of lace, thin down the ends and then glue them over the threads that tie the ends of legs, arms and tail. Use any glue that will work on leather, Kwikgrip and Contact Cement are both suitable.





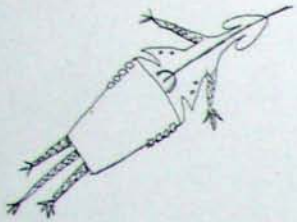
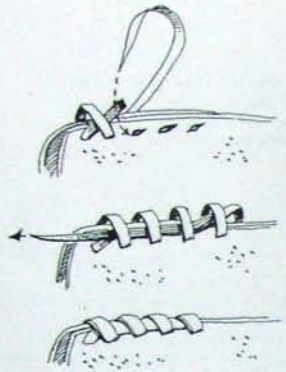


Fig.25. Lace on the pouch.



26-28

Figs.26-28. This is the method used to lace on the pouch. It is better to cut slits rather than punch holes for all laced work with kangaroo skin. however if you do not have a slit punch then use a hole punch.

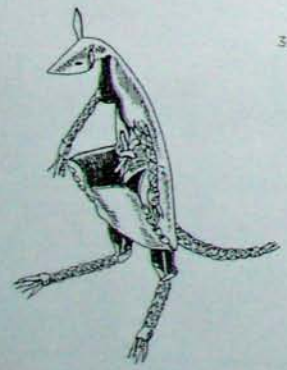
Fig.29. The end of the pouch can just be tucked under. There is no need to fasten it to anything, although you can tie it to one of the wires if you want to.

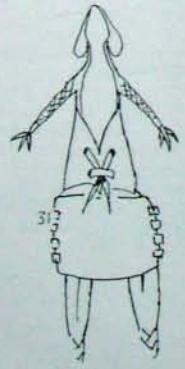
29

Fig.30. The wire from the tail goes right up to the nose. Glue the inside piece over it to hide it. Before the glue dries bend the head down to the right shape.

30

Fig.31. Use a scrap of lace and this simple hitch to tie the waistcoat together. Bend the legs to the right position and the roo is finished.





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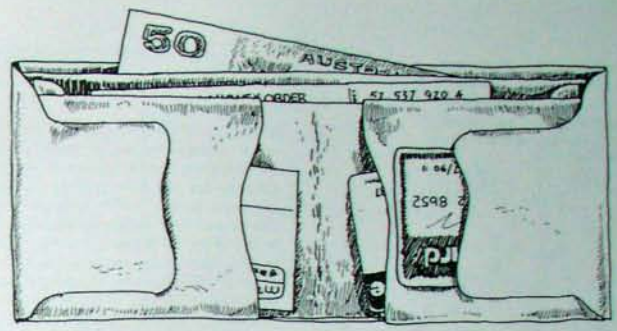


MAGIC WALLET

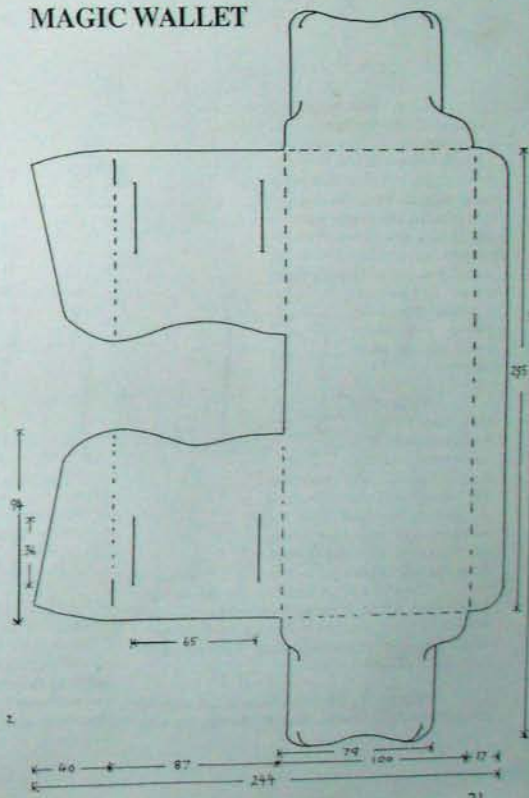
This wallet is made from only three pieces of kangaroo skin and is all folded together without any stitching. I have had one in my pocket now for the past ten or fifteen years and it is still as good as new and will never come apart. I don't know who first thought of the idea but it is very clever.

The wallet is folded in the pocket, but is shown here open.

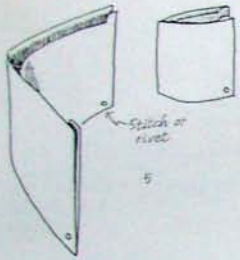
Fig.2. Use the best quality kangaroo for this job if you intend to make it last for a long time. Get the drawing enlarged by photocopier to the correct size, or scale it up by drawing a square around the drawing with a pencil. Divide the square into half and then into quarters and so on until you have a lot of squares drawn over the paper.

Now take a larger sheet of paper and draw a square 370x370mm. Divide this into half and again into quarters and so on the same as the other one. Now you can easily copy the design square by square to the right size.

The whole secret with this wallet is in cutting the leather accurately.



Figs.3&4. These are the two inside pieces. There are holes shown in the corners but do not do anything more than mark where they are to go at this stage.



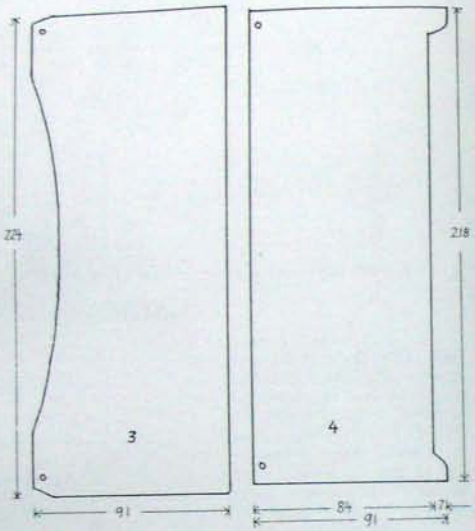


Fig.5. This is a folded wallet, so if you were to join these two pieces of leather together when they were flat on the table one of them would buckle badly when folded. To avoid this you now fold the two pieces together and then mark through at the corners where they are to be joined. You can use speedy rivets or a couple of stitches. The two pieces are only joined at the outer corners.

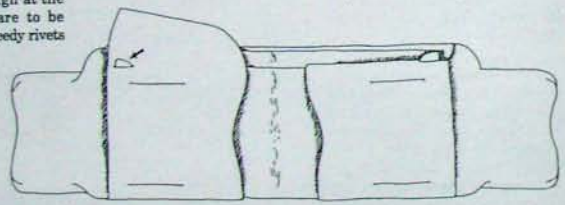


Fig.6. The best way to fold leather like this is to take a small brush or a cotton bud and some water. Wet the leather on the inside along the line to be folded. Fold the leather and run something smooth, such as a bone folder, along the fold to get a good edge.

The leather is folded along the dotted lines shown on the drawing of the pattern. Slip the two insert pieces into the wallet and push the tabs up through the slots as shown by the arrow and then fold the leather over.

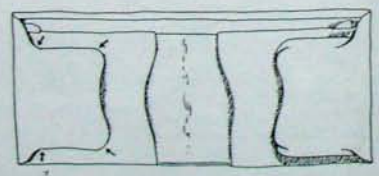


Fig.7. The little cuts made in the edges of the leather act like hooks. They are fed into the slits and hook in at the points marked by the arrows. Do the outer pair first then the ones near the middle. The wallet is now complete.

HEADSTALL WITH FIADOR KNOT

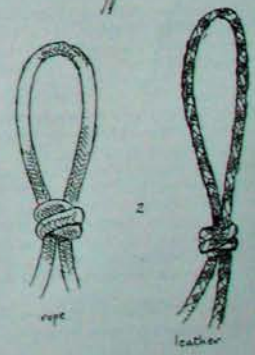
Because this headstall looks rather complex to work they are not very common in our part of north Queensland. A bushman brought a couple into our saddlery recently, but we don't see them all that often. When constructed neatly this is a handsome headstall, both strong and decorative, and for the cost of only a length of rope. The sketch shows one that I made to fit to my old mare, Sugar. I just compared this drawing to one that I did of her to begin the section on making bridles in *More Bush Leatherwork* and I can see how she has aged. Not surprising in view of the fact that she is now over 30.

They are usually made from rope but some years ago I saw one made from plaited kangaroo lace. Although this may sound complicated in fact it takes only as long as it takes to do a rope one plus the time to do a four plait of the right length. See the end of this section for a sketch of the plaited version.

The difference between using rope and leather can be seen in **figure 2.** The loop on the left is formed in rope, the one on the right in plaited leather. (For the sample I used two different colours of lace, a middle and light tan). The plaited one has to be much thinner than the rope one otherwise the knots cannot be pulled up neatly.

ROPE HEADSTALL. For a rope headstall any type of soft rope can be used, but if you are going to spend some time making it then it is better if you use a decent type of rope. The best is a soft braided rope of 10mm in diameter, and this can be bought at a shop that deals with yacht fittings and cordage. A knockabout one can be made from 8mm diameter silver rope.

LEATHER HEADSTALL. If the job is to be plaited you will first need a cord core. The cord should be quite thin, no more than 5mm in diameter, and it should be very flexible, strong and soft. It should also be a braided cord, as smooth as possible.



Around this you plait tightly a four plait, using 4.5 or 5mm lace. The lace should be as thin and flexible as possible and the plaiting must be done smoothly and tightly.

When about half a metre of plaiting has been done try and form up the True-lover's loop (the method is shown a little further on). When properly formed look at the knot to see if any of the cord core is showing through the lacing. If it is then you will have to use either wider lace or a thinner cord for the core, and it is best to find this out right at the start of the job rather than after you have plaited up several metres.

AMOUNT NEEDED. For an average size horse 6 metres (20') of rope or plaited cord will be needed, but best allow a little extra so that it can be adjusted later if necessary. I would suggest that you begin with a rope headstall for practise before trying one in plaited cord.

Fig.3. Fold the rope in three and then straighten out one section so that there is a long and short length as shown.

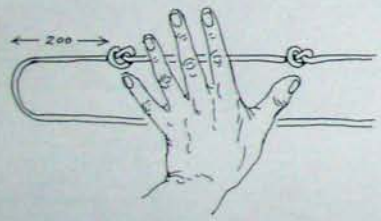


Fig.4&5. Go down the long section about 200mm and tie an overhand knot, then go down a handspan as shown and tie another. I can only give you approximate measurements for this job because thick rope takes up more in the knots and thin cord takes up less. And of course the measurements will also differ according to the size of the horse to be fitted. In the long run you will find it better to start with a little more rope than you need and trim it off later rather than finding that the finished job ends up with one end shorter than the other.

THE FIADOR KNOT.

The most difficult part of the whole job comes now, right at the beginning. The fiador knot has never been very common in Australia, being used only for odd jobs such as this one, but in the United States it has always been an important knot to the cowboy, being an essential part of a popular type of hackamore bridle.

It is supposed to have originated on the Pampas of South America and worked its way north through Mexico and into the Southwest of the United States. Its South American name was Fiador, but the American cowboy often mispronounced this as Theodore.

According to Grant in his *Encyclopedia of Rawhide Braiding* " The fiador is the toughest of all horse gear knots to tie". He gives a brief method of tying it using a board with tacks in it, and also shows another method, but these are illustrated with only two drawings each.

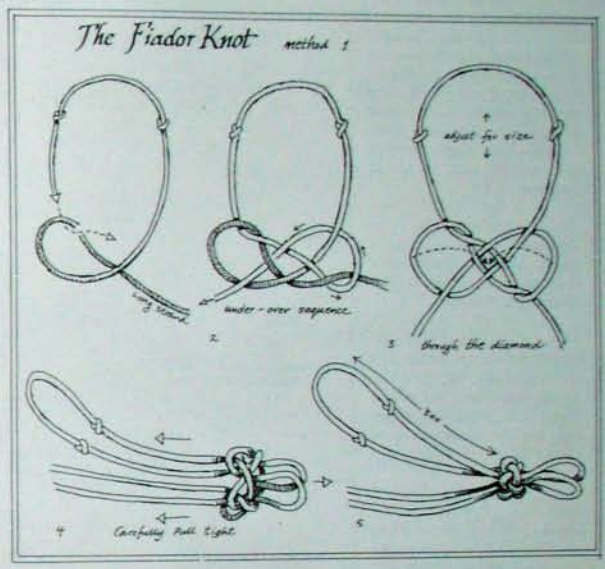
I found both his methods difficult to follow and so had to sit down and work out my own, and they are given here as method 2.

However the world is full of strange coincidences. I had a stall at a local market, and the day after I had prepared these drawings I was there when a friend of mine turned up for a yarn. I was telling him about the knot and showing one of the points with a length of rope when a young fellow, a stranger by the name of Jason Greiner, stopped and watched for a minute, and then said that he knew a better way to tie it!

It turned out that he worked on a horse stud owned by Hugh Sawry, founder of the Stockman's Hall of Fame, and that he had tied hundreds of these headstalls. Taking my length of cord he made up a complete one, including the fiador knot and all the other knots, in less than 10 minutes.

I got him to do it again, and did some sketches as he worked, and then the next day I made up half a dozen headstalls and did drawings of his method.

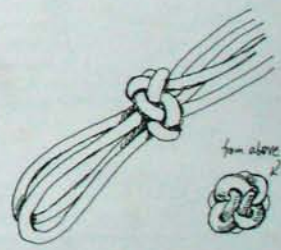
METHOD 1.



I have since met other people who tie the knot in this way and the method is neat and interesting. I suggest that you try it first. You need to lay the rope down on a bench or on the ground and carefully lay it out as shown in the first two drawings.

The trick with it is in the way that you pull the two loops through the diamond hole, as shown in the third drawing. If you do not pull the loops through just right then the knot will not be formed properly.

It is easy to see if the knot is not formed properly because it will not be completely even all the way round. If you look at my sketch here it will give an idea of how the job should look. If you turned it around to show the back part it would look just the same. The small sketch attempts to show what it looks like from both above and below, a series of four interlocking loops.



The second drawing of method 1 has a note under it saying "under-over sequence". This means that you take the long end and you do just that, under one strand over the next, under the next, over the next and so on.

If the knot does not form properly when you pull the loops through then push them back again, spread out the work and just check against this diagram to make sure that all you cords followed the correct under-over sequence. Then have another try. If it still won't work begin once more and try again, when it does come out right you will be surprised how easy it seems.

SIZE OF THE LOOPS. It saves a lot of trouble if you get the loops the right size the first time. The large loop goes around the horse's nose and so it should be large enough for this. In my fig.5 here I have shown it stretched out and it measures about 300mm.

The two small loops that go below the knot are used to fix the tether rope to, so they should be large enough for this job, say about 60-80mm long.

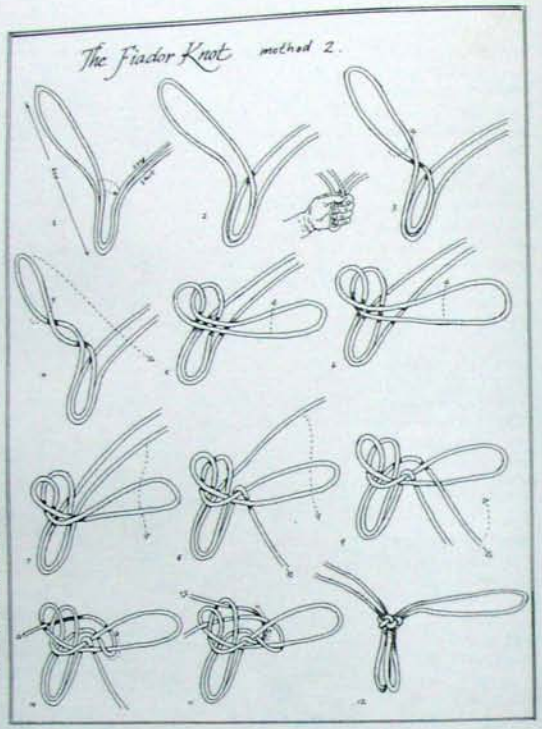
METHOD 2.

In the second method that I am illustrating here you grasp the lower part in one hand and tie the knot with the other. The part that is held in the hand eventually becomes the loops through which the lead rope is attached.

NOTE. It is important when attaching a lead rope later to always put it through both loops or you might upset the knot.

Follow the diagrams closely. When you get to fig.11 the whole thing may look like a dog's breakfast, but at this stage it is carefully pulled together and should end up as shown in the last sketch.

Study the finished knot closely, it should look the same all the way round. When you look at it from above you should see four even loops, and the same when looked at from below. I have illustrated this earlier. If there are any uneven loops then just pull it apart and try again.



HOW TO TIE THE REST OF THE HEADSTALL.

Having got the fiador knot right the rest of the job is fairly straightforward, once you understand what you are doing.

Fig.7. Lay out the job as shown with the long strand at the top and check that the strands are all approximately the right lengths.

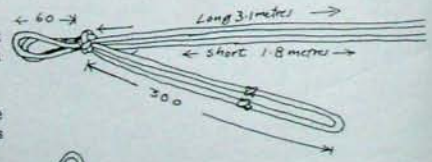


Fig.8 The measurements shown from here on refer to the distance between the knots after they have been tied. Of course you may want to adjust these later for larger or smaller horses, but generally these will be all right for most horses.

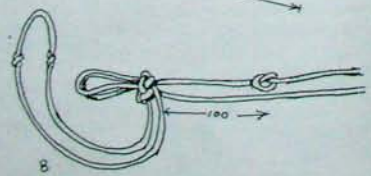
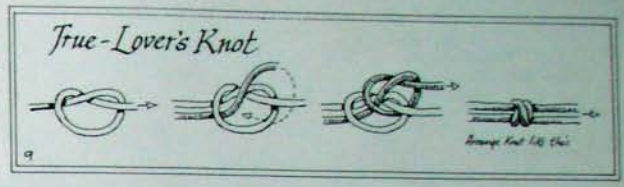
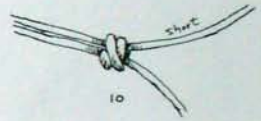


Fig.9. The next knot is called a True-lover's knot. There are at least four different sorts of True-lover's knot as well as a False-lover's knot. They all have one thing in common, being made up of a pair of very simple overhand knots which are linked together so that they cannot come apart.





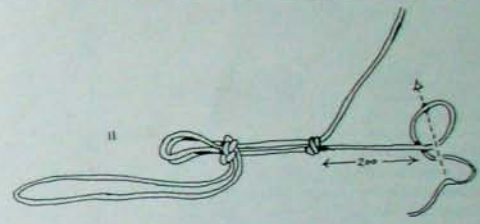
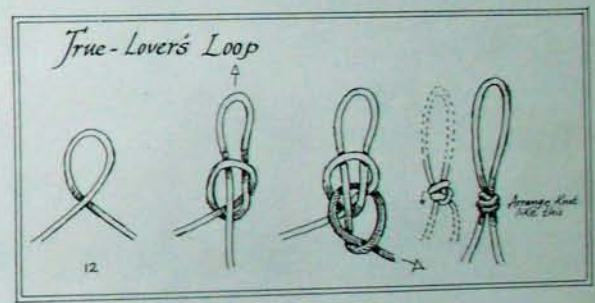


Fig.10. The short piece is on the top.

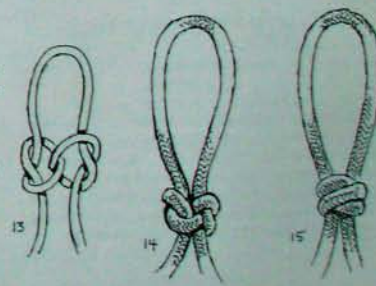
Figs.11&12

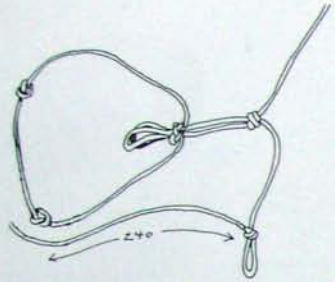
Next a small True-lover's loop is formed, and there are two ways to do this. The first method is the one used in my example. The loop is used to fasten the finished headstall on the horse.



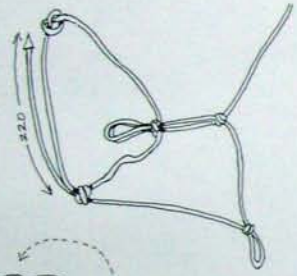
Figs 13 &14. This is another way to tie the loop, and this is actually another version of the True-lover's knot.

Fig.15. Take your pick which you like, the first True-lover's loop is on the right.

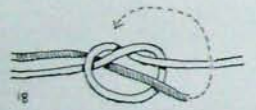


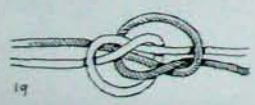


Figs.16 Now move on to the large loop and tie another true-lover's knot as shown in figure 9.

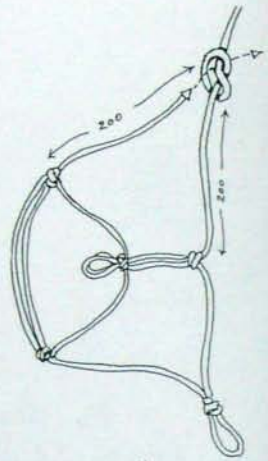


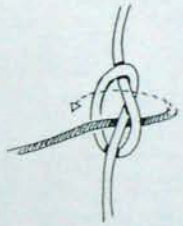
Figs.17 This doubled section forms the noseband of the finished job, so make sure both of the overhand knots are the same distance from the fiador knot.

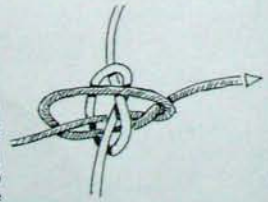




Figs.18-20. The noseband is completed with another true-lover's knot. Although this is the same knot as the first one it may help to follow these sketches rather than have to twist the job around to make it appear the same as the earlier sketches. If you look at fig.20 you will notice that the strands change sides as they go across the noseband.







Figs 21-24. The job is completed with another True-lover's knot. With so many of these True-lover's knots this might be a good present to make for your loved one.

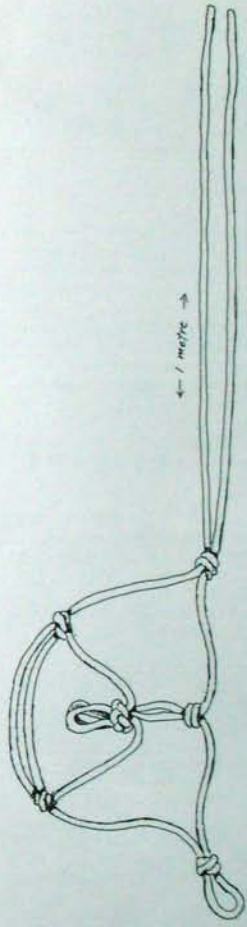


Fig.25. The completed job should look like this, with around a metre of free ends remaining. Check that each piece is the same length as the one opposite otherwise it will not fit properly on the horse. You may have to adjust some of these lengths in order to make a good fit on your own horse.

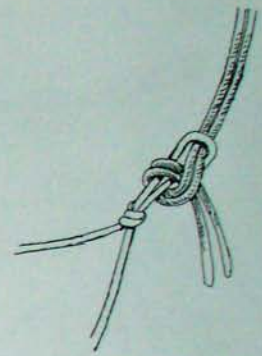


Fig.26. Fasten the headstall on the horse with this simple but effective hitch.

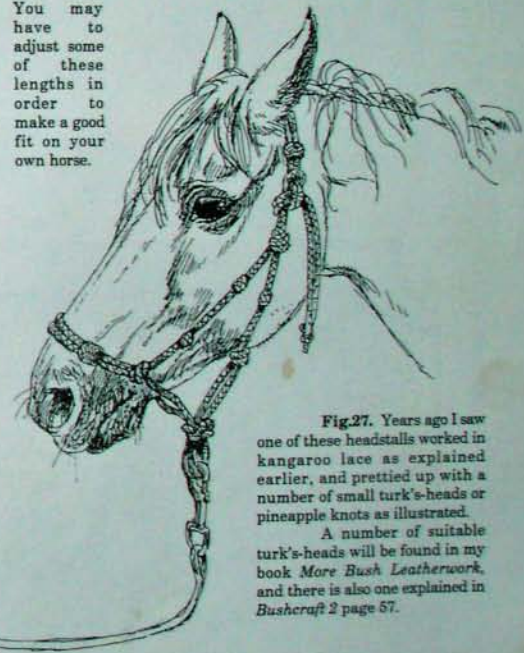
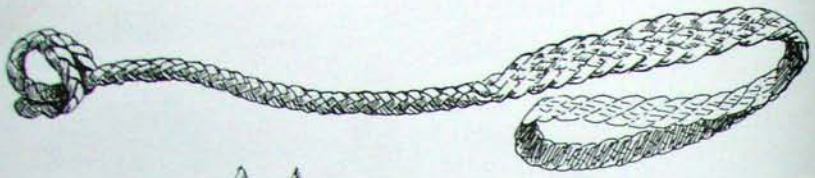


Fig.27. Years ago I saw one of these headstalls worked in kangaroo lace as explained earlier, and prettied up with a number of small turk's-heads or pineapple knots as illustrated.

A number of suitable turk's-heads will be found in my book *More Bush Leatherwork*, and there is also one explained in *Bushcraft* 2 page 57.



PLAITED LEAD

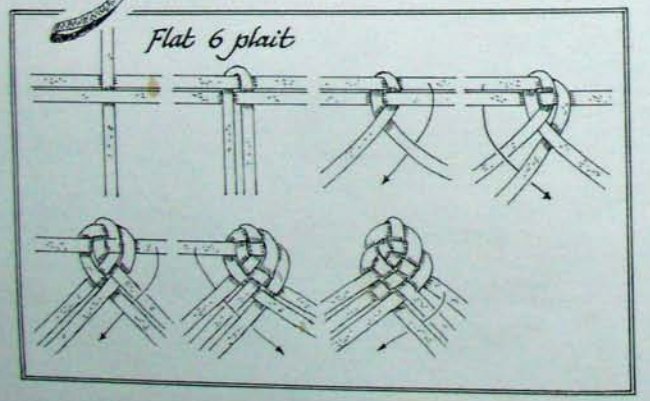
This is a handsome, functional lead, and not very difficult to make, a good project for the beginner who has mastered the various basic plaiting techniques. The sketch at the top of the page is not to scale, I have shortened the whole thing so as to fit it in and you can work out your own required length. Around 1 metre is usual.

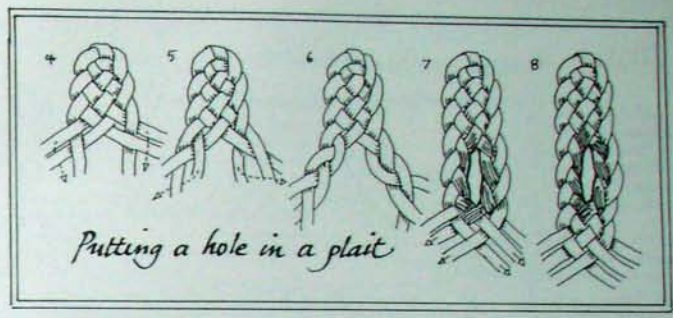
The proportion can be seen better in the sketch showing it attached to a horse, but it works just as well as a dog lead.

AMOUNT NEEDED. You will lose about one quarter to one third in the plaiting, so cut the strands that much longer.

DOG LEAD. For a dog lead the lace will depend on the size of the dog, chunky 4.5mm lace for a medium dog, fine thin 3 mm lace for a small dog.

HORSE LEAD. Kangaroo lace is a bit fine for a horse lead, unless you put a strong core





into it, and if you were to do that then you would be better off doing an eight plait instead of what I have shown here.

If you wish to follow the instructions here then I would suggest that you use steer hide cut to strands of 6mm (quarter inch). You may wish to bevel the edges, or not, it all depends on what sort of finished look you are seeking.

The method is simple. Begin with three long strands and start an ordinary flat 6 plait, divide it into two three plaits and then bring it together again into a flat 6 plait, as illustrated.

You will see that you have now formed a flat tab with an eye in it, and this will form the loop in the finished job. This can be seen on the left side of the drawing at the start.

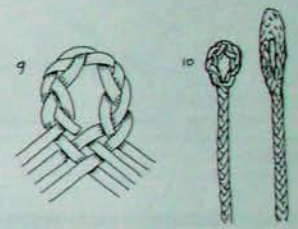
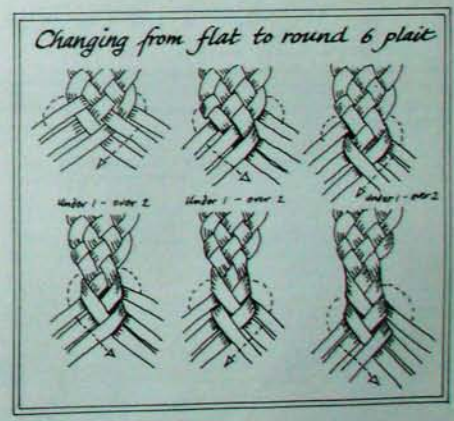


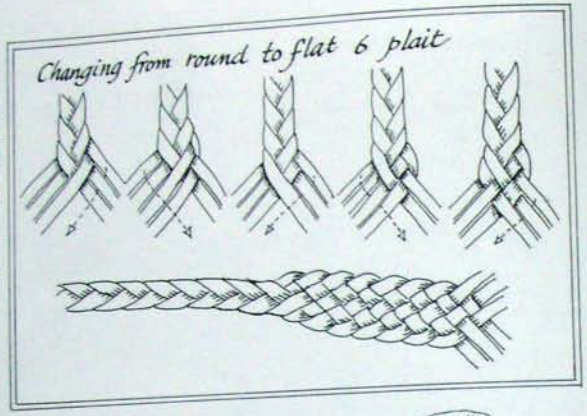
Fig.9. If you don't like the idea of the tab then you can begin the job by simply working a short length of 3 plait and the joining this together as shown. From here you go straight into a round 6 plait.

Fig.10. The left hand sketch shows what the end looks like if done with a 3 plait, the right side shows it done with a tab as described here.

CHANGING FROM FLAT TO ROUND. Fig.11. When you get as far as figure 8 change from a flat 6 plait to a round 6 plait as shown.

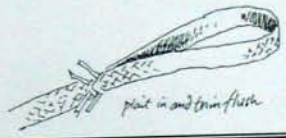


Do as much of the round plait as you want to, say about 700mm, then change to a flat plait. This flat plait can be continued for about 350mm, long enough to form a loop.



FINISHING OFF.

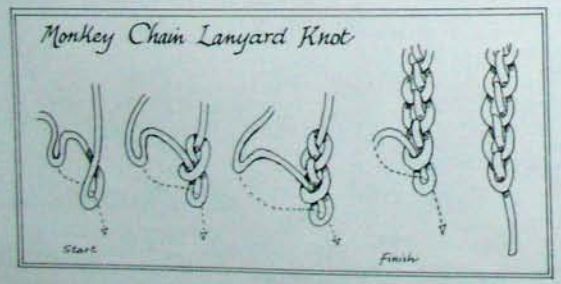
Finally form a loop to put your hand through. This is done by forming the loop and then plaiting the strands back into the job in the same way that you finish a plaited belt. (see page 16)



MONKEY CHAIN LANYARD KNOT.

This is a method of shortening a tether rope so that it can be used as a lead rope, and it also gives a better grip on the rope. This does not shorten the rope as much as the scout coil, 1 metre of rope will be reduced to only 250mm.

To undo it simply pull out the last locking strand and then pull the end and the whole thing will come apart with one tug.



THE SCOUT COIL

A COMBINED TETHER AND LEAD ROPE FOR THE HEADSTALL.

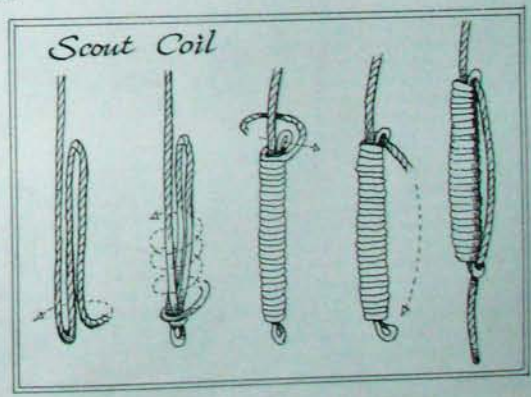
Quite often it is useful to have a lead rope for a horse which can also be used to tether the animal out, in other words a short rope which can be easily turned into a long one when needed.

There are a couple of ways of doing this, and the easiest and fastest is the coil known by a variety of names, but which Ashley, the famous knot expert, called the scout coil.

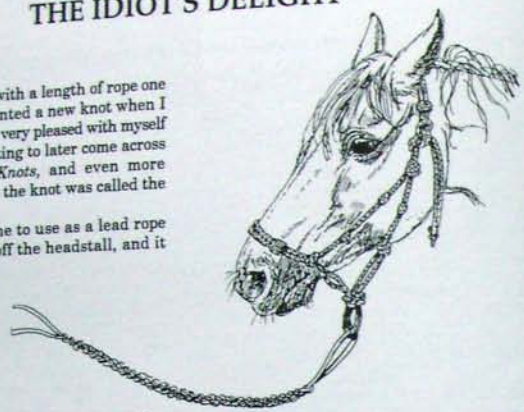
The first four drawings show how it is formed, and it is complete in the fourth drawing. However if you use the coiled section as a handhold there is a good chance of it pulling undone, so the last sketch shows how it is anchored.

This coil will reduce a 3 metre length of rope to 200mm, but of course it can be done with any length of rope.

This coil can sometimes be seen in old photographs of around the Boer War period. In these photos the rope is tied to the bridle rather than the headstall and the free end is left much longer, usually around a metre. This is looped around the horse's neck and tied back onto itself, and in this way the horse can be ridden without having to remove the rope which is always at hand when it is needed.



THE IDIOT'S DELIGHT

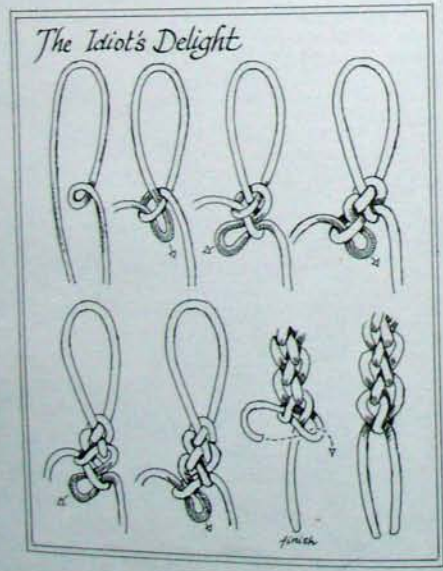


Working away with a length of rope one day I thought I had invented a new knot when I created this method. I felt very pleased with myself and it was rather frustrating to later come across it in Ashley's *Book of Knots*, and even more embarassing to find that the knot was called the Idiot's Delight!

It is a good one to use as a lead rope because it cannot come off the headstall, and it gives a good grip to the hands. It will reduce a 3 metre rope to 1 metre.

Don't forget to put the rope through the loops in the headstall before you start forming the hitch! As you form each loop pull the previous one tight, this makes a neater job.

To undo the rope simply pull out the final two locking strands and then pull both ends and the whole thing will come apart.



MUD BRICK TECHNIQUES

This section was originally issued as a small booklet entitled *Mud Brick Techniques*, and first came out in 1990. Many people who are interested in the subject have been unable to obtain this booklet because bookshops do not like stocking small booklets. They claim that they are hard to display and get lost on the bookshelves. By including it in this volume the information will now be available to everyone. I have also edited the original text and added some new material to it.

METHODS OF BUILDING IN EARTH

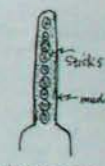
There are quite a number of methods of building in earth and each has its advantages and disadvantages.

COB. Handfuls of mud are simply heaped up to make a wall. The wall can only be built up to a certain height each day and then must be left until it has dried before another layer can be added. I have built a couple of walls in this manner for hen houses and a tractor shed. Its disadvantage is that the final wall tends to be rather rough and uneven and requires a lot of work to finish if you want a neat job.

WATTLE AND DAUB. The method favoured by early miners who wanted a home in a hurry. The roof of the house is supported by stout poles and the space in between the poles is filled in with a screen of thin sticks. These are then covered on both sides with mud and the walls are complete.

I have built in this method, but it only works if you have access to plenty of long thin sticks. The finished walls are much thinner than other earth building methods, but are still quite strong, and there are still examples around the Australian countryside that are over a century old and still as strong as when they were built.

The main disadvantage of wattle and daub in my experience is that termites and other wood eating pests may get into the walls if precautions are not taken in the form of high foundations, and this can lead to a lot of trouble.



POLE MOULD, ETC. There are a number of other methods of working in earth which are both simple and practical but which have not been practised in this country. Pole Mould uses a quickly erected mould of natural round timbers. It is ideal for thick walls and we have used it for stables and other work.

RAMMED BRICKS. These are used in areas where water is short, the weather is dry and the soil suitable. We have used it in special cases where we needed bricks in a hurry and could not wait for normal bricks to dry. In favourable hot dry weather rammed bricks can be used within three or four days of being made.

These and other methods are explained in my book *Mud Brick and Earth Building the Chinese Way*. This book was written to explain how the Chinese methods of earth building can be adapted for use in Australia.

RAMMED EARTH. Sometimes known as pise, this method produces a strong, dense wall, ideal as a load bearing wall or for the lower walls of a two story home. The method is explained later in this book.

MUD BRICK. Mud brick is sometimes called Adobe. Mud brick building is slower than rammed earth. With rammed earth the soil is taken directly from the ground and put into the wall, which means it is only handled once. With mud brick the mud must be handled half a dozen times at least.

However working in rammed earth is also a strenuous activity, while working with mud bricks can be made as easy, or hard, as you wish. Rammed earth tends to be physically demanding and so is suited to the young and fit, but the whole family, irrespective of age or strength, can help in the making of mud bricks.

One of the nicest things about mud brick is that when you are tired you can stop, and whenever you have a few minutes to spare you can always do a little more. No one ever puts in a few minutes working on a cement home, cement has to be prepared before work can commence, and once a

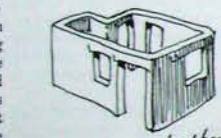
batch has been made work must continue until it is all used up and all the tools and mixer cleaned up. But a few mud bricks can be made or laid at any time, and when you wish to stop you simply wash your hands and walk away.

BUILDING IN MUD BRICK

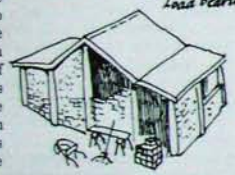
This book is about building in mud brick. As I mentioned above other methods of working in earth are explained in my book *Mud Brick and Earth Building the Chinese Way* which also has a large section on the mud brick methods used in China and this should be read by anyone interested in the subject. This present book sets out to explain how we have adapted various methods for use in Australia, not only the Chinese methods but also those used by our early settlers.

LOAD BEARING WALLS AND SPACE FILLING WALLS

There are two main ways of using mud brick, one is to make load bearing walls which support the roof, the other is to support the roof on a frame of timber poles and use the bricks to fill in the spaces between the poles.



Load bearing



Space filling walls

Whichever method is used the bricks are made and prepared in exactly the same way, the only major difference being that a load bearing wall must be relatively thick in order to support the weight while a space filling wall has to only support itself.

This book deals in particular with space filling walls as these require more complex techniques than load bearing walls. However load bearing walls can be constructed from these same instructions by simply skipping over the sections which deal with space filling techniques. Believe me, both methods are simple and require only sensible adherence to a number of basic rules.

DON'T BE MEAN.

Earth is free so why be mean about it? The Asians worked that out years ago. A good solid well made wall will last for centuries, but if you try to save a bit of time by making the walls just that little bit thinner then you are asking for trouble. In this book I am suggesting using bricks slightly smaller than what is normal in Australia, but using them is such a way that you will produce a thicker than average wall.

Stupid method

I was discussing this with a colleague and speculated that suggesting a smaller dimension brick might be dangerous as there would probably be someone out there silly enough to try and use it not to make a thick wall but by laying them end to end (called stretcher bond) and so creating a very weak and unstable wall. My friend said that even worse than that he has actually seen people so mean about their bricks that they built walls by standing the bricks on their edges! This could only be regarded as criminally dangerous, and about as sensible as using string to fasten the roof rather than nails.

THE LASTING POWER OF EARTH

A properly made earth wall with a roof over it will last forever. In very dry areas even the loss of the roof will not instantly cause the collapse of the wall. Out along the old Silk Road that ran from China to the West I have seen the remains of forts, watchtowers and walls, abandoned centuries ago but still recognisable. The city of Gaochang was abandoned a thousand years ago but some walls still remain above head height.

Protected by a roof there is nothing at all to cause an earth wall to deteriorate. If you were to bury an earth house in the ground it would still remain in the same form, and this was proven to me when I was shown a section of the Great Wall, built in the Han dynasty of mud brick two thousand years ago and later covered by earth from the hills. Work on a modern road cutting had revealed the wall and each brick was still clearly to be seen and with the mud mortar in between.

The roof over an earth wall does not have to be all that wide. Rain hitting the top of a wall will soon destroy it but rain hitting the side will have little effect. I have proved this in my own garden.Ten years ago I built a couple of small sections of wall out in the garden and away from

the building just to see how they would be effected by the heavy tropical storms that we get and the seemingly endless rains of the monsoon season.

Both walls were covered by a narrow capping of cement, otherwise they would not have outlasted the first big storm. This capping did not have much of an overhang, 50mm on one section, none on the other. One wall was painted with a white cement paint, the other left raw.

Ten years later and ferns are growing on the raw wall and the paint is falling off the the other wall, but both are as strong as when they were built.

By contrast I built a similar wall recently but did not get around to putting a capping on the top, intending to take it up a little higher. After two days of light rain and one day of heavy rain this wall had collapsed at either end and eroded along the rest of the upper section from about 240mm wide to less than 50mm.

There are earth buildings in Australia over a hundred years old that should be still as good as new in another hundred years time. Properly used earth is just about the most durable building method available.

EARTHQUAKES

Recently I built a small building of mud brick according to the methods that have been used in Australia for the past century. A week ago we heard on the news about the Newcastle earthquake and I began to rethink my whole approach to the subject. If solidly built brick and stone churches cracked and moved what would the effect be on walls such as I had just constructed?

Brick, stone and earth walls all depend for their solidity on one thing, the stability of the earth. Move the earth enough and they will all tumble down.

I had built the walls in a manner known as stretcher bond (the various bonds are described later in more detail), because up till this time in Australia we have not really thought about earthquakes when building a house. In the light of the Newcastle disaster I would now strongly recommend using a bond that is locked into a more solid mass, and these are described later.

In *Mud Brick and Earth Building the Chinese Way* I show details of timber framework used in mud brick buildings in earthquake zones. In these areas a timber framework is always preferred. One old farmer told me that they had a saying about earthquakes which went "Though the walls may fall yet the house will stand". They built their homes on a timber frame that was well locked together so that it would not fall apart during a tremor. If the earthquake was severe enough some of the mud brick walls would fall down, but the frame would still remain upright supporting the roof. This is one important advantage that the frame building has over a home built of load bearing walls.

The other important advantage is that once the roof has been put in place the task of building the walls can take place in the shade and without having to worry about the weather. This has been the greatest advantage to us over the years.

THE FOUR DANGERS TO AN EARTH WALL.

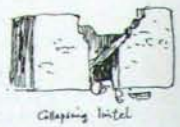
An earth wall will only last forever if it is well and properly made, but there are four main dangers which must be avoided at all costs.

1. WET FEET. If moisture can lay at the foot of a wall for long enough the wall will collapse. This is discussed under the section on foundations.

2. WET TOP. If you are building walls to fill space then you will be working under the roof and so the walls will be protected from above, but if you are building a load bearing wall then great care must be taken to keep the very top of it dry at all times. (Rain on the sides is of no consequence). If covering sheets blow away and the top does get damp then work must stop until it has all dried out thoroughly. Failure to do this can result in lots of problems.

3. WALLS MUST BE VERTICAL. There is enormous weight in an earth wall and gravity is what keeps it in place. A leaning wall is on its way to falling over. Forty years ago, when I first became interested in earth building, my wife and I bought a block of land at Eltham, Vic, and began to build an mud brick home. I will never forget one of our neighbours who had built a very high and long wall which was to become the front of his home. He was mean with bricks, making a wall much too narrow for its height, and in addition had been very casual about getting the wall perfectly upright. As a result we woke one Sunday to see his entire wall collapsed and spread out onto the road. Months of weekend work gone in a few seconds. Always remember that upright is essential.

4. WALLS BEING BLOWN APART BY ROT AND RUST. In many parts of rural South Australia there are the remains of old abandoned earth homes that could still be made habitable except for the fact that walls have collapsed above the doors and windows. Once a building is deserted termites can move in, or wood rot can go on unchecked, and in time the timber lintels above doors and windows may collapse bringing down the earth or stone walls above them.



In addition if there are heavy iron fittings set into the walls in areas that get a lot of rain and remain damp then there is always the chance of the metal beginning to rust, and as it rusts it expands and so in time may crack the walls.

None of these problems will occur if proper construction and maintenance is carried out, but it is a good idea to be aware of them.

DO NOT PRACTISE EXCESSIVE SPRING CLEANING

I have written this before, but it is always worth repeating. When you announce to your friends that you are going to build in earth they will almost invariably ask "But what will happen to the walls when it rains?". I have a stock answer to this which is nearly as silly as the question.

I say "If you are one of those people who are extremely tidy and do a lot of spring cleaning then you could be in trouble, especially if you regularly remove your roof in order to dust the walls. However if you are a normal sort of person and leave the roof on then you will have no problems".

The time of danger to mud bricks is from when you begin to make them until the time that you get them under the roof. Once there, and with dry foundations, your bricks will last forever.

INSECTS AND EARTH WALLS

Odd as it may seem insects do not seem to be any problem with earth walls and I cannot recall seeing any examples of insects boring into walls. Even the northern termite does not attempt to attack them, nor do mice seem to try and burrow through.

FIRE AND FLOOD

Have you ever tried to set fire to a lump of earth? When the wooden upper parts of the pub at Genoa, Victoria, burned down earlier this century the owners rebuilt on the earth walls, which had not been affected. In fact if anything a fire would tend to harden the walls.

As for floods, they are an obvious danger to earth buildings, and yet there are reports of buildings in Victoria having gone through floods when the water came half way up the walls and yet escaping damage. This could only happen in cases where the walls were very thick and the water did not rise for any great length of time.

SELECTING THE SOIL

One of the beginners worries seems to be deciding whether or not the earth on their land is suitable for earth building. Don't worry, unless you live on the beach with sand all around you then it is almost certain that your soil will be suitable for some form of earth building.

The cry most often heard is "My land is just clay", and my stock answer to that is "How lucky you are, you will be able to sell it at great profit to a brick making company". The fact is that deposits of pure clay are not all that common, what most people have is a soil with a high clay content, and that is quite a different thing.

There are various tests to establish what the proportion of clay to sand is in your soil, and these may be found in my other books. However for most purposes you can forget about these tests, the most practical way to discover whether or not your soil is suitable is to make a few sample bricks.

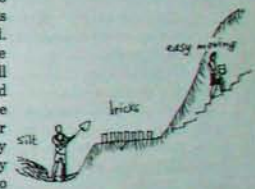
If you think making a few bricks is too much of a bother then you have found out something very important right at the beginning of the job, and that is that you should forget about earth building right away and start drawing up different plans. If you have not dirtied this book too much you can sell it to a friend and so not be out of pocket.

For those who have decided to read on let us consider the situation. In order to build a house you will be making at least a thousand bricks. To make a dozen trial ones at the start is surely nothing to worry about, and in any case if they are any good they can be used.

Recently I wanted to prepare some figures on the relative times required to make and lay bricks and so I made 35 bricks. Although the soil looked excellent material in fact it contained a high proportion of a very fine sand that was almost like powder. As a result it was not until the bricks had dried that it became apparent that they were too soft to use in the walls of a house. However, not to worry, they went into the walls of a garden shed, and once in place turned out to be quite satisfactory. Interestingly enough we then dug down another 300mm and found good brick making soil and then, a metre below this, red clay which had to be mixed with the top sandy material in order to make bricks. In each case test bricks were made until the right soil or the right mixture of different soils were discovered.

A few years ago we were cleaning out a dam that had become silted up. It was in a very steep gully and so we could not get a vehicle near it and all the silt had to be brought up by hand. Wet mud in buckets is very heavy so I hit on the idea of making bricks on flat section of the bottom of the dam right next to the mud hole. My reasoning was this, whether the bricks worked as bricks or not, the very making of them would result in the drying out of the water content, and this meant that we would be carrying up only half the weight that we would have handled in bringing up wet mud.

So a hundred or two bricks were made, and they were not really very good looking bricks, the silt in the bottom of the dam contained a fair bit of sand and so they were a bit crumbly. However the aim of eliminating the water worked and we found it much easier to carry up dry bricks rather than mud. The bricks were later used in a wall that was not load bearing, and once plastered over were perfectly good. In this way we combined two jobs in one.



HOW TO TEST A TEST BRICK

Once the Government gets involved in earth building everything begins to go wrong. Some authorities test mud bricks by squirting a jet of water at them and seeing how long it takes for the brick to dissolve. This is about as sensible as testing the paint of automobiles by pouring acid on them. We all know that the paint will dissolve, but what is proved by the exercise?

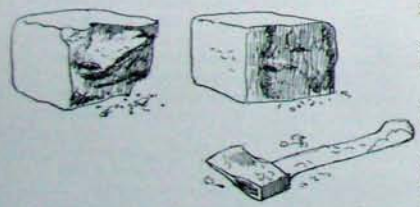
Cars do not have acid poured on them in the natural course of things, and mud dwellings are not subject to direct jets of water. We experienced a small cyclone here a while back, and in this case the wind came from anunexpectedquarter and the rain slammed against a couple of mud brick walls which had only very small roof overhangs of around 250mm. The force of the rain was such that it came in through the gaps between the windows and doors, tiny as they were, and we had to work

constantly to mop it up from the floor. The combination of wind and rain brought down hundreds of large trees throughout the city of Cairns, but the earth walls showed not the slightest effects.

You do not test bricks by squirting water at them, but you do test them. The easiest test is to kick them, if you dislocate your toe you have a good brick. I shouldn't joke about this because at present I have a black fingernail caused when stacking bricks and swinging a brick into place too closely to its neighbour. They were good solid bricks.

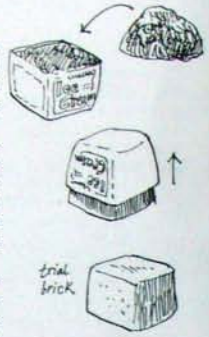
The most simple test is to take a tomahawk and break a brick in two. In the course of building you will need many half bricks so you are not losing anything. If the brick breaks cleanly then you have a good brick (if the brick contains a lot of straw it may not break all that cleanly, but even so an examination of the broken surface will show if it was a good break).

If the brick breaks into more than two pieces and if the smaller pieces are crumbly then your soil mixture is not good. Examine the broken surfaces, if there are bands of different colours or textures then the fault may be that you have not properly mixed the soil. In this case do a proper mix and try again. However if the brick is crumbly and of an even colour then you will have to add some other soil with a higher clay content to it.



MAKING TEST BRICKS

If you are right at the beginning of your project and have not even got around to making brick moulds there is still no problem. Take some of the chosen soil, mix it with water into a muddy consistency and put it into a square plastic 4 litre icecream container or similar object, the exact size is not important except that the closer it is to a brick size the better.



There is no need to prepare the container in any way, just put the mud in and then turn it upside on the ground and lift the mould off, just as a kid makes a sand castle.

Make a few of these bricks and let them dry. As they will be smaller than a normal brick they will dry so much faster and so you will soon be able to see whether or not your soil is going to make a good brick. We once made an incinerator out of such test bricks and it worked quite well.

STRAW IN THE MUD

Some people talk about straw in the mud as if it was some sort of secret magic. The Chinese are much more matter of fact about it, if straw is available they use it, if there is none then they make bricks without. Either way it does not stop them making bricks.

Soils that have a very high clay content tend to crack as they dry. If these are only surface cracks there is no problem, but sometimes the cracks can be wide enough to damage the brick.

There are two ways to treat this problem, and straw is one of them. Chopped lengths of straw 100-200 mm long, mixed in with the mud will act as a series of small reinforcing strands and so prevent a brick from cracking badly.

If you cannot obtain straw then some sandy soil must be mixed with the clay until a mixture is arrived at that will not crack badly.

Cracking can also be controlled to some extent by the way that the bricks are dried and this is discussed later.

If you take a brick that has been made of good quality soil but has been made without straw and drop it on a cement floor it will break. A brick of the same soil but with straw in it may crack but will not necessarily break. Therefore bricks with straw can be given much rougher treatment around the work site. However once either of these bricks has been built into the wall the straw factor does not really become very important.

The exception to this is that if a brick is put in a situation where it will get a lot of direct water on it (and this should not happen) then the brick with the high straw content will erode slower than the one without.

SELECTING THE SITE FOR BRICKMAKING

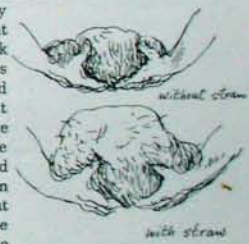
Having made a few test bricks and decided that you like the process and that the bricks are going to work for you the next step is to seriously plan the operation.

One person should be able to comfortably make one hundred bricks in a day. If you do not think things through properly then this can easily be reduced to fifty bricks a day, and so the job is going to take twice as long for the same amount of work. Chinese farmers plan their brick making very well and so can make 250 and more bricks in a day, but they have been doing it all their lives.

There is a lot of footwork in making bricks, and if you can eliminate just half your steps then you will considerably speed up production. If you can lessen the number of times that you have to stand up and squat down this will also contribute to the speed, and if you can make your hand movements efficient this will add a little extra again to the speed.

STRAW MAKES FASTER BRICKS

One very positive effect that straw has in brick making, besides those mentioned above, is that it helps speed up the job. If you are working with mud that has no straw in it you will find that it may take three handfuls to fill the mould. If the mixture has lots of long strands of straw in it then you will be able to fill the mould with just two handfuls, speeding up the process by 50% in so doing.



SOIL TO THE SITE

Every home site is different and so no firm rules about planning can be given, only suggestions that you may be able to adapt. For instance if you have good soil all over the site then the best place to get the soil is from a slope next to a flat area so that you can pull down soil rather than have to lift it up.

TOPSOIL

Topsoil is for growing vegetables, not for making bricks, and in any case topsoil in Australia is a valuable substance and should not be wasted. So in planning your soil heap you must decide where the topsoil is going to go and where your brick making soil is going to come from.

Soils can vary very greatly from one area to another. On a recent job we found sandy soil not suitable for bricks only fifty metres from heavy clay soil that tended to crack as it dried. Mixed together they made ideal bricks. This is what you establish with your test bricks, trying out different mixtures.

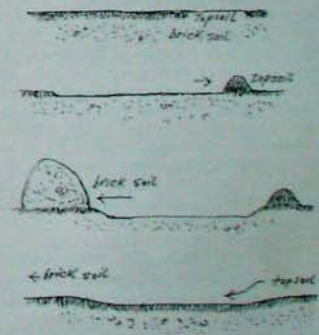
MECHANICAL EXCAVATORS

Early in the piece you will have to decide whether or not you are going to use mechanical excavators in order to obtain your earth. Sometimes the earth can be obtained as a by-product of some other process, for instance we built a house with soil obtained from digging a swimming pool.

Recently I had a backhoe in making a track and before he left asked him to get me some soil for earth building.

We chose a spot convenient to the job and he dug a hole as deep as a country dunny and soon made a heap of dirt big enough for our purposes. We then filled this from a mound of sandy soil a short distance away that was of no use for earth building. In this way we ended up with no hole but a heap of earth of the right type and in the right place.

On another occasion we also used a backhoe, but this time we got him to first scrape the top soil of a reasonably large area and put it to one side.



Having done this he then scraped up all the earth building material that we needed, and in so doing lowered the area by about 250-300mm, but without making any holes. Having pushed this close to the job he then spread the topsoil back over the area. As a result we had all the earth that we needed but there was no sign of where it had come from.

Sometimes earth can be obtained for nothing, we once got a few truck loads from council workers who were scraping the edges of a road close by. They were pleased to dump it at our site as it saved them having to drive some distance to get rid of it.

HEAPS NOT HOLES

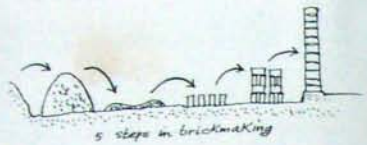
It is always better to get your earth from a heap rather than a hole as this saves a lot of lifting. Whether the heap has been made by the use of a mechanical excavator or whether you are digting by hand into a slope, either way is better than standing in a hole lifting soil up to ground level.

PLAN EVERY MOVE

Every brickmaking site differs to the next so it is rather pointless giving plans for the perfect site if they do not in any way match your own situation. Some sites afford lots of space, in others everything must work around obstacles. On a sloping site things have to be moved in a different way to how they can be handled on a level site. Even nearby banks of trees have to be considered because the shade will affect the drying time of the bricks. Small hollows must also be avoided because of the danger of flooding during sudden storms.

So although I can offer suggestions it is up to you to plan your own brickmaking site according to your own conditions. The sequence is as follows,

from the ground to the heap -
from the heap to the mixing area -
from the mixing area to brickmaking area -
from the brickmaking area to stacking area-
from the stacking area to the house site -
from the house site into the walls.



Each of these moves affects the speed of your brickmaking and so let us look at them in turn.

GROUND TO HEAP

This has been discussed above, sometimes the earth can be obtained close to where the heap will be, at other times you will have to move it to the heap. If you are moving it by hand then you will probably not use a heap at all but take it straight from the ground to the mixing area.

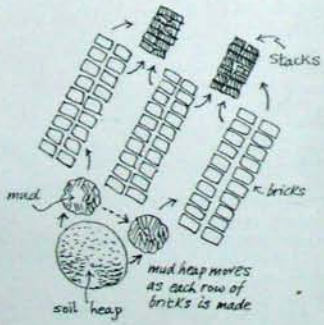
HEAP TO MIXING AREA.

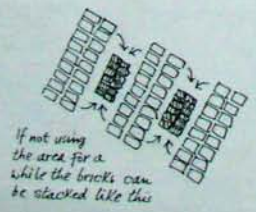
These should be as close as possible, in fact almost touching.

MIXING AREA TO BRICK MAKING AREA.

This is the part that requires the greatest amount of planning and it is here that you can halve your labour or double the amount of work that you will have to do.

Once the bricks have been made they will remain in the same space for at least three days. You will not be able to move your heap, and will not want to move the mixing area, so the whole area



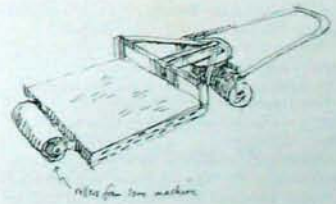


must be planned in such a way that you can comfortably accomodate three days brick making.

It is at this stage that you will have to decide how you are going to move the mud from the mixing area to where the brick is to be made. Do not even consider doing this by walking along from heap to mould with a shovelful of mud. We have tried different methods and all are worth looking at.

A wheelbarrow is the most obvious, but it has one disadvantage in that you have to constantly stand up and crouch down as you work. At one time we got over this by using a trolley with small wheels which meant that the mud was less than 300mm from the ground. This was a much better idea and meant that the brick maker did not have to stand up and down all the time. Recently we obtained a small two wheeled barrow that is ideal for the job, being both stable and low to the ground. If you decide to use one of these weigh a few samples of your earth and bricks so that you do not overload it, ours is marked as having a limit of 70kg.

The most simple idea of all is to throw the mud onto a large sack or square of very heavy canvas and then drag it along the ground to where the brick is to be made. This method works well but depends on having very flat smooth ground



otherwise not enough mud can be moved at one time to make it worth while.

I have eased up the dragging work by throwing water on the ground so that the bag will slide over it easier, and also tried putting down some old plastic sheeting which made a good sliding surface.

Having decided on your method of moving the mud around you then plan your walkways accordingly.

BRICK MAKING AREA TO STACKS.

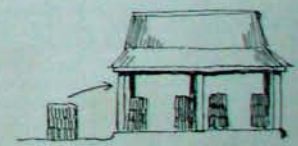
When the bricks are dry enough to move they are put into stacks and remain there for about eighteen days (the general rule is three weeks from making the bricks to putting them into the wall supposing the weather is fine and dry). The position of the stacks is usually right against the area in which the bricks have been made in order to avoid extra walking.

Because the bricks will remain in the stacks for some time the stacks will have to be arranged so that there is room for all the bricks that are likely to be made over a three week period.

STACKS TO HOUSE SITE.

Depending on your timetable it is sometimes possible to take the bricks from the stacks before they are fully dry and put them under the roof (assuming it is already up and that you are using the bricks to make space filling walls). The great advantage of this is that you can finally breath easy, free from the worry of sudden storms. The bricks dry very much slower under cover, but you will have planned for this.

Once during the wet season I made two hundred bricks under a long verandah and



discovered just how much this slows down the drying process, it took double the usual 21 days before the bricks could be used.

SITE TO WALL.

Even when stacking the bricks next to where the walls are to be built it is still important to position them in the best possible manner so that they will not have to be carried a centimetre further than necessary. Do not forget to leave space for scaffolding, but otherwise put them as close to the intended wall area as possible.

Having designed your work areas according to these notes walk through it a few times to make sure that it is the best possible layout. Every unnecessary step that can be eliminated will help speed up the total production and also make the job far less tiring.

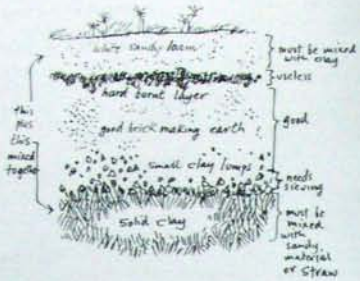
ROCKY SPEWY MONGREL COUNTRY

Although nearly all soils, apart from very sandy ones, can be used to make mud bricks there are some which require their own special treatment. One of the worst to deal with is that type of poor hungry soil full of grit and gravel that will almost bend a crowbar when you come to dig it out. Yet this rotten stuff makes quite good bricks.

A lot of heartache can be avoided by getting in a machine to do the digging. Once out of the ground and in heaps put some sort of a rough cover over it to prevent it going hard again after rain. Old bags will do, it does not have to be completely weatherproof, any sort of old material will shed most of the water.

The next problem is what to do about the stones and gravel in the mixture, and the way you tackle this will depend upon just how much of a problem it is. Gravel the size of a thumbnail and smaller can be left in. Anything larger than this should be pulled out, not because it will weaken the brick but because bricks tend to break around large stones, usually just when you are fitting them into place. Once in the wall they are no problem.

If there are not too many stones they can be pulled out by hand as you are preparing the material, but if the soil contains lots of stones it may be necessary to put it through a sieve before using it. This is slow work and should be avoided if at all possible. Try and obtain soil from a different part of the block, or dig down a bit to see if there are any layers that contain less stones. The ideal soil for mud brick is one that needs no preparation other than wetting it. Mixing soil or sieving it are tasks that add a lot to the time that it is going to take to finish the house.



The sketch shows the cross section of some country that we have used for brickmaking. The sandy soil could only be used by mixing it with the red clay from the bottom, while the burnt layer was of no use at all. The middle layer needed no preparation other than wetting it.

If you are hiring a machine to make your earth heap it is worth while hunting about for the best possible soil. The extra cost in machine time will be saved many times in having to do less hand work later.

If you are finally forced to sieve the soil then try and do it in the easiest possible manner.

Do not buy a new sieve, or try to use light materials to sieve earth. We went to a scrap metal yard and picked up a metre square section of very heavy steel mesh and find that this is quite good for the job, but a larger piece would have been even better.

Sometimes it is best to have two sieves, one above the other. The top one should stop anything larger than a walnut, this will get rid of the big rocks and also break up the rest of the soil so that it will pass through the finer mesh underneath in a much easier manner.

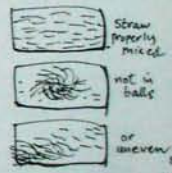
ADDING THE STRAW

If you have a helper throwing in the straw while you are sieving or just shovelling from the heap to the mixing area this will help in getting the straw properly mixed in with the other materials.

HOW MUCH STRAW SHOULD BE ADDED?

No exact quantities can be given for this because it depends on a number of things, including the age, thickness, length and strength of the straw. These in turn depend on the type of grass that you are using. Any type of grass can be used, or in fact any sort of fibre that will not rot away.

Select the straw when it is properly dry, if it crumbles away when rubbed between the hands it is unsuitable, you are looking for strength in the fibre not bulk in the brick.



The straw will not rot away in the brick if it is properly dry when put in, so what you see in your hand is what you will get in the brick. Is it strong? Will it help hold the brick together?

The quantity to be used in the mix is judged by eye and is more often judged by the amount of straw available rather than any other rule. What you are looking for is a finished brick that has fibres of straw all through it, you are trying to make mud bricks not mud and straw bricks, or worse still straw bricks with mud in them. A handful of straw to a brick is probably quite enough.

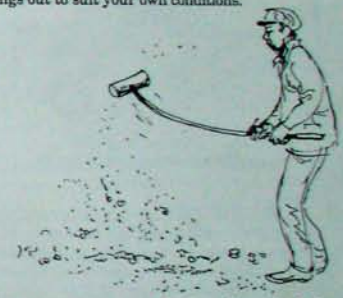
Long strands of straw can be a problem if they get bunched up together and form an air pocket in the middle of the brick as this will create a weak spot. For this reason the straw should be roughly chopped into lengths of 100-200mm so that the strands can be easily separated. They should be sprinkled into the mud mix not thrown in lumps.

A little straw is better than no straw at all. When we lived at the foot of the mountains we could gather lots of straw from the edges of the road after the council slasher had been along, and this was already chopped and ready to use. However now that we live up in the mountains there is little straw available and we generally make bricks without it. As I said earlier once the brick is set into the wall the straw is not really so important.

To me its greatest practical advantage is the fact that one can lift up much bigger handfuls of mud if they have plenty of long strands of straw in them and this certainly speeds up brick making.

PREPARING THE MUD

When it comes to turning dry soil into mud you can save a lot of trouble and work if you think it out first. Each soil and site is different to the next so you should not stick to a set of rules but work things out to suit your own conditions.

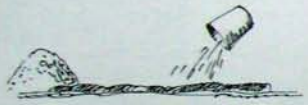


LUMPS. The soil will have lumps in it. In some types of soil the lumps will dissolve easily as you are preparing the mud, but in other cases they will not. It only takes one small batch to find out what kind of soil you have. If the soil in the heap is loose then it may be easy enough to throw it through a very coarse wire mesh and break up the lumps that way.

Another method used in the East is to put a long whippy handle onto a piece of wood (about firewood size), spread out the soil and belt the lumps with this, using the whip in the handle to do the work rather than swinging the thing like a maul.

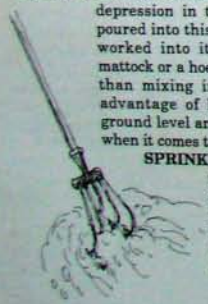
When working straight from the soil, or with a heap that has gone hard, I use a mattock, an old rusty mattock that has become sharp over the years of digging. Instead of belting into the ground I shave off thin slices. This is not only easier work but it cuts the material down into the right size and gets rid of all the lumps.

There are a few of ways of adding water to the dry earth.



MUD PIT. A shallow pit is dug, water is put into it and the earth is sprinkled in from the shovel as much as possible so that it gets properly wet. A long handled shovel is then used to mix it together properly, or you get in and trample it with your feet. This method is faster than the others, but has the disadvantage that you then must lift all the mud up to ground level again to move it to the moulds.

CONE. In this method the earth is formed up like a shallow volcanic cone with a large depression in the middle, water is poured into this and the dry material worked into it, using a shovel, a mattock or a hoe. This is a little slower than mixing in a pit but has the advantage of keeping the mud at ground level and so making less work when it comes to moving it.



SPRINKLE AND SPREAD. In this method a thin layer of soil (around 50mm) is thrown down over a wide area, perhaps up to a couple of metres, and sprinkled with as much water as it will take, and then another layer is thrown down and so on. The heap is then worked over by trampling on it or using a shovel or hoe. If the soil will absorb water quickly this is probably the easiest way to do it.

TEMPERING THE MUD

Various writers, including myself, have made much about the need to temper the mud before using it. Tempering means making the mud and then leaving it till the next day before using it. However recently I encountered some soil which made mud that was a pleasure to work with as soon as it was mixed, but which became heavy and dead the following day and was harder to use.

This lead to some experimenting, and I have come to the conclusion that tempering is not always necessary. Like so much else in earth building it depends on your own special soil conditions.

The theory behind tempering is that it gives the water time to be absorbed into all the clay particles and so make a better mix. However even setting a time limit does not work. Another soil that I also encountered recently had lots of very small lumps of hard red clay in it mixed with the rest of the yellow sandy-clay. These lumps were about the size of a little finger nail, and although they were no problem when making bricks they were a nuisance when making mud mortar.

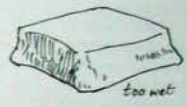
Tempering for 24 hours had no effect on them at all, in order to dissolve them the mud had to be kept well wet and left for at least three days. When we were in a hurry we just had to sieve them out before we began making mud.

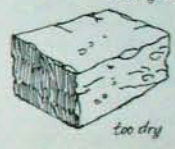
TESTING FOR TEMPERING. In view of this you must make your own decisions about tempering. Mix up some mud and squeeze it in your hands, feel the lumps and the texture. Cover it with some plastic for a day, make sure it is brought back to the same degree of wetness and feel it once again.

If tempering is going to help you then you will be able to decide by this simple test.

If you are using straw in the mix then you will have mixed it in during the course of making the mud.

HOW WET SHOULD THE MUD BE? It is hard work making bricks with mud that is not wet enough, it takes extra effort to push it into the mould and there are usually air pockets left. You may think that less water is going to make a stronger brick, but the opposite is the case, wet mud will dry out to form a dense strong brick while not so wet mud will not bond together properly and make a weak brick.





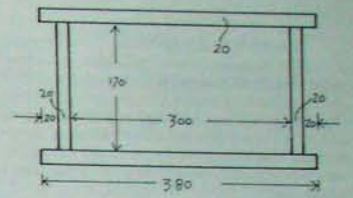
I make the mixture as wet as possible. If the brick visibly slumps when you lift up the mould then the mud is too wet, so I make it with just a little less water than that. If the mix is a little dry then the sides will show irregularities or even small air pockets when you lift off the mould, but if the mud is well wet then the sides will be smooth and shiny as the mould is lifted. The newly made brick should be so soft that the slightest touch will damage it.

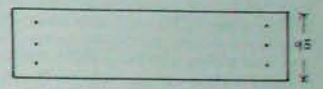
MAKING THE MOULD

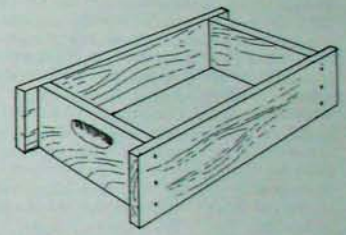
Now that the mud has been prepared you are ready for the mould. You will probably have made the mould by now, but I have included it at this point in order to indicate that mould making can be such a simple process that you really could leave it until the mud was mixed, then knock it together and go to work.

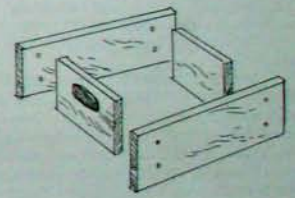
STRENGTH OF THE MOULD. A simple mould can be easily knocked up from four pieces of timber and some nails, and this can be made in half an hour.

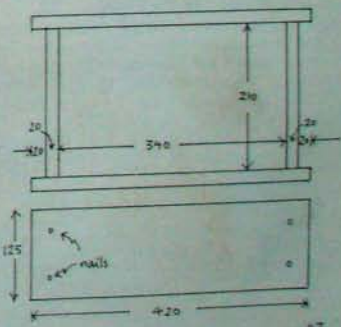
However at this stage you must decide how your are going to work, and then make the mould accordingly.











HAND FILLED MOULD. If you are going to fill the mould by hand then it can be made out of light timber, pine shelving is good, or the sides of packing cases. It can be as light as 10mm thick. Smooth the timber by planing or sanding so that it is like glass and you can rub your hands on the surface without any chance of splinters. A smooth mould will make bricks very much faster than a rough one.

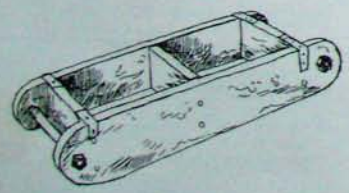
You can screw the mould together if you want, but nailing is usually quite sufficient for a hand filled mould. The longer sides are extended a little as you can see in the drawing so as to avoid the timber splitting when being nailed. A chisel can be used to make a small groove for the fingers, or a scrap of timber can be tacked on to make a grip. Once the mould is nailed together no other preparation is necessary and it can be used at once.

SHOVEL FILLED MOULD. If a shovel is to be used to fill the mould then a very much stronger construction must be prepared. It is astonishing how much damage a shovel can do to a mould, so all precautions must be taken. The timber will need to be harder, and should be around 15-20mm. The mould should be screwed together, or it can be nailed and then two long bolts put on the ends as shown to hold it together and also act as handles.

You will also almost certainly need reinforcing on some of the corners sooner or later so it is easier to put hoop iron straps on right at the start.

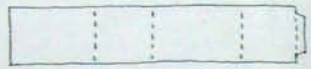
DOUBLE MOULDS AND MULTIPLE MOULDS. For efficient brick making the moulds must be wet between each brick. If you have a large mould then you must have a larger water container, this is heavier and must be constantly moved along as you make the bricks. For this reason alone I would prefer to use a single mould, although I have used a double mould over the years.

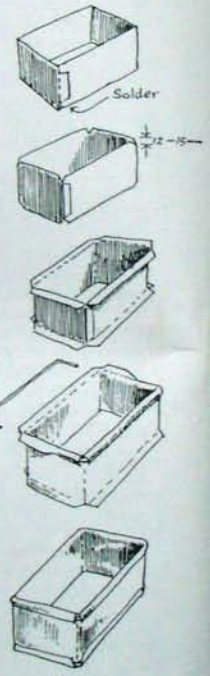
A double mould does not really save as much time as some people think, the same amount of soil has to be used and filling a double mould takes exactly double the time that it takes to fill a single mould. It is more difficult to lift a double mould cleanly and also requires more effort than lifting a single mould twice. However I have friends who prefer to use them and so you can make your own choice.



As for multiple moulds that will make three or four bricks, little time is saved with them as they require two people to lift them and are even more difficult to wet.

METAL MOULDS. If you can readily make or obtain a metal mould this is as good as any being usually lighter in weight than timber and needing less maintenance . The metal need not be as exotic as aluminium or stainless steel, plain galvanized iron is as good as any, reinforced with fencing wire around the rim. I have had such a mould for years and it works quite well. The making of such a mould is described in *Mud Brick and Earth Building the Chinese Way*.





TAPERED MOULDS. Some writers on the subject advocate tapered moulds, claiming that they release the brick easier. I do not agree with this, if the mould has good smooth sides and is wet it will release the brick easily without the sides being tapered. The obvious disadvantage of tapered bricks as they then have to be laid all with the taper in the same direction, which means having to examine each brick as it goes into the wall, while a straight sided brick can be put in just as it is picked up.

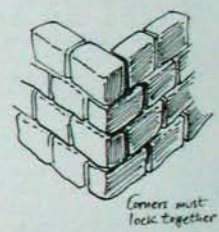
PLANNING THE WALLS

As I mentioned earlier there are two sorts of walls that can be built, load bearing walls, where the roof is supported by the walls, and space filling walls where the walls only have to support themselves and the roof is held up by posts. The techniques used to build either type of wall are the same, the only difference being that a load bearing wall is usually thicker than a space filling wall as it has to carry a heavy load.

Some councils will not approve load bearing earth walls while others place fairly stiff restrictions on them. Space filling walls can often get approval because the wall is not such an important structural member.

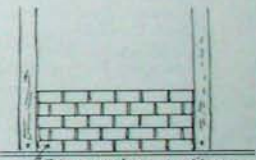
CORNERS

One thing that the load bearing wall has that the space filling wall seldom uses is corners where the bricks meet. The only thing to notice here is that the bricks must always lock together as shown.



THE BRICKS SHOULD FIT

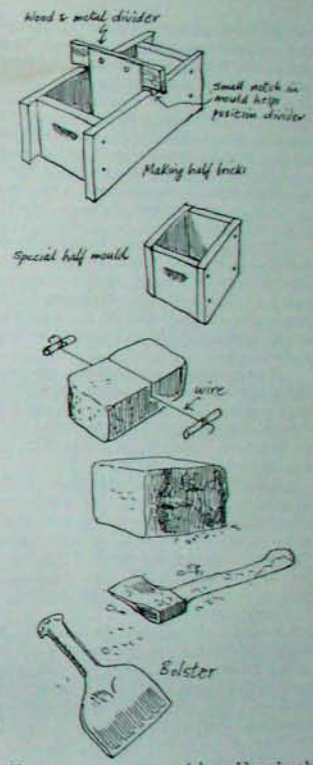
A sensible person plans his house so that the brick size is an exact multiple of the length of the walls to be built. In other words the wall will be exactly 6 bricks long or exactly 12 bricks long, and in this way you are not forced to be forever cutting odd shaped bricks.



This is good sensible advice, but I must admit that I have never followed it in my whole life, and am forever having to cut bricks into odd lengths.

HALF BRICKS

In order to get a proper bonding of the bricks you will need quite a few half bricks. Alternate courses of bricks require a half brick at the beginning of each course. Foolish people like me have to often waste time cutting bricks but sensible people put a thin metal or wood divider into their mould, or even prepare a special mould, and make half bricks which are neat and of a standard size.



The brick is made in the mould and then the divider is pushed into the mud and pulled out again. Even though the mud might appear to join together again in fact as the brick dries it shrinks away from this division and divides itself into two half bricks. The mould s then removed. This method only works for bricks without straw in them.

CUTTING BRICKS WITH WIRE

If you are making bricks without straw in them it is also possible to cut the brick with a piece of wire when it has dried a little but is still soft. It is even easier to produce half bricks by cutting

through the bricks with a piece of thin wire when they are partly dry but still soft. Wrap the wire around a stick at each end so that it does not cut into your fingers and simply push down on the brick.

This is so easy and such a pleasure to do that I often cut a lot more bricks in two than I really need to! I find it also handy to cut a number of bricks about a third along and so produce a range of bricks that will fit almost any space.

CHOPPING BRICKS

The most convenient tool for cutting bricks is a tomahawk, but other tools such as a bricklayer's bolster can also be used. On one job we used an old crosscut saw with teeth about 40mm long. This did a good and accurate job but the grit in the bricks was such that it wore the teeth almost away in the course of the job.

If your bricks are of a good even consistency you simply score all round them with the tomahawk and then give a couple of good blows to break the brick, which should split where you want it with a good clean faces. If there is a lot of straw in the brick it will take a little more cutting.

If the bricks have been poorly mixed they may shatter or crumble. I had friends make me a batch of bricks a little while ago and quite a few of the bricks were like this, they looked good on the outside but when broken would show bands of sandy soil alternating with bands of clay, making for a very poor brick. It is very difficult to cut this sort of brick in half.

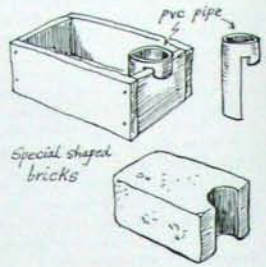
If you are going to plaster the walls later then some slight unevenness in the cut bricks is no problem, but if you wish the outline of the bricks to show in the wall then you would be much better off to avoid cutting bricks and make special half bricks as mentioned above.

CUSTOM BRICKS

You can also make custom bricks with hollows in them to take pipes and wiring of different sorts. This is not difficult and only needs a little advance planning.

It sometimes happens that you need a small number of special bricks and it is not worth while making up a special mould for them. I recently had this happen when the bricks had to wrap around a steel post..

Chopping a section out of a brick not only takes up a lot of time but also results in the loss of a lot of bricks. In this case I looked around for something that was about the same size as the pipe. What I found was an old ice cube tray from a refrigerator. This was held in place with one hand against the side of the mould until I had thrown in the first handful of mud and then it supported itself. It was removed from the mud before the mould was pulled off.



The result was a brick that fitted perfectly around the pipe and concealed it, and the bricks were laid as quickly as ordinary bricks.

THE SIZE OF THE BRICK

Unlike baked bricks there is no standard size for mud bricks, and dimensions vary widely from builder to builder. First forget any ideas of larger is stronger, it is quite possible to make a weak wall with large and heavy bricks and a very thick and strong wall with small bricks.

Making and laying large bricks requires a lot more physical effort than using small bricks.

I have often heard the argument that it is quicker to make and lay large bricks than to produce the same size wall with small bricks. This is quite true, but if you are seeking speed and do not mind some tough physical labour then you would make the job even faster by building in rammed earth rather than mud brick.

In deciding on the size of your bricks you should forget the question of speed but look instead at the physical capabilities of the people who are going to be involved in the making and laying. Think especially of how they are going to be lifted if you are working on a very tall house.

There has always been a certain macho element amongst earth builders in Australia a sort of "Me strong, me lift big brick" attitude, and the result of this is that the average mud brick in Australia tends to be fairly heavy.

Large bricks are also made in Asia, but if the home is going go be a combined family effort then the bricks tend to be adjusted down to a size convenient for everyone to handle. The cover of *Mud Brick and Earth Building the Chinese Way* shows a girl catching a brick that has just been thrown up to her by a young man who is below her and out of the photo. Can you imagine anyone throwing the average Australian brick a couple of metres into the air? The sort of person who could do that would be able to drop kick a bag of spuds.

MINIMUM WALL THICKNESS

Whatever size brick you finally decide on do not make the walls any thinner than 210mm. Exposed outside walls and tall walls should be proportionally thicker. Load bearing walls should be thicker again, 300mm would be a reasonable minimum for a single story building and 400mm for the lower floor of a two story house.

Having decided on the thickness of the wall decide on the manner in which you are going to lay the bricks. If they are going to be laid in stretcher bond, that is longways, then the width of the brick will have to be at least 210mm.

We sometimes make bricks 340x210x140mm. This produces a brick that weighs around 16 kilograms. These bricks are easy to lay up to chest height but as I get older I find that they are getting heavier and heavier to lift above that height, and very tiring to manage when you are right at the top of the wall and they have to be lifted up onto the scaffold and lifted again from there.

BIG BRICKS

G.F. Middleton, the great pioneer of mud brick building techniques in Australia, wrote a book called *Build Your House of Earth*, Angus & Robertson 1953. In this he included six suggested sizes for bricks, the smallest 4x8x16inches. Note that each of these measurements is double the one next to it. This would allow you to build a wall in Flemish Bond or other patterns that require the width of the brick to be half its length.

This book was given a complete revision in 1979 by Bob Young who rounded Middleton's figures off into metric and also included his own preferred size of 375x250x125mm, with a weight of 21 kilograms, rather too heavy for me. They must have been real men in the early days for Middleton's largest size of 600x300x155mm weighed in at 45.5 kilograms. I don't think I could even lift the mould for such a brick!

ALISTAIR KNOX. Alistair Knox was another pioneer in Australian earth building techniques, and many of his homes still stand around the Eltham area of Victoria. I have a small booklet from around 1950 called *Concrete, Mud, Stone and How to Use Them*, edited by W.Shum and published by Cologravure, Melbourne. There is a chapter in it by Alistair Knox on mud bricks. His recommended brick size was 12x9x6inches - 300x170x150mm, volume .01 cub m., about 17 kilograms. He also specified a wall 300mm thick, and used the bricks lengthways in the wall to achieve this thickness.

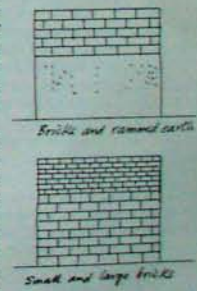
SMALL BRICKS. In addition to the size mentioned above (340x210x140mm) we also use a mould that is only 300x170x95mm. This produces a small brick of about 8kg that is very easy to handle, but as it is put into the wall lengthways it always produces a wall that is 300mm thick, and this is a good thickness for general use.

BRICKS FOR SPECIAL BONDS. If you are going to build with a special bond such as English bond or Colonial bond then you will need to make a brick of special proportions. Both these bonds, and also Flemish bond, require that the width of the brick is just under half the length of the brick. The reason will soon be seen if you try and lay out some bricks in these patterns.

COMPOSITE WALLS. One system that I have used and advocated in the past is to build the lower part of the wall with rammed earth to whatever is a convenient height and then continue the upper part with mud bricks. This takes advantage of the better aspects of both systems.

The same idea can be used with an all mud brick construction by using the larger bricks for the lower part of the wall where they are easy to place and so quickly fill up the space. Above chest height the wall is then constructed with smaller bricks which are placed side by side in the wall, so that the finished wall is the same thickness throughout. The change of size also creates a more interesting pattern to the wall if you are planning on leaving the bricks showing.

This is one of the great advantages of mud brick building, you are not restricted to using just one size of brick, and you can also create for yourself the exact size of brick that will suit your needs.



I do not think that the Chinese ever bother with a ruler when making a brick mould. They decide on the general size that they want and then nail together the

first four bits of wood that come to hand and are about the right size. The result is that almost every house uses bricks of a slightly different size, though there is a slight regional uniformity, and in some places most homes will be built of large bricks and a hundred kilometres away it might be traditional to make small bricks. However if the whole family helps in the making and laying of bricks they will generally be found to be of a size that is easily managed.

WHAT IS A GOOD SIZE BRICK? Having read all the above I think that you will agree that it is rather difficult to decide on the perfect size for a mud brick. I certainly would not go any larger than 340x210x140mm (.009 cub m) for the reasons of weight, 16 kilograms is quite heavy enough to sling around.

For family work I would recommend a smaller mould, perhaps not as small as my 300x170x95mm (.0048 cub m), but perhaps 260x170x120mm (.005 cub m). Working with smaller bricks does not slow down the work all that much, in fact in places where you have to work above your head and into awkward corners it will be found that the lighter brick can be put in place much faster than the larger and heavier brick which is difficult to handle in these positions.

THE GOLDEN MEAN

The Golden Mean (or Golden Section) is a very interesting proportion that was known to the ancient Greeks and has been used by artists for centuries. It is said that the spiral of sea shells grows in this proportion and that it occurs all throughout nature. As a result it has been in the past regarded as a mystical proportion that has been created by nature and is in harmony with the universe.

It is also regarded as the most pleasing visual proportion for a painting, a home, a room or in this case a brick. It is defined as a line which is divided in such a way that the smaller part is to the larger as the larger is to the whole. (If AB is the line which is cut at C then CB:AB as AC:AB.) In practise the proportion works out at about 8:13 (or more accurately 0.618 to 1).

If then you would like your bricks to conform to this mystical proportion you need only draw out a rectangle that measures 13x8 (inches or centimetres it does not matter). Draw a diagonal from corner to corner and extend it as long as you wish. Any rectangle that you now draw that meets on this diagonal line will conform to the golden mean.

You can then take this one step further so that the end section of the brick also conforms to the Golden Mean. For instance here are four useful sizes that I have worked out that conform to this system.

340x210x130mm, volume .009 cub.m., about 15.5kg. This would be a good sort of brick for most people, heavy, but not too heavy, and producing a wall 210mm thick, quite good for interior walls or small buildings and sheds. What interested me most about this size is that the mould that I use most and which I just knocked up years ago by eye and without any sort of thought of the Golden Mean turned out to be exactly right in length and width but not in thickness (340x210x140)

.300x186x115mm, volume .0058 cub m., about 10kg. Much lighter than the previous brick and therefore ideal for family participation. Used lengthways it will give a wall of 300mm thickness, good for an exterior wall.

For a wall in which you use large bricks up to a convenient height and small ones above this consider the following pair which also conform to the Golden Mean.

Lower wall, 405x250x155mm, volume .013 cub m., about 22kg. This is a heavy brick but could be laid easily up to about chest height.

Upper wall 250x155x96mm, volume .003 cub m., about 5 kg. These light bricks would go lengthways into the wall so that it remained 250mm thick. Even though I suggest 300mm for outside walls this is quite acceptable and is recommended by other writers on the subject.

MAKING THE BRICKS

Now comes the most exciting part of the job, making the bricks. The excitement fades after the first forty but is revived every time another hundred bricks are completed.

Having planned out the area where the bricks are to be made the question to be decided is whether to start at the outer edge and work towards the mud heap or begin at the mud heap and work out. An optimist will begin at the outer edge and work inwards because this is easier as you avoid having to walk around already made bricks. A pessimist always begins at the heap and works outwards, working on the theory that he might die before he gets the job finished and so will have not wasted too much time moving the mud that extra distance.

PREPARING THE GROUND.

The ground must be prepared before you make bricks on it. If you take a lump of part dried mud push it on the ground and then lift it up you will see why. As the brick dries it will form into the shape of the ground below it. If there is a hole in the ground then the brick will come out with a lump on it, if there is a crack in the ground then the brick will have a ridge on it, whatever the shape of the ground will be mirrored in the finished brick.

Pebbles, twigs, dry grass and leaves will all stick to the brick and be a nuisance later on. Sometimes the soil itself will lift up in lumps and stick to the new brick and this can be a major time waster as it must be trimmed off by hand later. In addition there will be a hole left in the ground when you come to make a new brick on that spot.

If this looks like being a problem then you must sprinkle sand or powdered earth all over the drying area before beginning. Dry powdered earth works almost as well as sand and only a thin layer is needed. Newspaper can also be used, but this can prove to be a bother to remove later. Shade cloth will also do the job.

AVOID PLASTIC.

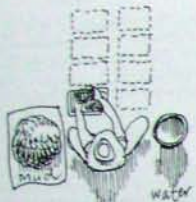
Do not use plastic sheets on the ground when making bricks, tempting as the idea may seem. For one thing although the plastic may look smooth when placed on the ground it will mould itself into the shape of the ground below when the brick is made, and so all the uneven areas will come through and spoil the brick just as if the plastic was not there.

This however is not the real reason for avoiding plastic. The brick is dried not only by the heat of the sun but also by moisture being absorbed by the earth below. Plastic will keep the water in the brick and so slow up the process by quite a bit. Shade cloth works because the water can soak away through it.

MOVING THE MUD.

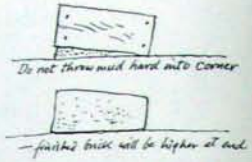
When the ground is quite smooth and suitable to take the bricks you can commence work, and now comes the job of moving the mud to the mould. Avoid taking even a few steps with a handful of mud, it will slow up the job. If you have only a short distance to go then put the mud on a bag and drag it as explained earlier, or get it into a barrow or better still a low trolley. Something like a kid's billy-cart would be ideal, and if a ten year old kid can make one then you should be able to do the same. The lower you can keep the mud to the ground the less work there will be in making a lot of bricks.

MAKING THE BRICK Having trundled the mud to the place where the bricks are to be made get a bucket of water and place it as close to you as convenient. Unless the mud is particularly gritty and unpleasant to handle, or you have some other problems, I would suggest you make the bricks the way they are made all over the world, using your hands. That being the case you can also use a light, single mould of wood or metal.



A convenient Layout


1. Wet the mould



1. Wet the mould. Dip the mould in the bucket of water and wet it all over. It will save a lot of time if you get a bucket that is deep enough to wet all the mould in one action, having to put in one end and then the other wastes time and effort.

Put the wet mould on the ground. Both mud and water should be so close that you do not have to move your feet to reach them.

2. Pick up the mud. Take as big a handful of mud as you can manage and put it into the mould. If you throw it in with too much vigour the force of the blow will often cause the mould to rise, sometimes just on one side, and this will end up by giving you an uneven brick or one that is larger than its mates. Keep your eyes open for this as it can happen quite easily.

Avoid air pockets in the mould, these form more often if the mud is not wet enough or is lumpy. You may find that you have to push the mud into each of the bottom corners in order to avoid air pockets, but if you find that you are having to do a lot of pushing of the mud in this way then sit back and have a look at the situation and try and find out how to improve it.

Is there too much straw and is it rolled into balls? Is the mould properly wet? Check again that the mixture is the right consistency, this is more that half the battle. If the consistency is right then a couple of pushes into the corners should be about all that is needed to get rid of air pockets.

In a short time you will work out just how many handfuls of mud is needed to fill your mould. If there is plenty of straw in the mud you will be able to lift up nearly twice as much at a time and this is a great help in speeding up the work.

Avoid filling the mould nearly up to the top and then having to add just a little bit more, this also wastes time. Having worked out how many handfuls are needed to fill the mould you work it so that the last handful is either exact or too much. The surplus is then scraped off with the hand and


2. Pick up the mud


3. Place in the mould


4 Lift mould off the brick

dropped on the ground just where the next brick is going to be made, do not bother putting it back on the mud heap.

NO NEED FOR A SCRAPING STICK.

Some people suggest using a stick to scrape off the surplus mud, but I have never ever seen anyone doing this in practise. It would be just something extra to have to move around, and in any case you can smooth off the top perfectly well with a sweep of the hands.

Do not sit around admiring this first brick but lift the mould off as soon as it is made, it will come off so much easier, and drop it straight back into the bucket of water, quickly wipe off any lumps of mud and place it down ready for the next brick.

Do not be tempted to try and make two or three bricks with only one wetting of the mould, it can be done but the mould will not lift as easily as when it is wet each time. Also lumps of mud will pull off the bricks and stick to the mould much more readily if you attempt this, the drier the mould the greater the lumps. If your mud mixture is right and you dip it in water each time it will often remain quite clean and free from lumps.

KEEP BRICKS CLOSE TOGETHER.

Having made the first brick put the mould as close to it as you can for the next one. The closer you make the bricks the less distance you have to drag the mud and water. Make the bricks in pairs, or even three across if you want to, then leave a walkway on each side. I like to put as many bricks across as I can comfortably straddle later when I am standing them on edge.

MAN'S BEST FRIEND.

For some reason dogs and cats usually find the nearest distance between two points is across newly made bricks, so keep this in mind. Half the time it takes longer to try and patch up a damaged brick than to make a new one. When an animal steps on a new brick, even a small animal, the brick will become both wider and flatter and this can be a real nuisance later when building a wall. The only way to patch up a walked on brick is to drop the wetted mould over it again, scrape up the mud that will squeeze out when this is done and smooth the top off again before lifting the mould.

SLUMPING BRICKS.

If the bricks slump when the mould is lifted then the mixture is too wet. A small amount of slumping is acceptable but it should be consistent. If all the bricks slump the same amount then it will not be noticed in the final job, but if some slump and some do not then you are in for trouble so ensure that the mud mixture is the same consistency throughout.

SHADE.

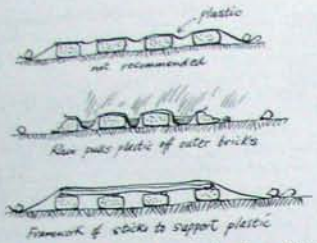
Try and arrange it so that your drying area is in the sun. Patches of shade can be a nuisance because the bricks will not all dry at the same speed and this will slow down the stacking process and also cause problems if you want to get another batch down.

DRYING THE BRICKS

If, having made your first batch of bricks, you want to dance with joy then go ahead, but avoid doing a rain dance. The first day of the brick making process is the most critical. When freshly made the bricks are so soft that even trying to get covers over them will usually result in some damage.

This is another reason for making sure that the ground of the drying area is as level as possible, so that there are no hollows where water can collect.

Once the first day has passed then you have a good chance of protecting the bricks from the



weather, although you cannot feel really confident until they are in their stacks and properly covered.

Even a slight amount of rain on a freshly made brick will add just enough moisture to cause the brick to collapse. A framework above the bricks over which a tarp could be spread would do the job, but this would take some arranging and would be a bit expensive for most people.

We have found the best thing is large sheets of thin plastic. The sort that goes under cement floors is the best but even thinner material can be used. Being very light it does not press on the newly made brick. However if the rain is heavy and the bricks still very soft then another problem arises because water begins to settle in the slight hollows that soon form between each brick, and the weight of this water can cause the plastic to move and also press down on the bricks.

The only way out of this is to criss-cross long thin stick on the bricks and lay the plastic on this. Luckily these problems are lessened by the second day and heavier tarps or sheets of iron can be placed on the bricks in the case of rain.

Always remember to remove plastic sheets as soon as the rain stops or the bricks will sweat and can become soft again on the surface.

VERY HOT WEATHER

Hot dry weather can also pose problems, though nowhere near as many as rain. If the bricks have a high clay content and the weather is extremely hot and dry on the day that they are made then there is a chance that the surface will begin to dry too quickly and will develop deep cracks.

A friend of mine who has been building mud brick houses in South Australia tells me that they have solved this problem by covering the bricks with sheets of black plastic as soon as the cracks begin to develop. This causes the bricks to sweat as the moisture is drawn from the inside of the brick, and this in turn will cause the cracks to close (as long as this is done early enough). The bricks need to be constantly looked at, and as soon as possible the plastic is removed again before the surface becomes too soft.

This process is repeated as often as is necessary until the bricks have ceased to crack and are dry enough to be left uncovered. The brick usually ends up with fine surface cracks but no major ones.

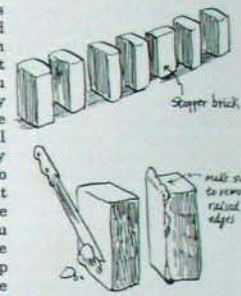
PUTTING THE BRICKS ON EDGE

Bricks are most at risk when they are flat on the ground, so as soon as possible they should be tipped up onto their long edge. After some practise you will soon develop a way of gripping the brick with the flat of the hand and rolling it up in such as way as to not put a mark on it, even though at this stage the sides and base may still be a little soft. This lifting can usually be done the day after they are made, but if it is overcast weather or if the bricks have been made in the shade it will take longer.

PUTTING THE BRICKS ON END

If the weather is warm and dry you should be able to stand the bricks on end by the third day. It is at this point you will appreciate having a flat drying ground as a toppling brick can have a domino effect. If worried about this then give every fifth brick a 90 degree twist so that it acts as a stopper.

At the same time as you stand the bricks on end it is a good idea to have with you a large blunt knife so that you can trim off any lumps while the material is still soft. It is very much easier to do this at this point rather than have to stop while you are laying the bricks and chop away at the lumps which by now are very hard.



Once the bricks are on end they are very much safer from the effects of rain, and in fact a light shower will not affect them at all, though they should be covered from any heavy rain.

A framework of sticks will be found essential at this stage in order to cover the bricks as the space between them is now so large that rain forming pockets in between bricks will soon pull the plastic away from the edge of the batch.

If you are making lots of bricks at once we have found it best to keep them in groups of one hundred. It is not really all that important but it is nice to be able to glance over the area and count the total quickly, how many are on edge, how many on end and how many in the stacks. It also helps later when it comes time to move them as you can decide where each hundred is to go.

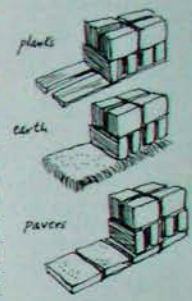
If the weather is kind and there are no forecasts of rain the bricks may stay out on edge for a few days. However it is best to get them into their stacks as soon as possible if there is the slightest chance of rain. Another consideration is that although they are getting the sun and air all around them while they are on end there is still the one part that is in contact with the ground, and so is not drying out.

STACKING THE BRICKS

Plan your stacks to that you have to carry the bricks the minimum possible distance. For instance if you are not going to use the drying area for some time then stack the bricks in the walkways so that you can lift up bricks from both sides.

CAUTION AGAINST WET FEET

Water on the ground is a greater danger to a stack than water falling from above. Be quite certain that the stack is not built in any sort of a hollow. A few years ago when we were working on one job we made a whole lot of cement paving bricks using the same mould that is used for rammed earth bricks and is described in *Mud Brick and Earth Building the Chinese Way*. These bricks could be put down wherever we wanted to build a stack and they kept the mud bricks from contact with the ground and any possible water. When the job was finished the pavers were used to make a path.

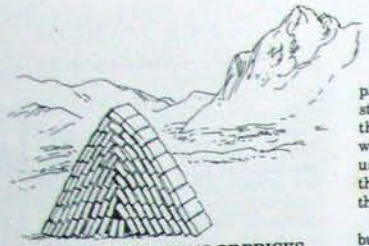


Planks can be used in the same way, or a few centimetres of soil can be spread to make a low platform.

The bricks can be stacked as high as is convenient, chest height is normal, or a little lower.

If there is a chance of rain they must be covered, but as they are being stacked in order to dry out it follows that they must be uncovered as soon as the rain passes. Tin or plastic can be used in this way, but make sure it is well anchored.

If this covering and uncovering is a bit of a bore then do what the Chinese do and throw handfuls of straw onto the top of the heap to make a rough sort of thatching. Weigh it down with rocks. Hessian bags can also be used in the same way. Although both these materials will let a certain amount of water in it will not be enough to damage the bricks. The advantage is that both thatch and bags breath and so when the rain has gone the bricks will continue to dry out even if it is left in place.



TRIANGULAR STACKING OF BRICKS

Bricks are generally stacked in rectangular heaps for drying, but there are other variations, and I noted this shape near Lhasa in Tibet.

As can be seen in the sketch every brick is placed at an angle. In this way the stack can be continually added to until it is no longer convenient to reach up to the top of the stack.

In this method each brick has a larger surface in contact with adjoining bricks than is the case with other stacking methods, and in a moist climate this would slow down the drying process.

However the method works well in the extremely dry air of Tibet. The great virtue of the shape is that is sheds the snow readily, whereas the normal rectangular heap allows snow to settle on the top, where it later melts and so dampens the bricks. There was light snow every morning of our visit to this area.

In this climate the stacks do not have to be covered against the rain, and the outer layer of bricks is sufficient to protect the inside from any light falls.

RADIAL STACKING In very dry climates bricks can be stacked in the easiest manner possible because there is no necessity to provide an air space between each brick. This heap was also noticed in the country near Lhasa, Tibet, the bricks stacked up against the edge of a raised pathway.

The small boy was pushing a toy wheelbarrow.

GET THE BRICKS UNDER THE ROOF

If you are using the mud bricks to fill in panels then you may have your roof in place at this stage. The general rule of thumb for mud bricks is that it takes 21 days from when they are made to when they can go in the wall. If you do not intend using them for some time and the roof is in place then consider moving them into new stacks under the roof and close to where they are going to be used.

It will take longer for them to fully dry out, but you will be saved the worry of waking up in the middle of the night with a gale blowing and the rain thundering on the roof and wondering whether your stacks have all been uncovered and are dissolving at that very moment.

FROM STACK TO HOUSE

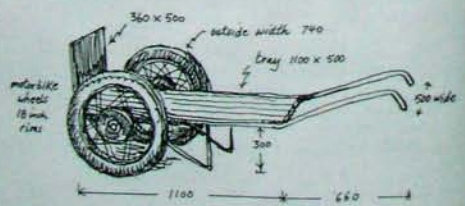
Moving the bricks from the stack to the house can be a big job. If you have a trailer that can be towed that makes the job so much easier, even if it is only twenty metres. If they have to be moved by hand then think seriously about making a vehicle for the job.

A wheelbarrow tends to be top-heavy and will not carry many bricks in any case. We have an old wheelbarrow frame with the tray removed and a flat plate in its place and this has been used for moving bricks.

However the best thing we have found is the two wheel trolley that the Chinese call a ban-cher (plank-vehicle) and which we constructed from a pair of motor bike wheels. This was built for moving our welding gear but is now used for everything. It is also illustrated in *Bushcraft 3* and *Bushcraft 4*.

Having two wheels it is much more stable than a barrow and will carry a much greater load. It is stood with the tray up to load it and then the handles are pulled down to get the load in the right position to move it.

Of course if you had made a billy-cart for moving the mud you would also be able to use this for bricks around. The main thing is to use wheels rather than muscles at all times. A cunning mud brick builder avoids anything but a light sweat at all times.



THE FOUNDATIONS

It may seem odd to include the section on making the foundations after we have talked about making the bricks, but in practise that is the way it often works out, brick making is begun before the foundations are made so as to give the bricks plenty of time to dry.

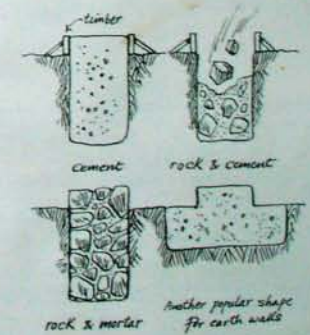
The foundations for a mud brick house are the same as the foundations for a cement block or ordinary brick house and the local building inspector will be able to tell you the particular regulations that apply In your area. It is also a good idea to ask locals about what depth of foundations they used.

The general rule to remember is that the foundations should be a little wider than the wall and reasonably deep. You may also want to put steel reinforcing into the cement, although this is not really necessary if the country is stable, and it is not done in the Chinese countryside where millions of people live in very sound earth homes.

Always keep in mind that a section of earth wall 2.5 metres tall and 2.5 metres long will weigh over two tonnes. You do not want this to move in the slightest way, either by sinking or tilting, and only strong foundations will guarantee a stable wall.

CEMENT FOUNDATIONS. The foundations can be of cement, 1 part of cement to 2 of sand and 3 of gravel. For large masses you may use 2.5 of sand and 3.5 of gravel to 1 of cement.

ROCK AND CEMENT. If you have plenty of loose rock on your block you can save money and time by utilizing this in the foundations. The easiest way is to make the cement mixture fairly wet and drop the stones in as you go.



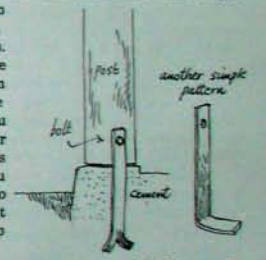
ROCK FOUNDATIONS. It is also possible to make the foundation from mainly rock, held together with a mortar of 1 part of cement 1 of lime and 3 of sand.

ROCK AND MUD. For hen houses and such like you may even use a foundation of large rocks with mud mortar in between them. This method is common for homes in China, but there it is a case of necessity and the result is certainly not as strong as using cement mortar. It requires a little skill for the rocks must be placed so that they would support themselves even if the mud mortar was not there.

Whichever method you use the foundations will need to stand above the ground level. In order to do this you will need to make a wooden formwork of some kind to support them until they are dry. On a wall protected by deep overhangs or a verandah the footings may be only 50mm out of the ground, but generally it is a good idea to make them 100mm clear. This saves the base of the earth wall from kicks and scuffs and the effects of sudden storms.

FISH PLATES.

Steel anchors, sometimes known as fish plates, are set into the foundations wherever you are going to position wooden poles. These can be bought from hardware stores or you can make your own. This is easy if you have access to oxy equipment and scrap steel.



DAMP COURSE.

Moisture from the earth can be absorbed into the cement foundations and then soak slowly upwards into the earth wall unless you provide some sort of barrier. In the past tar paper was used for this purpose, but today a layer of plastic will do the job, or you can buy special dampcourse material. It is also a good idea to make the top skin of the foundations from a good strong mix of cement, say 1 part of cement to 3 of sand. A waterproofing compound can also be added if you wish but this should not be necessary if the damp course is in place.

CALCULATING THE NUMBER OF BRICKS NEEDED.

It is not difficult to calculate the number of bricks you will need for any given section of wall. Measure the length and depth of the brick that will be showing in the wall, add 10mm to each measurement to allow for the mortar and multiply them together. For instance if you are using the smaller sized brick 300x170x95mm lengthways in the wall so as to make the wall 300mm thick then what you will see in the finished wall is the end of the brick which measures 170x95. Add 10mm for mortar to make this 180x105. Add a dot to make it a fraction of a metre so it becomes .180x.105 m. Multiply together and you get .0189 square metres.

Now measure the wall area, say it is 2.5 metres long and 2.4 metres high, multiply these together and you will get 6 square metres.

Divide the size of the brick, .0189 into the size of the wall, 6, and you will find that you will need 317 bricks to make this section of wall.

What then if you made a thinner wall and used larger bricks? Taking the larger size brick 340x210x125 and using them to make a wall 210mm thick we then multiply .350x.135 (having allowed for the mortar) and get .0472 square metres. Divide into 6 and you arrive at 127 bricks.

If you wanted a really solid wall you could use this brick lengthways in the wall so as to make it 340mm thick. In that case you would calculate .220x.135=.0297, and divide this into 6 to discover that you would need 202 bricks. (I would rather lift 317 light bricks than 202 heavy bricks).

Take the house section by section and work each one out, add them together and you will find out how many bricks it will take to build the whole house.

WALLS AS INSULATION

Australian earth builders tend to use as few bricks as possible, being very conscious of the effort needed to make them. To the Australian builder every brick seems to be a precious treasure. The Chinese and Tibetans do not think in this way, and use as many bricks as are needed to achieve the effect that they are seeking.

This broken wall was noticed in an almost deserted settlement in the desert near Golmud, on the Tibetan plateau. The temperature here is very high in the summer, and well below zero in the winter, so the walls are built to provide the maximum amount of insulation.

This wall is 800mm wide, and is made of no less than ten mud bricks standing on edge! Such a wall could stand for centuries, and in this case had only been broken in order to remove the door frames.

INTERIOR WALLS

Interior walls do not have to be as thick as exterior walls, but they should be thick enough to provide both soundproofing and insulation. The sketch shows a broken wall near Lake Qinghai in north-west China, and illustrates a common way of constructing interior walls.

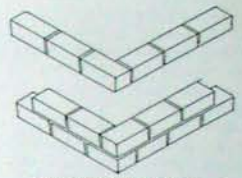
The wall is 400mm thick and made with bricks stood on their edge and laid in mud mortar. The method of laying can be seen in the sketch. The wall stood on a good high foundation of rock, also put together with mud mortar.

DECIDING ON A BOND

Right at the start you should decide what the final thickness of the wall is going to be and the size of the brick that you will need to build the wall. You will also need to decide in what manner you are going to lay the bricks.

A number of bonds are illustrated in *Mud Brick and Earth Building*, but here I will deal only with the most common.

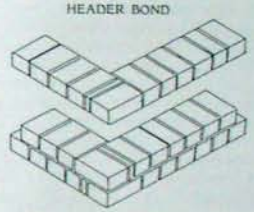
STRETCHER BOND



STRETCHER BOND.

So called because it stretches along the wall, using the full length of the brick. This is the most common one used in Australia for mud, but it is not the strongest. The strength of an earth wall is in its thickness, and if you want a wall in stretcher bond to be strong then you will have to use a wide brick.

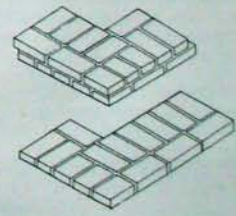
HEADER BOND



HEADER BOND.

The length of the brick goes across the wall and only the head of the brick shows in the finished section, so this called a header because only the heads show. It gives a good solid wall.

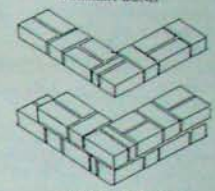
HEADER AND STRETCHER BOND



HEADER AND STRETCHER BOND.

This combines the bricks as headers and stretchers and so produces a very thick wall suitable as the lower wall in a two story building.

FLEMISH BOND



FLEMISH BOND

A popular bond for fired bricks but not used so much for mud bricks, mainly because the brick has to be twice as long as it is wide in order to form this bond.

MAKE SURE THE BOND IS A BOND.

Always remember to place the bricks so that the join is above a solid section of brick and not above another join. If the bricks are laid so that a series of joins are above each other then the wall can crack at this point.

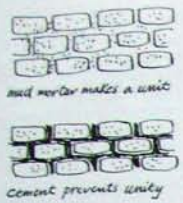
DOWNWARD SHRINKAGE OF THE WALL.

As a wall dries it shrinks a little and the weight of it also compresses it to some degree. A professional earth builder tells me that they always make an allowance for this, checking the top of each wall a fortnight or so after the wall has been made and adding a little more mud mortar to fill in the area between the top plate and the bricks where the wall has settled.

LAYING THE BRICKS

The bricks are put together with a mud mortar, and you get the best results by using the same mud as was used to make the bricks. By using the same material you end up with a wall that is a complete unit of one material. This will be

appreciated if you ever have occasion to pull a wall down, for a well made mortar will be found to have become almost part of the bricks around it.



Do not be tempted to add cement to the mortar in the misguided belief that it will add to the strength of the brick. An earth wall is an organic thing and as such moves fractionally with the seasons. Cement does not respond to weather changes, so if you put the two together you will end up with what is really a series of bricks sitting on cement shelves rather than a completely bonded wall.

ADDING CEMENT TO MUD BRICKS

While on the subject of adding cement to mortar some people ask about adding cement to the brick mixture as well as the mortar. My answer to this is that if you want to build in earth then build in earth, if you want to build in cement then build in cement, but do not mix the two up. The reasons that people build in earth are often as much philosophical as practical, and adding cement does not fit into this approach. If you are going to build properly in earth then adding cement will not add to the life of the building (and in any case your local building inspector will not be around in 200 years to see how the wall is holding up).

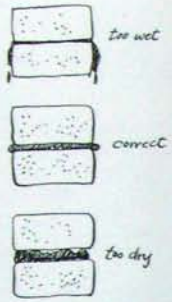
The exception to this is when using very sandy soils, and in this case cement will help. However you must understand that what you then have is not a mud brick but a cement brick.

SIEVE THE MUD

It is best to always sieve the earth that is going to be used for the mud mortar in order to get out all the gravel and lumps. Just one lump is enough to tilt a brick up or lift it higher than its neighbours.

TEMPERING THE MORTAR.

It is important that the mortar should be as smooth and as plastic as possible. As I mentioned earlier different soils call for different treatments, some seem to be at their best as soon as they are made while others improve by standing overnight. It is worth experimenting to find out what your soil responds to. A well made mortar makes brick laying a pleasure, but a hard, uneven, lumpy one takes all the fun out of the job.



The mortar should be fairly wet, you will notice that a lot of the moisture is drawn out of it as soon as it is put on the dry brick. The correct amount of moisture will soon be apparent. When you lay a brick into the wet mortar you should also push down on it a little to get a good seating. If the mortar is too wet it will squeeze out at this stage until the brick is almost in contact with the one below it. This is not a good thing.

On the other hand if the mortar is too dry you will not be able to push the brick into it enough and the space between the bricks will be too thick. The ideal distance is about the thickness of the little finger.

MIXING MUD MORTAR

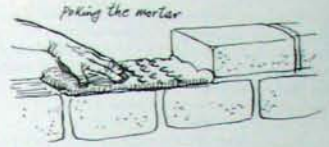
Not long ago I came by accident onto an easy method of mixing mortar. It had been raining and I was laying some bricks under cover. When it came time to get the soil for the mortar I found the wheelbarrow was part filled with water.

Instead of tipping it out I shovelled the loose soil directly into it. The result was that when I tipped the barrow out at the job the mortar was all but ready and only required some additional stamping to crush small lumps.

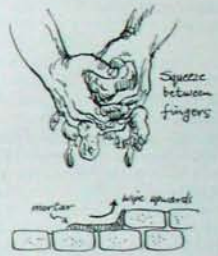
This method will only work with soils that are well broken up and free from large lumps. If the soil is right then it cuts the mixing time by half.

POKING THE MORTAR.

After a while you develop a number of little tricks that help make the job run smoother. As I spread the mortar I run my hands along it pushing all four fingers into it. Not only does this quickly even out the layer, but it serves the main purpose of locating any stones or lumps.



Another method is to take the batch of mud that you are working with at that moment and squeeze it between the fingers, this also locates lumps and makes for a uniform degree of moisture.



Having poked the mortar I then wipe my hands along to take up any surplus and smooth this up in one single stroke onto the end of the previous brick.

It is not a good idea to spread too much mortar at once because the dry bricks of the course below will start to suck out the moisture. I usually put down just enough for one or two bricks.

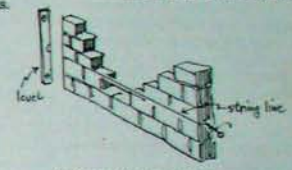
If you are going to have a cement floor in the building then it is a good idea to have this laid at the same time as you are doing your foundations. This then gives a good working area and you can make your mud mortar on it. The mortar does not need to have straw in it, but of course you can add it if you wish.

Make the mortar close to the wall so that you can reach down easily and get a handful. You do not need trowels or other tools to spread it. Have the mortar close to your feet and a heap of bricks at either side. You will also need some half bricks so have them also to one side where they can be easily reached.

LEVELS

It is absolutely essential to make sure that your wall is vertical, and you must prepare for this. I usually like to first lay one course of mud bricks onto the foundations and then set up the levels to this course (this of course assumes that you have got your foundations in the right place and straight).

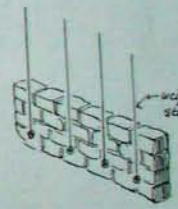
There are two basic ways to work your levels, one is to follow the methods adopted by professional bricklayers for cement block and baked brick walls, and the other to use a slightly more primitive but quite efficient method that is quite suited to mud bricks.



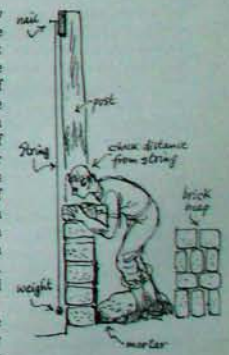
BRICKIE'S METHOD.

The professional bricklayer builds up the corners at each end of the wall section using a spirit level to get them vertical. Having done this he then stretches a cord from one end to another and lays his brick to this line. This method ensures that the wall is both straight and vertical.

TYPICAL SLACK MUDDIE'S METHOD.



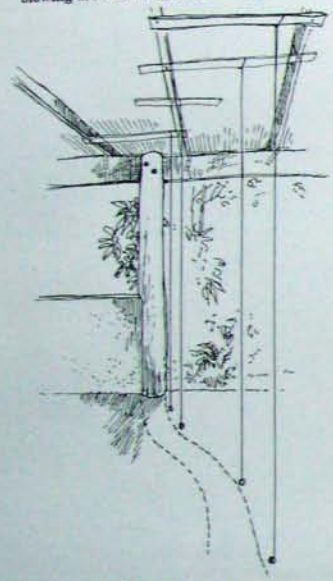
Lay the first row of bricks along the edge of the cement foundations or to some other straight line. If there are no suitable roof timbers above you then nail a length of timber between your poles. Put long nails into the length of timber spaced about a metre apart and from them hang strings with small weights on them. Metal washers are good for this.



The strings are positioned so that they hang about 25mm clear

of the wall. This is done so that if a little mud mortar squeezes out between the bricks it will not touch the string and alter its angle. The strings hang on the opposite side of the wall to which you work and so are not in the way.

If you are in a windy area make sure that the weights on the string are sufficient to prevent it blowing around and giving a wrong reading.



CURVED WALL.

The above method works well for building curved walls. However as you cannot sight along a curved wall the strings should be closer together, say 500mm. It may require a little ingenuity to arrange points for the strings to hang from, but with a few scraps of packing case timber you can work it out. The sketch shows how we arranged it for a curved wall. This type of wall looks very good, it is also very strong and highlights the flexibility of mud brick as a building method.

DOMES.

However do not get carried away by this flexibility and start dreaming of mud domes. Earth walls are strong and solid because of gravity, once you try to hang them in space you are getting into a very dangerous situation. Domes can be made and have been made, but only by highly skilled people who have worked in the medium all their lives and know just what they are doing. The part time builder should not attempt such things.

ARCHES.

Small arches above windows and doorways are quite possible in mud brick, but I would caution any first time home builder from attempting them unless you have a very sound understanding of the stresses involved. If you did want to build arched doorways then I suggest that you follow the method outlined in my book *Bushcraft 3*, page 40. This creates a strong and permanent arch for doors and windows.

SCAFFOLDS

Avoid climbing ladders with one brick at a time. A pair of saw horses with planks across will make a simple scaffold and, if the horses are strong enough, mud bricks and more planks can be used to make this higher as the job goes up (but proper builder's trestles are even better).

The bricks you are going to use are stacked on each end of this platform. Make sure you put an even number of bricks at each end and that their weight is above the saw horse. Also make sure that you take bricks evenly from each end as you work.

Put a plastic bag or sheet in the centre and the mud mortar on this. You will find yourself steeping over, around and into it as you work, but it is still the most convenient place to have it. Remember that is is always easier to have all the materials at your feet than down on the floor.

SLURRY MORTAR

This very fast and unusual method of laying mud bricks was noted in a village near Lijiang in Yunnan province, China, in 1985. The village belonged to Naxi people, an unusual group in that they still have a matriarchal society in which the women own the houses and control the household.

We arrived just as a two story house frame was being erected. The pre-cut pieces had all been fitted together and were now being levelled on the stone foundations. The whole village was involved in the house raising, and the grandmother who was organizing the new building invited us into another courtyard where a great feast was underway.

We spent an hour or two eating and drinking with the villagers, and when we came to leave were surprised to discover that not only was the house frame now properly in place, but the mud brick walls were already half way up to the first floor all the way round the building!

One reason for this speed was the large workforce, but the other was the unusual method of laying the bricks. The wall was thick, 680mm, but this was for insulation, not support, as the roof was supported by the timber frame.

The bricks were laid five across as can be seen from the sketch, each row differing from the one below so as to form a good bond.

The bricks were not covered with mortar, but were simply stood in place with a good gap between them. A worker then came along with a bucket containing a very liquid mud slurry and poured this into the cracks and over the top of the bricks to provide a bed for the next course.

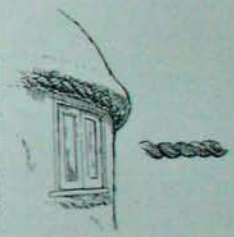
This method is the traditional one used in this area, and buildings made in this way stand up for many generations. However it should only be used for thick walls such as described here.

The reason for this is that very wet mortar tends to shrink more as it dries out, and careless pouring of the slurry can also cause air pockets. This does not affect a thick wall because of the mass involved, but could create problems in a thin wall.

USE OF STRAW ROPES

One general limitation of earth construction is that the earth cannot be used to make overhangs of any size. However even this can be overcome by the introduction of an armature of some sort.

Armatures can be used to add features to buildings that would not be possible with normal earth building techniques. For instance these grain silos in Du Lan, on the Tibetan plateau, are constructed from earth, yet have a 300mm overhand on the eaves of the earth roof.



I could not work out how this was achieved until I found a section where the mud plaster had fallen off to reveal the secret. This consisted of a number of thick ropes of twisted straw impregnated with mud. These were wired back to the walls, and so allowed the eaves to be formed.

The sills under the silo openings were constructed in the same way. In all cases the straw has to be tied back to the main structure, but once this is done it allows a great deal of flexibility in the way of overhangs and decoration.

MUD RUBBLE AS FILL

In the course of building with mud you often have to fill small spaces, areas that are less than half a brick wide. These can be a problem as it is difficult to cut bricks very small without the brick shattering. Bricks can be sawn, but this is very time consuming, and can be impossible if the soil contains gravel.

Filling small spaces with mud is not the answer as this will shrink on drying and can then become loose. The answer is to use mud rubble.

On every job there are failed bricks, bricks that the dog has walked on or bricks that have shattered when you have tried to cut them. All this rubble should be put to one side for later use. I have been using some rubble recently that has been recycled at least three times, so that some of the pieces have become old friends.

Some years ago I built a wall, later demolished, and the material was then used for a set of stairs, which also came down later, and then once more into another set of mud stairs. By the time this came down the rubble was getting smaller and the bricks more battered, but they were all put to one side.

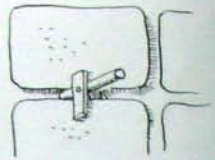
The latest job had a lot of small areas to be filled, mainly around window frames, and here the rubble was used once again. The method is quite simple, mud mortar is mixed and the rubble set into it just as if you were building a stone wall.

There are two rules to observe. Try and lay the rubble so that it is sitting firmly and does not rely on the mortar to remain in place. Do not do too much at one time if you are filling a narrow horizontal space, lay it a section at a time and let it dry overnight before doing another section.

Once fully dry a rubble section is almost as strong as a section made in complete mud bricks.

SMOOTH AS YOU GO.

As you build the wall the amount of finish you give it will depend upon how you are going to treat it later. If you are going to have the shape of the bricks show in the finished wall then you will have to lay the bricks carefully and evenly. You will need a certain number of half bricks in order to create the proper bond as explained earlier, and these are best made specially so that they are of uniform size and neat outline. As each course is laid you can use your finger or a small tool made from a piece of dowel, or even a scrap of wet bag, in order to smooth the line of mortar to a uniform depth between the bricks.

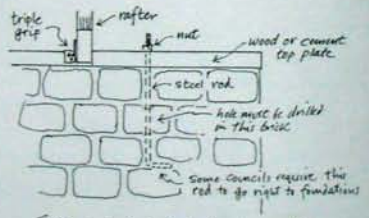


If however the wall is to be plastered later then the work can progress a little faster as the rows do not have to be so even and the mortar can be roughly smeared level with the finished bricks using the flat of your hand.

Bricks can also be chopped in half with the tomahawk, as the slightly (or sometimes extremely) rough edges will be filled with the mud mortar and so not be seen. As you lay the bricks roughly fill up an depressions or other irregularities as you go, this will help when you come to do the final plastering.

FINISHING A LOAD BEARING WALL.

If you are making a load bearing wall then the roof will not be in place and the wall is simply taken to the desired height and then finished off. It is recommended that a cement or timber top plate be then put right around the top of the wall to hold the whole building together. Provision is made in this for attaching the rafters and any other roof timbers.

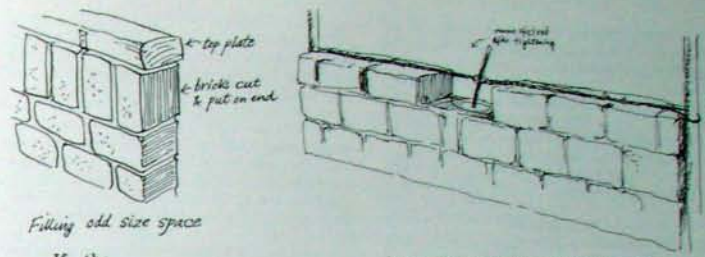


Fastening roof to load bearing wall

FINISHING A SPACE FILLING WALL.

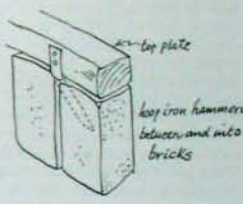
Before you get to the top of the wall, when there are still about four courses to go, stop and check that you will be able to do it with the size bricks that you are using. If the gap is not a convenient size then you have a number of choices.

If the wall is being made with bricks that go through lengthways in Header Bond then you may consider putting a few courses in with the bricks on edge.



Filling odd size space

If the wall is built with Stretcher Bond then you may cut the bricks to the correct height and stand them on end. It is also possible to do a whole final row with the complete bricks on end, but this should only be attempted when you are dealing with good wide solid bricks. If it looks at all unstable do not attempt it.



If I find it necessary to stand bricks on end I cut strips of hoop iron and punch a couple of holes in them. These can be hammered gently down between the bricks and in so doing they cut a small groove in each brick and so anchor themselves in place. A couple of nails are then put into the timber above and this anchors the top of the wall quite effectively.

It is almost impossible to thin a brick down, short of cutting it with an old crosscut saw. It is better to prepare for this likelihood ahead of time and have some smaller bricks made using a different mould, or by using the same mould and only half filling it.

Do not be afraid of having a few odd bricks around the job, they come in handy and can always be used afterwards for filling up odd spaces. We have made benches, and even a wood box, from left-over bricks.

REINFORCING IN WALLS

If the wall is tall and thin you may decide that you should put some reinforcing between some of the courses. Most writers in this country suggest using barbed wire, but I have tried this and really hate it. No matter how careful you are there seems to be always a time when the stuff will get you. The only interesting part of the exercise is that you will notice how surprisingly far your blood will spread through the wet mortar mix.

When we feel reinforcing is necessary we use a loop of fencing wire, either around the posts (if they are to be covered in mud) or attached to them. Using any convenient stick the wire is then twisted into one strong strand. This can be done easier if you leave one brick out of the course below until the wire is twisted up.

Another method is to simply lay in sections of hoop iron every so many courses. The weight of the bricks above will keep them firmly in place. This is illustrated a few pages on in the part about attaching door and window frames.

Some builders also use a light wire mesh which is obtainable from some hardware shops. It is a little narrower than the mud wall and is simply rolled out and tacked to the posts at either end.

Generally speaking a well made wall should not need any reinforcing, but if it makes you happier then do it.

PLASTERING AND BAGGING

If you intend leaving the bricks showing and in their natural state then it is a good idea to bag them. This is a simple operation and requires only some water and a coarse bag of the type that stock food come in. Dip the bag in the water and rub it on the wall. This will smooth off small lumps of mud, fill holes and result in a smooth dust free finish.

If this is done properly the wall can then be considered as complete. In our experience there are no dust problems with a well bagged wall, but if you happen to be using bricks which do cause a problem in this respect then you may like to paint them with some clear finish that will not greatly alter the colour or look of the brick.

BONDCRETE. Bondcrete is an acrylic based glue which should be obtainable from most builder's suppliers. It gives a clear finish and seals the surface.

LINSEED OIL. Another method is to paint the wall with raw linseed oil, obtainable from paint and hardware shops. This is a more natural finish and I have seen an old oiled garden wall in Japan that has lasted for centuries. The oil should be applied every few years.

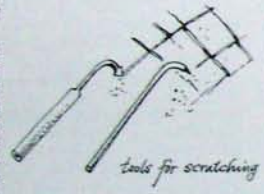
PLASTERING

Plaster can be applied in two ways, a single coat or a double coat.

SINGLE COAT PLASTER.

If you have been careful in making the wall then it will be ready to take the plaster. If however it is very rough then you may have to go over it with a flat spade to knock off the bumps, and you may also have to fill any bad holes with some mud plaster. Let this dry properly before going any further.

But if your finished wall surface is smooth then you will have to roughen it up. We use a tool made from a hooked piece of steel, it can be easily made and does a good job. Ours has some steel waterpipe on it to make a better handle, but you can use just a single bent piece of steel rod if you wish.


tools for scratching

INGREDIENTS FOR THE PLASTER.

No hard and fast proportions can be given for a mud based plaster, like brick making you must experiment with your own soils until you get the correct mixture. This is one that does not crack badly and is not dusty or crumbly.

For our most recent job we mixed 4 parts of a clay type soil with 2 parts of a sandy soil and added 1 part of builder's lime (obtainable from hardware shops). These proportions were arrived at after a couple of experimental batches and were different to those used on the previous job where the earth from the soil was usable without any other additions.

REINFORCING IN PLASTER.

If you can add some chopped straw to plaster then so much the better. It can vary from chaff size to 100mm. Good dried chaff like straw gives a nice golden fleck to the wall and also helps shed the rain. In our area straw is not readily available, and we have also used shredded paper with some success as a reinforcing agent.

SAWDUST IN THE PLASTER.

As we have trouble getting straw we have experimented with sawdust, one part to six, and found that it helps improve the plaster and helps prevent cracking. More sawdust could be added to a high clay soil. Always be prepared to spend a little time experimenting to get the right mixture.

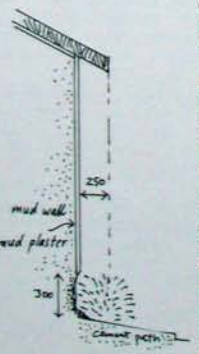
USE OF LIME.

We once began plastering a wall with a mixture that had lime it as mentioned above, and then decided to not bother with the lime. When the wall dried the section with the lime in it was a lighter colour, but apart from that we could see no other advantage. When scraped with the fingernail both plasters were equally as soft and the finish of both looked the same.

However a few days later we had heavy rain, and the gutters were not fixed in place at that time. The rain from the roof hit the path below and splashed up against the wall. This had no effect on the section that had the lime in it, but it damaged all the base of the wall that had been plastered without lime.

SPLASH PROBLEMS

The problem of water splash should always be kept in mind. The sketch shows the wall in question before the gutters were in place and the extent of the damage can be seen on the mud plaster that did not have lime in it.



However these measurements cannot be taken as a standard. This particular wall was fully exposed to the wind. Another wall of similar shape and facing the same direction had a well established bank of shrubs and trees near it, and this one showed not the slightest marks of splash damage.

APPLYING THE PLASTER.

Use a trowel in one hand and in the other carry something on which to put the plaster, either a proper plasterer's hawk or a simple homemade wooden paddle. The paddle is good in that it can be pushed into the heap of mud and used to scoop up as much as you need without having to use the other hand.

If you do not have a trowel there are quite a few kitchen implements that can be used to apply and smooth the plaster, have a look around. Even a paint scraper can be used.

TWO COAT PLASTER.

The only real reason to put on two layers of plaster is to get a better final finish. The first coat is the same as that described above. When this has dried it is scratched with the bent piece of rod as described earlier. This is then known traditionally as the "scratch coat".

The scratch coat should then be lightly misted with water before applying the final coat in order to get a good adhesion.

SECOND COAT If you want to have an earth coloured wall then the second coat is made just the same as the first except that the materials in it are sieved to get out all lumps. Add chaff or chopped straw to get that golden fleck and also the rain shedding effect, and also add a little more lime for extra weather resistance.

LIME PLASTER

If you do no want an earth coloured finish then the final plaster can be made from 1 part of builder's lime to 3 parts of fine sand, or plasterer's loam or your own soil. This will dry white or pink according to the colour of the soil or sand in it, and it is best to then give it a coat of whitewash.

WHITEWASH

Ordinary builder's lime (or garden lime, it is the same thing) is mixed with water into a creamy solution. In the old days they always added some salt to this as it was supposed to make it more scuff proof. I have tried it and cannot see any advantage, except for the negative one that the salt will attract moisture from the air.

We just mix lime and water in a shallow tray and apply it to the wall with an old broom. The broom is ten times faster than using a brush and you do not have to climb the ladder so often. The scrubbing effect of the broom also helps work the whitewash into the wall surface. It will take two or more coats to make a white wall.

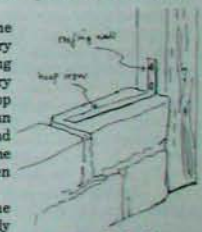
CEMENT AND LIME FINISH.

Whitewash will always rub off on hands or clothing and so is not suitable for places where people are likely to be touching it. There is a type of white cement paint known as Boncote which is good as a final white finish on earth walls but has become very expensive in recent years.

A mixture of equal parts of ordinary cement and lime can be mixed with water to make an equivalent but much cheaper paint. Yellow ochre can be added to give a better colour. White cement can also be used in the same way if a white finish is required, but this is much more expensive than ordinary cement.

FITTING DOOR AND WINDOW FRAMES

In the east blocks of wood are nailed to the door and window frames in order to provide a means to lock them into the wall. We have easy access to hoop iron and this provides an even better lock.



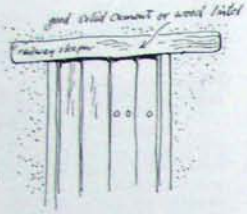
Stand the frame in place with temporary braces and begin laying the bricks up to it. Every so often nail on a hoop iron bracket. This can lay flat or go along and bend over the end of the brick to provide even more grip.

If possible fit the windows and doors early in the piece so that you know that they fit the frame. If they are fitted in place before you begin the wall then you will avoid the chance of jarring the fittings in the newly made wall by fitting them later.

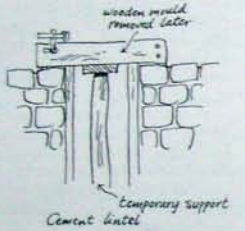
LINTELS.

Doors and windows should have good solid lintels above them, especially if you are going to have more bricks above them. Never underestimate

the weight of mud bricks, a weak lintel will soon sag and jam your doors and windows, as well as being dangerous.



Scattered throughout Australia there are the remains of many old cottages of stone and earth that would still be repairable except for the fact that the wooden lintels have all rotted out and brought down the sections of wall above them.



Consider casting a cement lintel in place if you do not have any suitable timbers, and do not forget to make sure that it has plenty of steel reinforcing rods in it and that they reach from side to side and into the walls. A temporary wooden framework is set up in the opening to support the cement until it has dried.

PATHS AROUND THE WALLS

Earth walls must be protected from the effects of moisture at the base of the walls. As I mentioned earlier they will take any amount of driving rain against them, but they cannot tolerate wet feet. In order to avoid danger from puddles sitting against the base of the wall, or water running along it during storms it is a good idea to have a cement or stone path along the wall at those points where you do not have a verandah. This does not have to be very wide, in fact it may be only a narrow strip between the wall and the garden and not used as a path at all.

This path also makes sure that you can always have access to the wall for routine maintenance work. Do not plant big trees near the walls, we are tree lovers and have always had problems in this direction, with paths slowly lifting and cracking under the pressure of expanding tree roots. Luckily we have never had an earth wall affected in this way, but it pays to be careful.

Also consider the roof line in relation to the path, and avoid situations where rain pouring off the roof can hit the path and splash up the wall.

BUMPED OUT BRICKS

This is a technique for use in special circumstances. I first saw it in Golmud, on the Tibetan Plateau, in April 1986, though oddly enough I had used the same technique in Queensland some years ago when I made a batch of bricks using a square gallon plastic ice cream container. Mud bricks are usually made in a mould that has no bottom, but in this case a mould with a bottom is used.

The advantages. and disadvantages, of this method are not readily apparent. It certainly does not affect the speed of brick making, for the young man I watched was making 400 bricks a day, working by himself.

The technique may have developed because of a shortage of water. The common mould without a bottom must be dipped in water between making each brick in order to get a good separation from the mould. If no supply of water is available then other techniques must be evolved.

Golmud is situated out in the desert, and we passed through a long section of Gobi to get to it. These bricks were being made outside the city and on the edge of the desert where there was no water available at all, except what was brought out in drums, and this tended to be too precious to be wasted in washing moulds.

On the other hand the moulds may have developed for different reasons entirely. For instance the brickmakers in this area may have decided that it was easier to carry the mud from the heap to where they were going to make the bricks in the mould rather than in the hands, and so put a bottom on the moulds for this purpose.

There were a number of men making bricks in this area, and it appeared to have been used as a brick field for many years, because the ground level was three metres lower than the surrounding countryside.

The mud was produced in pits. Water was brought out from the city and poured into the pits where it soaked in and turned the dusty soil into mud. The lumps were broken up using a tool similar to that illustrated earlier in the section on preparing the mud.

The resemblance of this tool to a hammer is superficial as only the side of the head is used and not the end.. The head is made from a section of log about 250mm long and 100mm in diameter.

The handle is the most curious thing of all, for it may be the height of a man, or a little shorter, but is only a little thicker than ones thumb.

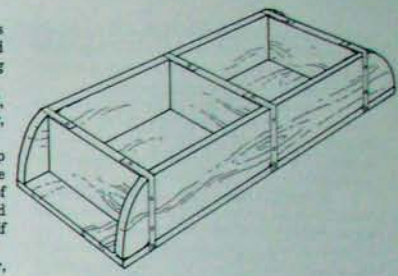
This gives it a tremendous amount of whip and flexibility, so that when the worker hits the clods of earth with what appears to be the side of the head a slight lift of the wrist will cause the head to fly up into the air ready for the next stroke as if it had a spring attached to it.

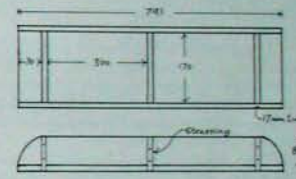
The powdered earth readily absorbs water, and is left overnight to mature. This is important in brickmaking whatever method is being used. Straw is not added in this area, for the very simple reason that it is not readily available, and in any case every scrap is needed to feed the animals.

Having prepared the mud in this simple manner, and without any laborious stamping, the brickmaker is ready to begin work. The mud is shovelled from the pit and placed close to where the bricks are to be made.

The mould being used here was constructed of 17mm thick softwood, probably scraps of pine flooring, and had been strengthened with strips of hoop-iron as it received much rougher handling than the common type of brick mould. It was designed to make two bricks at a time, each of them 300x170x80mm, an average sized brick for north-west China.

Before making a brick the worker dusted the inside of



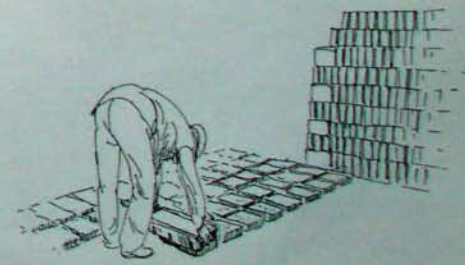


the mould. As mentioned earlier the soil here was very dry, and so was readily broken up into a fine powder. A pile of this was placed close to the mud heap.

Mud was now shovelled into the mould, and the excess removed with the shovel, the worker's hands did not touch the mud at all.

The mould was then carried to where the bricks were to be made and then turned over and bumped on the ground so that the bricks dropped out. The ground here had a natural fine coating of dust, so that the bricks did not adhere to the ground at all.

In this extremely dry climate they soon dried enough to stack, and did not require standing on



their edge as is the case in other more humid climates. The bricks were stacked in heaps, nine high standing on edge, the maximum height that a man could conveniently reach to stack them.

In most places there is a time lapse of 21 days between making a brick and being able to put it into a wall, but here in the dry desert the time was greatly reduced. The relatively small size of the brick also speeded up the drying time.

In Golmud, where I made these notes, the soil appears to be on the sandy side, as would be expected in the desert, and this seems to be very suitable for this particular technique. However it can also be used with heavy clay soils as we found when we first tried out the idea some years ago. The clay was broken up as small as possible, then wet and mixed with straw.

No particular measurement is used, the straw is simply added and mixed in until it looks to be sufficient. I know that this is not very satisfactory for those people who like to have everything explained in exact quantities, but that is the way that straw is added.

While this technique is fast and practical I am not suggesting that it is better than the normal use of a mould without a bottom. Its main virtue would appear to be in the circumstances in which I noted it, in desert areas where the soil tends to be sandy, with only a little clay in it, and where there is a real shortage of water and straw.

THE FINISHED PRODUCT

The sketch is one of the rooms we have added to our home, using the methods outlined in this book. The final surface was given a coat of mud plaster and then whitewashed, so the shape of the bricks cannot be seen.

The walls sit on a good foundation of rocks set well out of the ground to avoid rain splashing up against the base of the wall during heavy storms. In addition the foundations are also well below ground level to support the very considerable weight of the wall.

The rocks were laid with cement mortar rather than mud mortar to stop any chance of moisture creeping up through the mud (but of course mud mortar was used for the mud bricks).

400mm lengths of flat steel were pushed into the cement before it set, one at each corner and a pair by the French windows. The 50mm wide steel already had a couple of holes drilled into the 150mm section that stood up clear of the cement.

The cement was left for a few days to harden and then the posts were bolted to the steel. Top plates of good solid timber were bolted to these uprights and the rafters placed on these.

The rafters were straight round logs that a neighbour had felled on his property and was going to burn. They were good looking logs, 120 to 150mm in diameter, so we left them as exposed rafters inside the room.

Once the roof was in place we began building the walls free from the fear of sudden storms. At the right of the sketch you can see the length of chain that runs from the guttering. The rain clings to this and forms a most unusual tube of water as it runs down and into a gutter that leads to the duck pond.

A FINAL THOUGHT

Although earth building can be hard work take comfort as you stand there sweating that a good part of the exertion has been caused by your own stupidity in not planning the job through properly. In any case you sleep all the better after a hard days work. And there is no nicer room to sleep in than one made of earth, and one that you have created yourself.

BASIC RAMMED EARTH

Like the previous section this one was also originally published as a small booklet, in this case titled *Basic Rammed Earth* and first issued in 1988.

Most people who are considering building in earth think first about mud brick and quite a few beginners do not even realise that there are other methods of building in earth. So before going any further it may be as well to look at some of the choices available and what is good and bad about them.

THE GOOD NEWS AND THE BAD NEWS

MUD BRICK

The Good News

Mud brick is a very flexible material, as it allows for complex shapes and, if small bricks are used, can be tackled by anyone. Bricks can be made a few at time, as the opportunity arises, and stored until ready to be put into the wall. Moulds for mud bricks are very simple to make.

The Bad News

Mud bricks are labour intensive, every brick must be handled many times before it goes into the wall. From dirt to wall we have digging - mixing - putting into mould - first tilt - second tilt - stacking - putting into wall, at least 7 steps. Walls can only be used for load bearing if made very thick. There is also a time factor because at least 3 weeks must pass before bricks can be used.

RAMMED EARTH

The Good News

Speed is the greatest advantage - unlike mud brick, the handling is reduced to two actions, digging and tamping. It makes extremely dense, solid walls, a perfect material for a strong, well insulated building. Walls are good for load bearing. A fast method, earth goes from the ground directly into wall. More weather resistant than mud brick, though this is of little importance if the roof is sound.

The Bad News

Rammed earth is best suited for long, straight walls, and is not really suitable for complex plans. The work involved is also more physically demanding. The moulds used are much more complex to make.

WATTLE AND DAUB

The Good News

A fast method of building, the 'instant' house of many pioneers in this country. An excellent method of filling in small odd shapes, as can be seen on many old Elizabethan homes in Britain, where the spaces between the various angled timbers are filled in with this method.

The Bad News

The method is not intended for load bearing, but is always used to fill spaces. The method can only be used where a good supply of straight sticks (wattles) is available.

COB

The Good News

A rarely used method in which handfuls of mud are placed directly in position where the wall is to go. When this has dried sufficiently a further layer is added, and the wall built up in this method.

The Bad News

Because of the drying time needed between layers this is a slow method and the resulting wall is also rough in appearance. It is also considerably weaker than rammed earth.

COMBINED RAMMED EARTH AND MUD BRICK

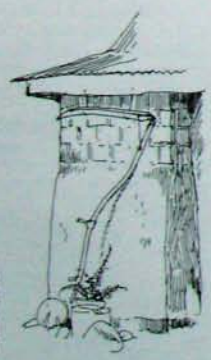
The Good News

An excellent method of building in which advantage is taken of the best aspects of each method. The lower half of the wall uses rammed earth giving strength and solidity where most needed. Rammed earth is also easiest to build at the lower levels and becomes increasingly more physically demanding as the walls go up.

Mud brick is used for the upper part of the wall and can thus be used around windows and any other odd shapes. If not load bearing the upper part can also be made a little thinner than the lower part and so save some time in building.

The Bad News

Bricks must be prepared at least 3 weeks before building takes place but apart from this it is a good family method of building as there is a variety of work to suit everyone.



CONCLUSION

The combined method, though new to Australia, can thus be seen as the best of the lot. Mud brick making is discussed in the previous chapter, and I also wrote *Mud Brick and Earth Building the Chinese Way* in which all the various methods are discussed.

The great aim in rammed earth building is to go for mass, the thicker the wall the easier it is to construct. This is because in a thick wall the tamping does not have to be so concentrated and exact, except on the outer edges.

A thick wall also looks better, as it gives a building an air of timelessness and solidity, and of course it is less likely to be damaged in any way. The only disadvantage of a thick wall is that it uses so much more earth. Interestingly enough a thick wall does not take all that much longer to build than a thin wall, once the material has been brought to the site, because the setting up and moving of the formwork takes the same time whatever the thickness of the wall.

When talking about a thick wall I mean something of around 500mm, which is thick by Australian standards, but which would be regarded as a very average or even a little on the thin side in some Asian and American countries. In the south west U.S.A. where a lot of rammed earth building goes on 24" (609mm) thick walls are considered normal as a good insulation against the summer heat.

The general principles of rammed earth are very simple, the details a little more complex. Briefly a wooden form is erected where the wall is to go and loose earth is put into this and rammed down firmly. The form is then moved along and the process repeated until the wall is completed.

It is not necessary to add straw or cement to the earth, and normally it is not necessary to moisten it. It is usually taken from the earth and put directly into the form without any other preparation. There is no waiting time when a form has been rammed, it can be moved immediately and relocated, though preferably not directly on top of the newly made section.

A freshly rammed section should be treated with a little respect as some soils take a few days to harden up properly and during this time the surface will damage fairy easily if roughly treated.

A well made rammed earth wall does not need to be plastered and is more weather resistant than mud brick due to the fact that the material has been compacted. The smooth surface also sheds the rain easier than a wall of unplastered mud brick.

However rammed earth walls can be plastered if desired, especially if the surface looks a little rough. The plasters are mud based and are discussed later.

Gaochang. The ruins of the wall stretch 3 Km.

LIFE OF A RAMMED EARTHWALL

As long as the building retains its roof, a rammed earth wall will last indefinitely and require little or no maintenance. I have seen any number of rammed earth buildings over a century old, with the walls as sound as the day they were built.

A few years ago I visited Gaochang, a once great city on the Old Silk Road that ran from China to the Mediterranean. For reasons that no one knows, but thought to perhaps be a slight change in climate that suddenly turned the area into a desert, this thriving city was deserted about one thousand years ago.

In time the roof timbers collapsed and the walls began to erode, but even today, a thousand years later, some of these earth walls still stand higher than a man, and a few very thick ones are not very far below their original height. Sections of the city wall also remain, entirely made of earth and still in parts higher than a three story building.

So you can see that rammed earth is permanent and certainly does not need additives, such as cement, in order to make it last.

One of the nicest aspects of an earth wall is its effect on the temperature. I notice this particularly in our bedroom. During the summer the room is always cooler than the outside temperature, even when the afternoon sun is shining directly on them. The earth mass is such that the heat never penetrates the wall and it retains a constant temperature on the inside no matter how hot it is outside.

In the winter the reverse happens. Although we live in the tropics our home is in the mountains and it can get very cold in the winter. On a cold night when frost is threatening it is sheer delight to walk from the outside into the bedroom, and feel the gentle warmth still retained by the walls from the winter sun. The contrast between this and the cold sterility of cement brick is most marked at this time.

To sum it up, rammed earth is simple, functional, and within the scope of anyone who does not mind a bit of physical work. Now to some details.

DECIDING WHETHER YOUR SOIL IS SUITABLE

There are various tests that can be made on soils, but the plain fact is that nearly all soils are suitable and common sense generally works as well as a scientific test. Soils can be anything from sand to clay. Now you don't have to be a scientific genius to work out that it is a waste of time going down to the beach and trying to build a rammed earth home from the stuff that you find there. At the other end of the scale you can build an earth home from pure clay, but pure clay is much rarer than most people imagine and what people usually have is a soil with a high clay content.

The main problem with this soil for building is that the higher the clay content the more it shrinks during drying, and as it shrinks it cracks. The quickest test for high clay content is to moisten it until it is like modelling clay, and roll some up into a sausage about the length and thickness of a finger. Now bend this into a circle and see what

happens. Pure clay will bend without cracking, but the higher the sand or grit content the more the material will crack. Very sandy soils will break before bending very far.

The best soil for rammed earth is what you might call sandy-clay. This has enough sand in it to dry without cracking, but enough clay to hold together into a strong mass. Fortunately most Australian soils are like this and earth homes have been built at one time or another in almost every part of the country.

The very centre of Australia is marked by the remains of an old rammed earth building, or it was when I visited it in 1971. This was originally Esther Station, which sits at the base of Central Mount Stuart, the official dead centre of Australia.

Many people think that earth building is a new skill in Australia, but it was a common method in the pioneering days, and even earlier in this century there were a very large number of earth buildings according to a census taken around the turn of the century.

To sum up, unless your soil is very sandy or has a very high clay content, it will be quite suitable for rammed earth.

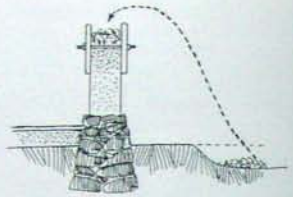
I have used soil with a high clay content and although it can be done there are two problems that soon become obvious. The first is that if the soil is only the slightest bit over moist it becomes plastic as you ram it, and instead of packing down under the blows of the tamper, it simply moves around. Even so this will still make a strong wall when it has dried. Such a wall can even develop bulges during construction, and the Chinese will belt the wall back into shape with the side of their tamper when this happens.

The second problem with high clay walls is that they inevitably develop cracks as the clay dries and shrinks. This can be minimised by putting in what the Chinese call the 'tendons' of the wall. These are lengths of thin sticks, usually split bamboo, placed under each course.

When the wall has completely dried the cracks can be filled with a mud mixture using the same soil as was used to build the wall.

Sandy soils also have their own problems. The worst that I have encountered was when using a very sandy soil. When the wall was three courses high we found that heavy tamping along the edge of the mould would sometimes cause pieces to fall off the lower sections. In this case we found the only remedy was to bring some soil in from part of the land where there was a higher clay content and mix this with the sandy soil. This solved the problem, but was not a good solution because it meant a lot of extra work in the mixing. We then searched around until we found soil that could be used without mixing and abandoned the very sandy patch.

The other disadvantage of the very sandy soil is that the surface is still soft when the formwork is first removed and can be easily damaged, especially when setting up the formwork for higher courses. Interestingly enough this seemingly crumbly surface changes as the wall cures over a period of weeks, and in time becomes comparatively hard. Even so such walls are better given a good coat of plaster as described later.



DIRECT FROM EARTH TO WALL

PREPARING THE EARTH.

The great thing about rammed earth is that the soil needs no preparation. It is simply dug from the ground, big lumps broken up and large stones removed, and placed directly into the mould, to be rammed. Even though the surface of the ground may be quite dry, only 100 or 200mm down, it will probably contain enough moisture to be used in a wall.

On the other hand, soil that has been dug up and heaped up and is then soaked in a shower will be found to be useless for rammed earth as it sticks to the tamper and moves around as slush instead of tamping down firmly. In this case the heap has to be abandoned until it dries out a bit, or a new lot dug up (and kept covered when it rains).

Soil in a heap will retain a consistent degree of moisture and be suitable for ramming as long as a few simple procedures are followed. The heap should be as large and compact as possible, a high large heap is also better than a shallow one, and much better than a number of small heaps.

When taking soil from the heap always take from the outer edge, rather than digging deeply into it. In this way the soil which would dry out fastest is being used up before it becomes useless for the work in hand. Digging deeply into the heap will also cause the whole heap to dry out too quickly.

In hot dry weather the heap should be kept covered with whatever is at hand, plastic will keep the moisture in the heap, but sheets of iron or even cardboard will do the job. The main thing is to stop the moisture drying out.

Re-moistening a heap is a slow, laborious job, so it is well worth taking precautions to avoid it. If a heap does dry out then the easiest way to get it back into working order is to sprinkle it with water, cover it with plastic and leave it for a couple of days then repeat the procedure until the heap is moist.

In any case if a heap is large and compact the inside will retain its moisture for a surprisingly long time, in the same way that the natural soil does. We have used soil taken directly from a heap that had been dumped four years earlier and it was no different to taking it from the ground.

USING MACHINERY.

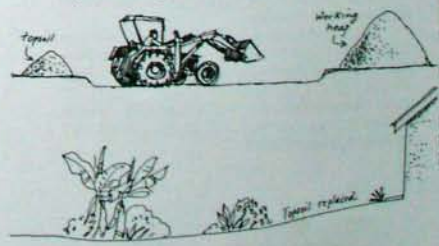
If you have to use a shovel to excavate your soil you have my sympathy, and I wish you good luck and easy digging. Digging is not all that easy and if it can be avoided so much the better. Sometimes the soil can be obtained as a bonus by-product of some other process. I once acquired a large and useful heap after a pool had been dug. This cost nothing and in fact saved money as the soil did not have to be carted away.

On another occasion I found I could do a deal with a local contractor. When excavating house sites contractors often have to cart away a lot of soil and this is an expense to them. For the price of his petrol plus a little extra the local man was happy to dump spoil at our building site. Having already been dug up this soil is usually already in just the right condition to be put directly into the wall, having first removed any sticks, stones, or lumps of good garden topsoil.

It is worth remembering if taking this approach that contractors often have to drive long distances to dump soil from building sites, and if your land is closer they may be more than willing to dump it there free.

While on the subject of topsoil arriving in the load, this should be treated as a bonus rather than nuisance, and put to one side for later use in the garden. Topsoil is one of our precious resources and should never be wasted in a wall. Apart from that it is not all that satisfactory for ramming, and the sight of squashed worms brings little pleasure.

If the soil has to be obtained from your own land then the obvious thing is to get it when digging foundations and landscaping the site. In the previous chapter I have explained how we sometimes get a backhoe to move the topsoil to one side, provide us with earth to work with, and then replace the topsoil.



On one job we planted and watered this area immediately to avoid any erosion problems through sudden storms and today it is impossible to see where the excavation took place.

An even more adventurous approach would be to plan the excavation so as to create a Japanese garden, with pools and small hills, and again with the topsoil replaced in the areas where it would do most good.

MAIN POINTS.

1. Discard large rocks, sticks, and good topsoil. Small gravel stones are usable as long as the earth is not too sandy. The less work you have to do the easier the job will be.

2. If you can get the earth for little or nothing you will be saving money, so look for excavations taking place in your area.

3. Once the soil is stacked make sure it is kept in working condition, neither too dry nor too wet. Cover it against the effects of sun and rain.

THE FORMWORK.

Now we come to the part of the job that often puts people off building with rammed earth. The form can be simple or complicated, depending on which style you decide to use, and it can be cheap or expensive depending on which materials you can scrounge.

There are all sorts of different forms in use for rammed earth work, and as all of them produce the same result your choice will depend on the size and complexity of the job as well as the sort of person that you are.

A complex form will take longer to make but will speed the job up over a long period. However on a small job, say a single room, it may make more sense to use a simple form. In situations where there is ample available loose soil and a thick wall is desired, the most primitive of methods may well be the easiest and most efficient.

COMPLEX FORM

The Good News The complex form will build a higher section of wall at one time before the form has to be moved and will create a more even surface than the other types.

The Bad News It is more expensive to build than a simple form and takes longer to construct.

SIMPLE FORM

The Good News The simple form is only a little cheaper to construct than the complex form, but can be constructed much faster and requires less skill.

The Bad News. The simple form is usually not as tall as the complex form and so does not make so much wall at each position.

POLE MOULD

The Good News. The mould simply uses round bush poles and requires no skill in construction. Pole mould walls often go up faster than other methods.

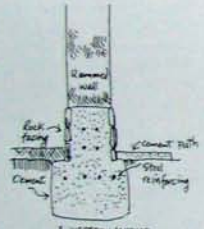
The Bad News. The finished wall has an uneven surface which needs trimming later. The wall is usually thicker and so needs more soil to construct.

FOUNDATIONS

Because of the great weight involved all earth buildings require strong foundations, similar to those that would be needed for a cement brick wall. Local council regulations for these vary from one place to another so the best idea is to ask local builders about the regulations for your area.

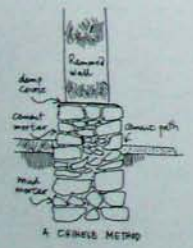
If you are building out in the bush and without council permission it is still common sense to abide by regulations as far as this important part of the building is concerned.

Foundations should be at least half a metre deep and should also be wider than the wall if you are following the Asian methods of building. First the trench is dug and then rocks are put in with a mud mortar up to ground level. Above ground level it is best to use a cement mortar.



A WESTERN METHOD

Councils in Australia would require a cement mortar all the way, but in China mud is more usually used. The reason for using cement above the ground is as a protection against local flooding. The foundations should be taken up about 300mm above the ground, or up to the level of any expected flooding.



A CHINESE METHOD

In the East mud mortar is often used for the whole job and in that case some tar paper or similar waterproof layer is put on top of the foundations to stop moisture rising up from the ground into the wall.

In part of China where there is no local rock for foundations the earth is removed, often to nearly a metre deep, and then rammed back into place. A waterproof layer is then placed on this when it is clear of the ground in the same way as with rock foundations.

It is a very sound idea to put a cement path or a cement gutter against the base of any earth wall that is not protected by a verandah as this stops the earth getting wet against the base of the wall. It also helps stop tree roots and plants getting a hold and breaking up the base of the wall.

The forms used for making the wall can be of three types, complex, simple or poles, and these are discussed below. Read all of this in order to understand the principles of rammed earth building.

COMPLEX FORM

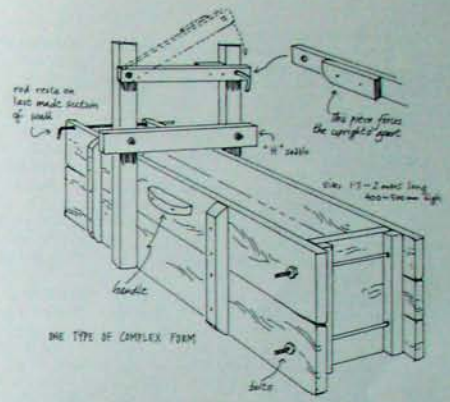
There are many designs available for complex forms and each has its own virtues and faults. The one described here is not as complex as some, and is based on a pattern commonly used in China. Its virtue is that it is a comparatively easy one to make and it has not too many disadvantages, except that the saddle is sometimes a nuisance when you are working.

The trap in building this form is using too thin timber for the sides. The pressure developed in ramming is much greater than the beginner imagines, and a bulging form creates all sorts of problems. Try and avoid the temptation of using old floor boards for this job, the amount of reinforcing needed to make the sides rigid will defeat the savings in material. However if flooring is all you have then use it, but make it strong with plenty of vertical strips.

The timber should be strong and at least 25mm thick. One wide plank can be used for each side, but two or three planks work just as well if you cannot find a single wide one. It doesn't matter if it is old, second-hand and full of holes. Holes up to 25mm do not present any problems and do not even have to be blocked up.

The end of the form can be made of quite light timber as it does not have to withstand the same pressure and is supported in any case by steel rods. The saddle can be made of any available scraps of around 75 x 100mm, or even natural sticks if you use the second type of saddle.

Although the complex form takes much longer to make than the other two, it is still the most popular form for home building in China. This is because it has two important advantages.

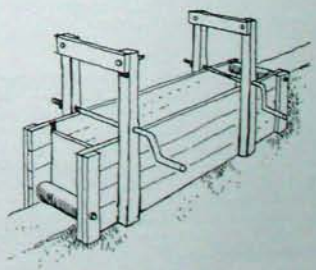


ONE TYPE OF COMPLEX FORM

First it will produce a wall with a smooth finish, which cannot be done with the pole mould method, and secondly it will make a taller section of wall at each position than is the case with the simple mould. Moving the mould is a time consuming operation, so this greater capacity is quite important in speeding up the work.

EVEN MORE COMPLEX MOULDS

The three types of mould described here are based on my Chinese fieldwork. There are even more complex moulds used in Australia, beautiful examples of the cabinetmaker's art that cost a fortune to build, but will produce a wall as smooth as if it was made of poured cement. Middleton's *Build Your Home of Earth* has examples of this type of mould, such as this one with rollers and crank tightening.



USING COMPLEX MOULDS

The complex mould is made with an end fixed in place with bolts or steel droppers. The end can be replaced when making thinner or wider walls, and can also be removed when the mould is being stored, allowing it to be packed flat.

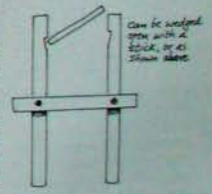
As mentioned earlier the mould should be made of good stout timber. I once made one out of floorboards, but found the sides bulged when ramming was taking place and I had to make an additional saddle to counteract this. 20-25mm thick planks will do the job. The end can be of lighter timber.

THE SADDLE

There are two basic types of saddle used in China and as both are equally common it is impossible to say that one is better than the other. As far as the finished wall is concerned there is a difference in that the mortised saddle leaves 40mm holes in the finished wall.

H SADDLE

So called because it looks like a letter H. It can be quickly made with scraps of 75x50mm timber, or any other off-cuts. A pair of bolts joins the three pieces, or even heavy nails. The two



uprights must be able to pivot.

A fourth piece of timber is used as a wedge. As it is pushed down it forces the lower part of the H tightly against the sides of the mould. There are a couple of ways of doing this, and the one shown here shows a stick which is forced into place. You may have to make a nick in one side of the upright to stop that end of the stick moving while you hammer down the other.

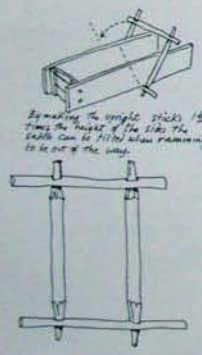
Another method is shown on the saddle on the top of the previous page. This one is bolted to the H on one side and held with a length of steel rod on the other.

When using this saddle the Chinese generally stand the mould on two thin sticks broken from the nearest tree. These are later pulled from the wall when the form has been moved and a pellet of moist earth pushed into the hole to cover it up.

If you do not want to do this then fix a steel rod across one end, on the top of the wooden sides (as shown in the drawing on top of the previous page). This will rest on the previous rammed section and support the mould at that end. The mould end piece will support it at the other.

MORTISED SADDLE

This is made with natural round timber which should be reasonably straight. The upright pieces are tapered and fit into slots in the horizontal sticks.



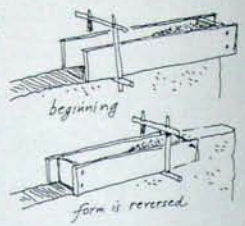
When using this saddle the bottom stick is placed on the wall. The mould sits on it then the other sticks are dropped into place. When the section has been rammed the saddle is dismounted and the form moved, leaving the bottom stick embedded in the wall. This is then pulled out. In order to do this easily the bottom stick must be straight and smooth.

Farm buildings made with this method can be readily recognised by the pattern of holes across the wall, for although it is easy enough to plug them with a wad of moist earth many builders in China do not bother except when making walls for houses.

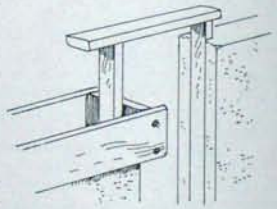
I found that it does not take long to make one of these saddles from bush timber and they work quite well.

BEGINNING A COURSE

If you are going to begin work at the right hand end of the wall then the closed end of the mould will be to your left all the time except for the very first filling.



There are a number of problems which arise when beginning at a door or window frame, and these will become apparent when you begin work. It is best to build frames into the wall rather than try to attach them later.



Wrap the mould around the door frame as shown. In this way the frame will be built into the wall.

If you do not want this then drop in loose lengths of timber on each side of the frame to fill the space. When these are later removed the frame will stand out from the wall.

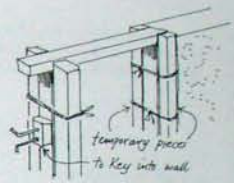
In this case there should be some blocks nailed onto the edge of the frame and these will lock into the wall.

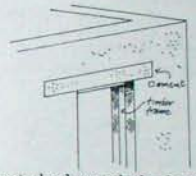
LINTELS

The top of door and window frames also present problems because of the enormous load they are called on to bear if you place rammed earth above them. Put some earth in a square ice cream carton and compact it. Weigh this and then calculate how many such cartons would be needed to fill in the space above your door and you will be surprised at the weight involved.

For this reason it is often more convenient to take windows right up to the top plate and put skylights above the doors.

If you wish to have a rammed wall above the door then a stout lintel must be constructed. I have successfully used railway sleepers for door frames, but if you cannot obtain heavy logs a cement lintel can be constructed on top of the door frame.





A temporary frame has to be built to support the cement while it is drying. A few lengths of reinforcing steel rod must also be placed in the cement and must be the full length of the lintel, which extends at least 400mm into the wall on either side. The lintel should be 100-150mm thick.

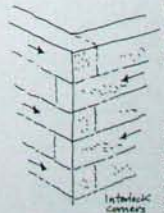
REINFORCING CORNERS

Rocks are sometimes set into corners which take a lot of knocking. If rocks are used then the greatest length must go into the wall in order to get a good bond with the rammed earth.

I would not advise using rocks unless you feel you really have to, as they can create as many problems as they solve and, unless very well fitted, can actually weaken a wall rather than strengthen it.

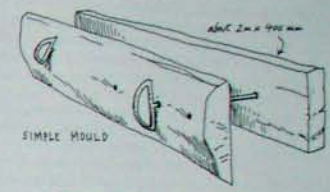
REINFORCING COURSES

When working with heavy clay soils subject to cracking, some form of reinforcing can be used between courses. The Chinese use split lengths of bamboo or long thin sticks. Some Australian experts recommend barbed wire, but I have tried this and would never use it again. It may do the job once it is embedded in the wall, but it seems you always get torn and cut before you see the last of it.



STAGGERING CORNERS

In order to achieve a staggered corner the laying of the courses must follow a fixed sequence. If the first course is laid from left to right then the second must go from right to left, and so on.



THE SIMPLE MOULD

The simple mould is made from two wide planks (or narrow ones fastened together) and is used when no complex mould is available. In China professional wall builders all use the complex mould and most big farms have one. A small farmer will borrow one if he can, but if not will knock up a simple mould.

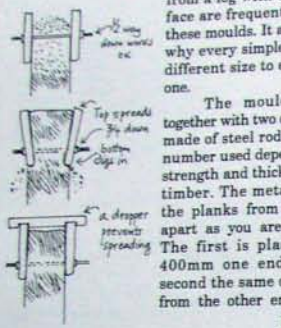
The timbers for a simple mould have to be wide and strong. The wider the plank the more wall can be rammed at the one time. Only one side of the plank needs to be flat, so for reasons of economy the forms are often built with offcuts from the timber mill, as these can be obtained cheaply.

The length of the plank does not matter, but 2 metres or a little more is the average. It also makes no difference whether the bottom edge of the plank is straight or irregular, so quite rough looking timber can be used for this job, as long as it is wide.

These measurements may seem a bit vague, and in fact it would be impossible to give exact information.

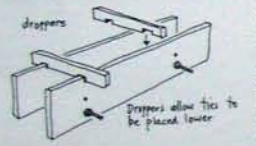
For instance I could say "Take 2 lengths of timber 2000x400x25mm and drill a hole 400mm in from each end. . . ."

I could go on like that, but that is not the way the simple mould works. That sort of timber costs a lot of money and the philosophy behind the simple mould is that you scrounge whatever you can get as cheaply as possible, or better still free. That is why rough first cuts



from a log with only one flat face are frequently used for these moulds. It also explains why every simple mould is a different size to every other one.

The mould is held together with two or three ties made of steel rod. The exact number used depends on the strength and thickness of the timber. The metal ties stop the planks from spreading apart as you are ramming. The first is placed about 400mm one end and the second the same distance in from the other end. If the plank is very long, or flexible, then another will be placed in the centre. If the plank has a weak spot it may be an idea to also place one there.



The positioning of the ties requires no brain fatigue at all, they are simply placed where you think they will do the job. If you later find they need to be moved it is a simple job to drill more holes, and the old holes do not have to be filled in. We have often had to drill extra holes in our planks to make them fit in odd positions.

The holes can be drilled about two thirds or more across the width of the plank, or they can be drilled halfway.

If drilled halfway the mould sits on the previously rammed section as shown. When you put in new earth and ram it, the top of the mould cannot spread because the bottom part prevents it from doing this. The only disadvantage is that only a small section of wall can be rammed before the mould has to be moved.

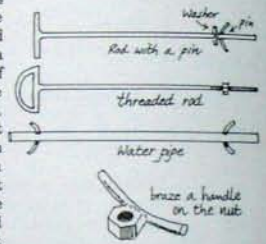
If the holes are drilled two thirds or even three quarters down a different situation arises. When new earth is rammed in there is a leverage effect and the bottom of the mould can dig into the previously made section. To prevent this droppers of wood are made which sit on the top edge and prevent it spreading.

They also get in the way when you are ramming, but this disadvantage is offset by the fact that you can ram a much higher section of wall.

THE TIES

The ties can be made of 10 mm (3/8") or 12mm (1\2") mild steel rod. The smaller size can handle the job, but gets bent easily so use the thicker rod if you have it.

The Chinese generally make a simple T shape as illustrated. We have improved on this design by adding a curved handle. This makes it much easier to pull out of the wall.



A hole is drilled in the other end, and this is always a problem area if you use the thinner rod. The hole must be large enough to accept a 75mm nail, but a hole this size makes the rod very weak at this point and it is easy to bend or break it. This is much less a problem with the thicker rod.

One problem with using 75mm nails is that the ramming sometimes causes them to bend and jam in the holes. It is essential to use large steel washers between the nail and the wood, and they help prevent the nail bending to a certain extent, but jamming still happens.

The thicker rod can accept a larger hole, and so a bigger nail or piece of steel can be used and this is less likely to bend.

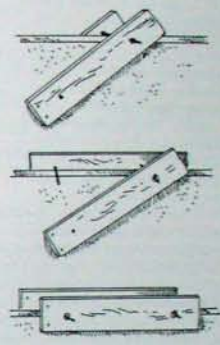
The ideal set-up would be a slot into which a key could be dropped, similar to that used on bullock bows, but the cutting of slots in steel of this size is beyond the scope of most home builders.

We have also experimented by threading the end of the rod using nuts to fasten the job together. This works quite well, but you need a wire brush handy to clean the threads of dirt each time the nut is removed.

Another idea is to use steel water pipe with holes drilled at each end. Bent pieces of steel rod are slipped into these to hold the timbers in position. By bending the steel pin it can be slipped in easily but will not drop out by itself.

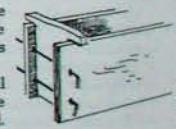
SETTING UP THE MOULD

The planks are often very heavy so a technique has to be worked out to make the work easier. If working alone you prop up both planks so that one end is above the job then put a tie in position. One plank is then lifted up and the second pushed through so that it sits on the top of the wall. The other end is then lifted and fitted to this tie.



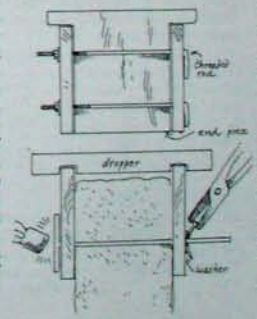
When working with two people we use a different technique. Both ties are put through one plank and one worker lifts this onto the wall and holds it there. The other then fits his plank onto the ties. With very heavy planks, this sometimes calls for strength and co-ordination, and often the first method is the easiest.

The pins or nuts are put in place, then the droppers, and the mould is ready for use.



If you are doing infill work between posts the moulds will not need an end. However if constructing a load-bearing wall an end will be needed.

This is simply made with any scraps of timber. It hangs in place and is prevented from spreading outwards by a couple of lengths of rod.



Threaded rod can also be used, and this serves the double function of being a tie as well.

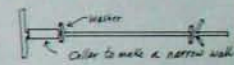
With the mould set up the earth is thrown in and rammed down firmly. When the mould is full the ties are undone. Sometimes the nails bend or jam and it is necessary to have someone gently tap the opposite end of the tie while the second person grabs the nail with pliers and pulls.

The tie should always be pulled through the wall, never hammered from the other end. Hammering will put a burr on the end of the rod and make it harder to pull through. Since we put the loop handles on our ties we have no trouble in pulling the ties through the wall by hand.

Obviously this method leaves small holes in the wall, but these can be quickly filled with pellets of moist earth.

CHANGING THE WIDTH OF THE WALL

When using threaded rod for the ties making a narrower wall simply calls for moving the nut in further, but when using ties with a hole bored in them, a different situation arises.



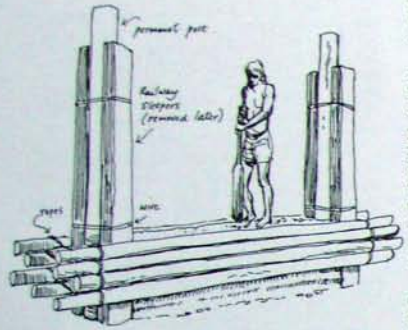
It is best not to drill more than one hole in the rod as this weakens it. A better idea is to cut some collars from steel waterpipe. These are slipped over the end to make the mould smaller.

POLE MOULD WALLS

This very basic method of construction is used throughout northern China, mainly for the large walls that surround farm buildings and country houses. I have used it and find it a good method where a thick wall is needed and a rough surface is not a problem. Even though the wall is thicker than with the other moulds and uses more earth it seems to go up faster, possibly because the tamping does not have to be so intense as with the other methods.

The principle is both simple and interesting. The formwork consists simply of loose poles stacked one on top of the other to form a rough partition on each side of the area where the wall is to be built. Earth is thrown in and tamped down, and as the wall goes upwards the poles at the bottom are removed and placed in new positions at the top. It is this leap-frogging of poles that makes this method unique.

One of the disadvantages of joining one section of a pole mould wall to another is that there

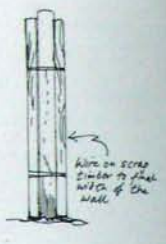


is a weak spot between each section, because there is one long join from the top of the wall to the bottom. (With other types of rammed earth building each section is staggered above the one below to create a locking effect.) As a result pole mould walls frequently develop cracks at these points. These can be plastered with a straw and mud mixture after the wall has properly dried out, but this rather spoils the appearance if you want to leave the finished wall in its natural state. However because this type of wall has a softer outer surface than the other types it is usually a good idea to plaster the whole surface to avoid dust problems.

FILLING A SPACE BETWEEN TWO POSTS

Rather than joining one section to another I have found this a good way of filling in the space between the two uprights that will be supporting the roof and in this case cracks do not develop between sections.

When this method is used for a single section of wall between two posts, as illustrated, the set-up is the same at both ends with the logs held by tightened cords as described later.



The walls should be at least 50mm thick, so if the house uprights are not this wide they should have extra pieces of timber, such as old railway sleepers, wired on to bring them up to the same width. These pieces of timber are removed when the wall section is completed and the wires are also pulled out.

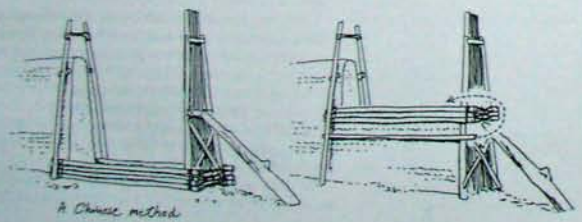
Now to begin work. The foundations should extend a little way out of the ground and the first two poles are placed in position, one on each side of the foundations. These poles are simply natural round poles and should be reasonably straight. Being a natural pole they will be thicker at one end than the other but this does not matter. Thick and thin ends should alternate one above the other and so even out the effect.

Earth is thrown in between the poles and rammed firm just as in the other methods. When the wall has come up to the height of the poles one or more of the bottom poles are untied and lifted up to raise the height so that more earth can be thrown in.

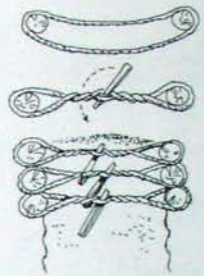
The number of poles used for pole mould work is simply a matter of choice, 4 on each side is quite satisfactory, but more can be used if desired. A greater number of poles does not necessarily speed up the work, it only means that a greater number can be leap-frogged at the one time.

As the wall grows in height care must be taken to always tie the poles tight and ram the wall firmly on the outside edges in order to prevent the poles sliding down.

As ramming takes place it causes the poles to try to move apart. To prevent this they are held together with a loop of rope.



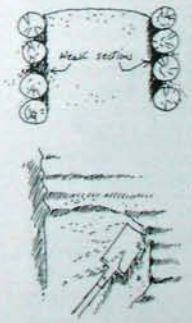
The knot in the loop can be tied firmly, it will not need to be undone during the job. The loop will need to be wider than the wall, as will be seen when you come to tighten it. Make sure the rope is strong enough for the job, 8mm diameter silver rope does the job well, but any light rope will do the job.



A small length of stick, 200-300mm long, is put in between the cords of the loop and twisted to tighten it, and the stick is then wedged against something, usually the upright post, to stop it unwinding. Sticks should not be wedged against ropes holding the poles in the pair below as the lower rope will be removed when the leap-frogging begins.

We have experimented with different methods of tying the poles together and found that the loop is the best method, as it is easier to tighten and untie than any other method.

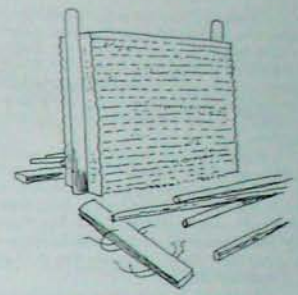
When tamping this sort of wall it is impossible to get direct pressure on parts where the poles meet and because the poles seldom meet all the way along there are often gaps between them, and the earth in the gaps does not get rammed.



When the poles are removed these sections are usually weak and crumble easily. For a rough wall this does not matter, but if a reasonably smooth finish is needed these crumbly sections will need to be trimmed back. We have found the best tool for this job is a small square spade. If the edge is sharpened a little it will work even better.

It is best to leave this trimming for a day or so after the wall has been completed, as the surface will have begun to cure a bit by then and be less crumbly, and so a neater job can be done.

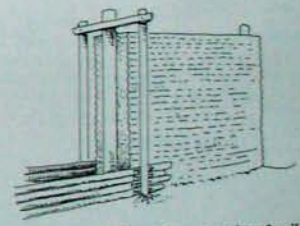
When the desired height is reached the poles are removed and also the scrap timber that had been wired on to the uprights.



MAKING A LONGER WALL

When making a wall longer than one section only the first can be put up with cords at both ends. The second and subsequent sections must be made in a different way.

A post is sunk into the ground on each side of the end of the first section of wall. The gap between the posts and the completed section of wall is just a little wider than the thickest pole used in the formwork. These posts stop the formwork poles from moving outwards and so must be sunk into the ground far enough to achieve this purpose. They are fastened together at the top to stop them spreading.



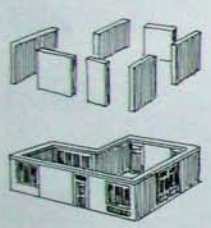
To begin work on the next section of wall the poles that make up the formwork are dropped into place between the upright posts and the previously made section of wall.

Scraps of wood are used to wedge the poles firmly in place. These wedges should be blunt at both ends so that they can be hammered in and out easily. The other ends of the poles are tightened with the loops of rope as described earlier.

It usually takes two people to move the poles each time, one knocking out the wedge at one end while the other untwists the cord. Although rammed earth work can be done solo it is really a group activity, especially as the wall goes higher, because the person doing the tamping does not want to have to be continually jumping down to shovel in more soil.

If making a wall of more than one panel it is important to firmly ram the area where one section is joined to the next as this is the weakest part of the structure. Even with good ramming vertical cracks will often appear at this point as the wall dries out, because this method basically creates a series of blocks sitting side by side, with nothing to bind them together.

This is why, for appearance sake, it is better to have a structural post dividing each section.



Another idea is to construct the house around a series of free standing sections of wall. The doors and windows are placed between each section. This has the great advantage of allowing flexibility of plan in a method which is generally regarded as not very flexible. Having laid out the sections at whatever angles desired the tops are tied together with a cement and steel reinforced top plate.

USE OF SQUARED POLES

In Xian and other parts of northern China, the pole mould building that I have watched in progress used round timbers, just as they came from the tree. However west of Xining, on the Tibetan plateau, I saw walls being put up using roughly squared timber.

Planks are not suitable for this as they will bend in the centre when tamping is taking place. The timbers used are logs with a flat surface adzed on two sides and roughly trimmed top and bottom.

Because these poles require more preparation only two or three are used on each side.

The advantage of using squared planks is readily apparent as the finished wall has a much smoother finish.

AN EVEN MORE SIMPLE METHOD

We have used this simple method with success on a number of walls, and it requires very little preparation. Post are erected every two and a half metres and these should be as thick as the wall is going to be when finished. If not then extra planks should be nailed to them to get the required width.

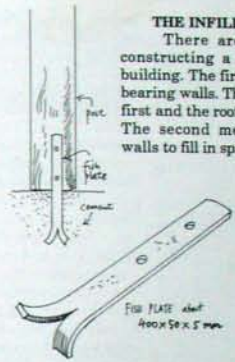
The planks sit one on each side of the posts and are held together with G clamps. If the planks are thick a couple will do, if not then more may be needed.

The planks sit on a couple of lengths of steel water pipe, and this is pulled out of the wall after each section has been rammed.

DOOR AND WINDOW FRAMES

Door and window frames are set in position before work begins, and a working method must be used which allows them to be locked into the structure, this is discussed in the previous chapter.. The doors and windows are then set into the frames when the ramming of the walls has been completed. This allows for easier access and also avoids damage.

On the subject of damage the Japanese, who do a lot of earth building in the form of wattle and daub, wrap all the timber that is to be exposed in paper during construction. When the job is finished the paper is removed to reveal the timber clean and free of mud splatters.



THE INFILL METHOD.

There are two ways of constructing a rammed earth building. The first is to have load bearing walls. The walls are built first and the roof placed on them. The second method uses the walls to fill in space Posts are set into the ground and the roof erected on them before the walls are completed. As mentioned earlier this is a very convenient method of building if you are in an area where rain can come at any time of the year. I live in such an area and so favour this method.

When the foundations are being built, steel fish plates are set into them. These can be bought but we usually make our own from scrap steel, cutting out the holes with an oxy torch.

The upright posts are then bolted to these, and then the roof built on top. It will be necessary to put some temporary bracing on the job to keep everything square until the rammed earth is begun.

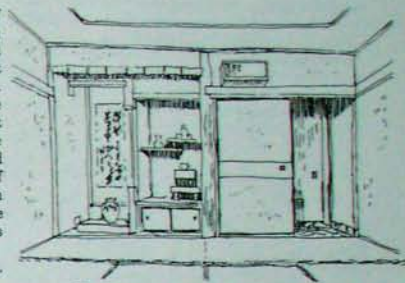
THE POSTS

Many potential owner builders in Australia appear to be more interested in creating a load bearing wall and then placing the roof structure on top of this, than using the infill method.

Their reason for this is often connected with the cost of the upright posts, and this is a very valid argument if you intend purchasing massive sections of milled timber, even old electricity poles can be expensive when cartage is considered.

One possible alternative is to purchase very long strainer posts from a fencing contractor. These are always solid, straight and of rot resistant timber (as are the electricity poles). I have had no trouble in obtaining these 2 or 3 metres long.

The best method of the lot, if you have a few acres or can get out into the bush, is to collect your own. Remember that a handmade house does not have to have everything in it mathematically straight, and natural shapes can add a lot of character.



The Japanese make use of this philosophy in their buildings and quite often the feature post of a room alcove will be a carefully chosen log in its natural shape with the earth wall following its curves. The sketch shows a room that I have often stayed in on Shikoku Island, with a natural log as a feature of the alcove, as well as a length of bamboo. The walls are of earth, but plastered so that this is not obvious.

When selecting timber in the bush try and choose already dead timber. If it has been dead for some time you win two ways, for one thing it will already be dry and seasoned and for another if it has not begun to rot or be eaten by insects then you can be assured it will be a lasting variety for your house.

In any case with good foundations well out of the soil and the poles not being in contact with anything other than the foundations and the walls, there is much less chance of any problems arising.

I have used bush timber a lot in particular for a kitchen which we built entirely out of timber from our block, and the only real problems that arose was due to my own neglect in having some of the upright posts sitting on a section of foundation that was too close to the ground. This allowed termites to bridge the gap and get into the base of the timber, and incidentally taught me the hard way that one inflexible rule of earth building is that neither post nor earth walls should be in contact with the ground. There must always be a good foundation to provide a safety zone.

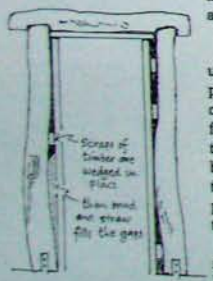
When bush poles are used to form a doorway, it becomes necessary to create at least one straight edge for the door frame. This can be done by adzing one side of the timber.

bolted. The posts that come on either side of doorways also have flanges welded onto them, so that you bolt small blocks of timber to them and nail the door jamb to these. Or the jamb can be bolted directly to the post.

One great thing about steel posts is that they can be set into the cement of the foundations and so create a very strong framework. With the steel posts in place the roof can be erected. During this work the whole structure will need bracing as it is quite flexible despite its strength.

Another method is to make a normal door jamb from milled timber, then use scraps of timber to fill the gap between this and the post wherever you are going to nail. This gap is then filled in with a mixture of mud and straw.

Some people do not believe that such a simple means can be used to fill up such gaps, but I can assure you that it works and that it is permanent.



STEEL POSTS

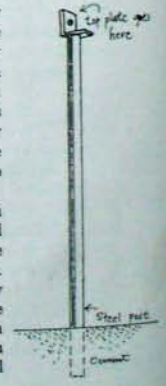
Steel posts can be used instead of bush poles. They are concealed inside the finished walls which then look like load bearing walls, and in fact the walls do play a vital part in the stability of this type of construction.

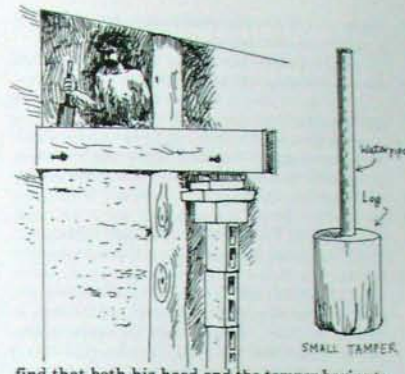
The steel posts need not be massive, we have successfully used 50mm water pipe for ordinary rooms. The pipe needs to have a flange welded onto the top to which the top plate can be

The stability comes when the steel posts are built into the earth wall. The walls are built so that the poles sit in the centre, the thicker the wall the better at this point. Make sure the earth is well rammed around the posts. I have also used this method in conjunction with mud brick construction.

Whether using mud brick or rammed earth, the beauty of the steel posts is that once firmly buried in the wall they remain structurally sound and maintenance free. The great mass of the earth wall provides stability and the steel firmly connects the roof structure through the walls to the foundations.

With the roof in place both you and the work are protected from both sun and rain and so the work is made much more pleasant. However this method has one very obvious problem which will become apparent as the wall grows in height, and this is that the person standing on the growing wall will





find that both his head and the tamper begins to come in contact with the top plate.

SMALL TAMPERS

The solution to this is to make some smaller tampers. The sketch shows my offsider working on a small section of wall. The sketch also illustrates a solution to another problem, what to do when the form is longer then the wall to be made. In this case we stood the end of the form on bricks.

These small tampers can be made quite quickly by using a tomahawk to trim down a section of log or even a scrap of milled timber. Using scraps of pine logs I have knocked one up in 15 minutes. A piece of water pipe and some timber also makes a quick tamper.

For a start a tamper that comes up to your waist will be handy, allowing you to still stand on the wall, but later the work will need to be done from the side and for this a tamper that can be held in one hand is needed.

Our smallest tamper is 600mm long, but the Chinese often use even smaller ones. With these they can finish a rammed wall right up to the top plate.

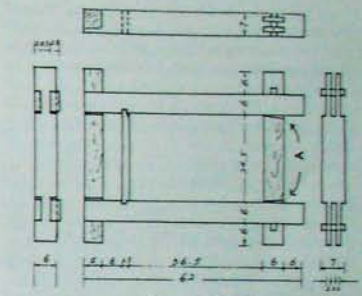
I prefer to use mud bricks for the very last section, but this is only a matter of choice and you may prefer to take the rammed earth all the way. Structurally the two methods blend together well and present no problems.

The only obvious disadvantage is that you have to prepare the mud bricks some weeks before you begin the rammed earth wall in order to have them dry.

Irregular shapes such as where the wall joins the roof, can create lots of problems in rammed earth, and this is where the use of bricks comes in handy.

RAMMED BRICKS

In northern China the delay caused by waiting for mud bricks to dry is solved by using rammed bricks for these awkward areas. Rammed bricks require a special form and technique and are described in *Mud Brick and Earth Building the Chinese Way*.



Rammed brick form

In theory a rammed brick can be placed in position as soon as it is made, using a plain mud mortar, but in practise it is better to leave them in the sun for two or three days to dry, as they are very fragile when newly made, even though they are used to build immensely strong buildings.

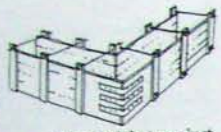
Rammed bricks break easily when freshly made, yet in the ruins of the ancient city of Gaochang there are still sections of wall built with these bricks a thousand years ago.

CORNERS

Corners are a particular problem in rammed brick construction, and more so with pole mould work. When using both the complex mould and the simple mould the Chinese solve the problem by interlocking the courses.

One point to note about this method is that as the wall dries cracks usually develop at each join. These do not alter the structural strength of the wall, but they look bad. Because the Chinese customarily plaster their buildings these cracks vanish when the mud plaster is applied. However in Australia many people wish to use the earth as a display feature and these cracks can spoil the appearance.

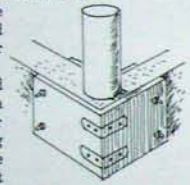
In Australia most rammed earth buildings are constructed using special corner moulds. These do an excellent job but are just another thing to be built, so you must make your own decision about them.



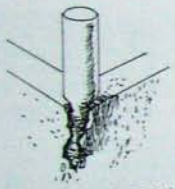
POSTS AT CORNERS

When the roof has been supported by posts the corners do not present a problem as the walls just stop at the corner posts. Joining the walls to the corner posts does require a little understanding of the medium that you are using.

If you put a mould around a pole like this and ram the earth you will find that no matter how firmly you ram it the corners are weak and will naturally fall off or get damaged.

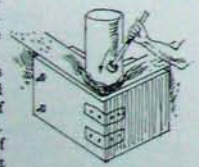


In order to avoid this you can ram in a mixture of moister earth containing long strands of straw. The straw must be brought into the centre of the wall as shown, if this is not done the straw too can fall away from the post.



CORNERS BREAK WITHOUT STRAW

The earth for this operation needs to be moister than that being used for the rest of the rammed earth, but not mud, otherwise you will not be able to ram it. Use a small bar for the ramming.



When the form is removed you may find some of the strands of straw still exposed. Take a few handfuls of the same earth and wet it down to mud, then smear it on with the hands to get a smooth surface.

The straw method can be used around corner posts but, as a greater area of exposed timber is involved, the strands may need to be almost a metre long. However this is not a completely satisfactory method because the corners are inevitably going to get bumped and damaged.

One idea is to use string and tacks to hold the straw in position around the post.

A better idea is to leave the post exposed on the outside. Tamp the earth as firmly as possible against the post, and leave it for two or three days after removing the formwork. Trim off the crumbly parts with a sharp blade until you come to firm material.

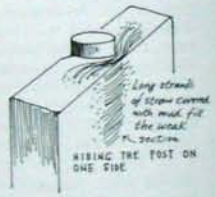
USING THE POSTS AS FEATURES

If you prefer to feature the posts there are two ways to do it.

1. HIDING THE POST ON ONE SIDE.

Place the posts so that they will only be visible on either the outside or the inside, as you prefer. At the weakest spot it is still a good idea to use some straw reinforcing to hold the earth in place.

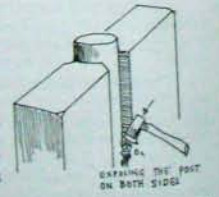
The straw can be long strands of any grain such as wheat, oats, barley etc., long strands of grass 700mm and over, rushes or even unlikely strands of vegetation such as canes of blackberry, stalks of bracken or the stems of tough creepers. The only proviso is that it should be something that does not rot away as it dries.



HIDING THE POST ON ONE SIDE

2. EXPOSING THE POST ON BOTH SIDES.

If the posts are about the same thickness as the walls, and you wish to feature them both inside and outside then ram the wall up to them, taking care to ram it as firmly as possible where it comes in contact with the pole, especially on the outside surfaces.



EXPOSING THE POST ON BOTH SIDES

When the wall has been finished leave it for two or three days, then use a sharp trowel, tomahawk or spade to trim back the earth. You will probably find the thin sections are still very crumbly so you must keep trimming back until the earth feels firm.

CRACKING AND SHRINKING.

Cracking is often encountered as the wall dries, especially if your earth has a high clay content and contained too much moisture when you rammed it.

It does sometimes happen that the soil heap dries out too much before you use it and then when you dampen it down, too much water is used (this is why the quickest and most convenient method of building in rammed earth is to take the soil direct from the ground and place it in the wall without any delay or further preparation).

If the soil does shrink too much in drying, then cracks will appear where the wall comes in contact with the post. These can quickly be remedied by pushing in a mud mixture, preferably mixed with some sort of straw.

If cracks are going to appear they will be seen within 3 weeks of finishing the wall (unless you have a long wet spell that keeps the wall from drying out). Usually they will only be hair cracks, 1mm or less wide, and can easily be patched by rubbing on a little mud.

If larger cracks appear it may be that the trouble is caused by poor foundations which have moved under the enormous weight of the wall. This is a serious problem and is best avoided by building good solid foundations in the first place.

To sum up, try and always work with earth as dry as can be, and containing only enough moisture to compact into a firm mass. If, when you are tamping, the earth feels at all plastic and spreads under the blows then it is too moist. When firmly tamped the earth should just go down and stay where it is put.

PLASTERING THE WALLS

In Australia many home builders prefer to leave their walls in the natural state they were in when the ramming was finished and the forms removed. However others prefer to plaster them and so achieve a smoother surface. This is simply a matter of personal choice.

Depending on the quality you may feel it needs plastering, or you may decide to just bag it.

BAGGING

When the wall has just been completed any holes are filled with plugs of moist earth and lumps are trimmed off. Hollows are different to holes, a hole may be plugged, but a hollow will not accept a plug (see below for more on this). The wall can then be given a rough bagging if you like but this is not essential.

Wait until the wall has begun to dry out to see whether any small cracks develop. If they do, rub mud or moist earth into them, then bag the surface.

Bagging is a simple operation, just take a hessian bag, keep it wet and rub the surface. This will create a uniform effect and hide all the patching that you may have done. You may have to bag the wall more than once as it dries out, to get the effect that you want.

BAGGING THE WALL

PLASTERING

A number of plastering techniques are discussed in *Mud Brick and Earth Building the Chinese Way*. For general work I find the simple mud and straw plaster the best, and certainly the easiest to prepare.

The earth used for the plaster is usually the same as has been used for the wall, though you could use earth from a different area if you were trying to achieve a special colour. If your soil has a high clay content it will be necessary to mix some sandy soil with it to prevent it cracking. Lime can also be added (ordinary builder's lime or garden lime), this will help strengthen the plaster and also lighten the colour.

The dry earth is mixed with straw and then water is added to make mud. The straw can be cut to roughly 100mm lengths, but I also use long strands when filling large hollows as they interlock and tie together better.

For a thin final plaster the straw should be cut as small as chaff.

We use all sorts of local grasses for the straw, it requires only simple observation to notice which grasses in your area dry out to straw and which rot away as they dry. We pick ours up sometimes after the slasher has gone through the paddock, and the cut grass is at least partly dry.

The straw creates a spider web of strands which interlock with each other and so prevent the surface flaking off. It is impossible to give a straw to mud proportion as some grasses are bulkier than others in the dry form and partly dry grass will be both heavier and bulkier than fully dried material. A thick plaster will also need more straw than a thin one.

As the straw acts as a reinforcing in helping prevent the plaster from cracking it should be used as generously as possible. The important thing to watch is that the straw is properly mixed with the mud. Make sure that your mud mixture does not contain wads of straw that have not been properly

mixed with the mud. This is very easy to do if you are not careful and happens more often when using long strands of straw.

SOAKING

In theory the mixed plaster should be left overnight before applying it as this allows the moisture to soak into dry particles of earth and also moisten the straw. Few of us ever do this.

SCRATCH COAT

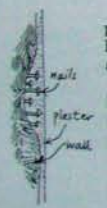
Plaster can be applied in one or two layers. If using two layers the first is the thickest and is used to get a good level surface. The straw can be quite long in this coat which is called the Scratch Coat. The second coat is applied with finely chopped straw and is as thin as possible.


SCRATCHING

The scratch coat is so called because the wall is scratched before the plaster is applied. Any pointed tool, such as a screwdriver, can be used to do this and the surface should be made as rough as possible. A chequerboard of grooves 100mm apart is usually adequate, but they can be closer.

If you apply a thick coat of plaster over a rammed wall that has not been scratched you will most likely have big lumps fall off later. I speak from experience in this matter having neglected once to scratch a wall and later having most of the surface flaking off when the interior walls had been finished and whitewashed and the furniture all put in place.

LARGE HOLLOWS



While the scratches give the plaster something to adhere to, large hollows present a different problem and must be treated accordingly.

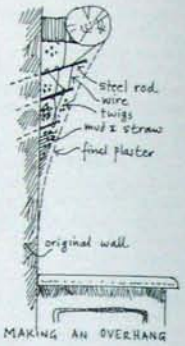
The simplest answer to filling a large hollw is to hammer roofing nails into the wall until they are firmly in place, but not fully in. Now when the plaster is applied the large head of the nail acts as an anchor and holds it on the wall.

If the hollow is deep and you feel this will not be enough then run a hairy cord, such as binder twine, from one nail to the next to provide extra reinforcing.

CREATING AN OVERHANG

Half the battle in building with earth is in understanding just what the material will and will not do. Once you have understood this, the medium becomes much easier to work.

For instance we had an ordinary earth wall in our kitchen with a beam above this, and a couple of years after it had been built I thought a wall that curved out at the top would look better. This could not be done by simply applying mud plaster as its own weight would soon cause it to fall off the wall.



MAKING AN OVERHANG

I hammered long lengths of steel rod into the wall until they were quite firmly in place. Then I placed twigs and sticks behind the rods and tied tie-wire across to keep everything in place and also act as reinforcing.

A mud and straw mixture was pushed into this framework until the whole lot was roughly covered and it was allowed to dry. When almost dry, another coat of mud and straw was applied and worked to a smooth finish.

This bonded in so well with the original wall that no cracks appeared and the new work could not be detected.

LASTING QUALITY OF RAMMED EARTH

The lasting quality of earth as a building material is best shown in an article "The Search for China's Earliest City" in *China Reconstructs* May 1986.

"In 1983 archaeologists discovered another well preserved Shang walled city in Henan . . . east of Luoyang . . . The wall measured 1,200 metres from east to west and 1,700 metres from north to south. The 18 metre thick rammed earth wall now dwindled to a height of a metre or two, but its foundations go two metres into the ground."

Archaeologists are still working on this site and did not yet have a precise date at the time the article was published, but know that it dates somewhere between the 11th and 17th century BC.

Another Shang city excavated near Zhengzhou in Henan province in 1955 had remains of city walls 7 kilometres in circumference. This rammed earth wall has been kept in repair for a longer time than the other and as a result sections of it still stand 6-7 metres high. At the base the wall measures an amazing 20 metres.

The wall was built in 1620 BC, over 3,600 years ago. Just mention that to your local building inspector if he queries the lasting properties of rammed earth! Both wheat and rice are grown in Henan province, and the climate is similar to a lot of parts of Australia.

TAMPERS

There is no such thing as a standard tamper, they can be round or square long or short and rough or highly finished. What matters is that they are used properly. I have made a number of them, based on Chinese patterns and some are illustrated.

No.1. Made from a length of softwood timber cut on our block. This was cut and shaped while green, and as a result it cracked open as it dried. Wire was tied on to stop the crack opening wider.

One end has a diameter of 150mm and is the one used for most work. The other end is oval with a diameter of 50mm. This is used to get into corners, especially when working around posts. The dumbell shape is easy to work with, the upper piece acting as a sort of counterweight.

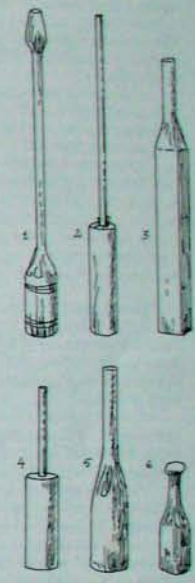
No.2. A section of pine log with a hole bored into it for 150mm into which a length of water pipe has been driven and held firm with rough wedges. This style is also often found with a smaller head on the opposite end, similar to the previous one. It can be made quickly and works well. A hardwood head would wear better than pine.

No.3. A length of milled hardwood with a handle shaped at one end. 125x75mm and 1.2 metres long. We also use this one a lot, but have noticed one odd thing. You would expect that a rectangular tamper would work better inside rectangular formwork, but this is not the case. In fact the rectangular tamper seems to strike the edge of the form more often than a round one for some reason.

Nos.4,5 & 6. Short tampers quickly made and used when working up high doing infill work. The smallest is only 600mm long and is held in one hand.

TAMPING TECHNIQUE

The earth is shovelled into the mould to a depth of 50-75mm and then tamped down. It is not difficult to judge when it is properly tamped, because there is a change of feeling in the material, it becomes firm and no longer compresses under the blows. The sound of the blow also changes and becomes clearer. Some writers talk about the earth giving off a ringing sound when firm, but this is unusual, and it is more usual to go by sight and feel rather than sound.



Force is not needed for this operation, the idea is to let the weight of the tamper do most of the work. I have watched builders in China work with one hand, changing from left to right as they worked.

When you first remove the mould from your new section of wall you may have some doubts about the technique. The wall may appear to be dense but softer than you expected, or even a bit crumbly on the outside.

Do not worry about this, if you have done your tamping properly it will dry like rock. I have seen walls in China made with clay so plastic that one side bulged out of shape when the form was removed. The builder was not at all perturbed but simply hammered it back into shape with the side of his tamper.

Such a casual approach is not recommended for beginners, but the Chinese are experts in the technique.. In addition they always build their rammed earth walls thicker than we do, and the thicker the wall the more stable it is, so hammering out a bulge presents no problem.

WALL THICKNESS

It is much harder to build a thin wall than a thick one, because the tamping is much more critical in a thin wall. It is also easier to work inside a wide mould. A thick wall is also much more resistant to damage and provides more insulation

against both heat and cold, and at no extra cost except that of the extra time in tamping it. The Chinese often make walls 500mm and wider, but 300mm is a common width and quite a good size to work with.

Research has been going on for some time now in New Mexico, USA, into the effects of the thermal mass of earth buildings. The findings are very complex, but what they boil down to is this. In the summer 600mm walls absorb the heat of the sun, but are so thick that they do not let the heat through, and so the room remains cooler than outside. During the winter the cold does not penetrate the walls because of the heat that is still stored inside the wall, and so the room remains warmer than the outside.

THE DANGER OF RAIN DURING WORK

If it rains heavily during the course of building a rammed earth wall in the open then it must be kept well covered and allowed to properly dry back to its original condition before any more work is done.

Failure to follow this simple rule can result in disaster, as I know from personal experience. You may notice that people who write books rarely own up to having made mistakes, but we all do it.

A while ago I was building a rammed earth wall for a duck-house, using the pole mould technique. We had some very heavy rain one night and the plastic sheeting that I had covering the section blew off. Instead of waiting till the top dried off properly I went ahead next day and rammed another metre on top of the moist section.

I was awoken in the middle of that night by a dull rumble, and ran out to find that the whole new section of wall had simply slipped off the top of the moist section which had slumped sideways under the pressure. The entire wall had to be demolished and built again from the ground up.

MUD BRICK AND THE WET SEASON

Whenever I give a talk on mud brick and earth building the question that is always asked is how earth walls stand up to the torrential rain that we get in northern Australia during the Wet Season.

In my book *Mud Brick and Earth Building the Chinese Way* I went into this problem in some detail, and pointed out that in southern China, which has a yearly monsoon season as well as frequent typhoons, earth building is quite common, as it is throughout the monsoon and typhoon prone areas of India.

The Chinese do not even have large overhanging eaves, often the end wall has a roof that is almost flush with the wall, jutting out perhaps no more than the width of a hand.

Australian mud brick builders like to make a feature of the bricks themselves, raking out the joints to show off the pattern.. In a monsoon area, where rain is driving directly onto the surface of the wall, these crevices only collect water and allow it to begin penetrating the surface. A smooth mud render, especially one with a high chopped straw content, sheds the water so fast that the rain does not present any problems.

The only danger is if the water is able to gather at the base of the walls, and during floods or in areas where streams or gutters overflow and water can run along the base of the wall this can lead to disaster. Otherwise well plastered earth walls are not affected by rain.

In the previous chapter I described how I built two test walls out in the open, each about three metres long and shoulder high. A cement cap was needed on top of each to prevent rain hitting directly from above. Both walls were made of mud brick and given a mud plaster.

One wall was then given a coat of Boncote, a white cement based paint, and the other left bare. As they were in a fully exposed outside position I did not expect them to last for long, but seven years later they were still as structurally sound as when they were built.

The wall with the Boncote has had problems as rain got under this coating through small cracks and the surface began to flake. This did not affect the wall, but meant regular repainting of certain patches, about once every two years.

I have now stopped using Boncote as it is expensive and instead use 1 part of Aquadhere PVA glue to 12 or 15 parts of builder's lime, plus enough water to make a creamy mixture. This makes an excellent whitewash, applied with a broom.

The unpainted wall now has small ferns growing from its surface and there has been a certain amount of surface erosion, but the wall is still as stong as when it was built.

Treated with respect earth building is quite appropriate to monsoon and high rainfall areas. The whole secret is in having foundations away from any chance of water damage, and having a good smooth wall surface or applying a smooth mud plaster.

Crocodile Ridge Belts

(This section was originally published in 1991 as a small booklet called *Crocodile Ridge Belts.)*

Although I wrote about crocodile ridges in *Stockman's Plaited Belts* I had not taken a great deal of interest in them until one day in late 1990 Jim McDowall brought in to our saddlery four different ridge plaits that he had learned from his father on Lakefield station, in north Queensland, in 1932.

Jim and I talked about them at some length and I decided that perhaps it would be interesting to prepare some illustrations to show the many variations that can be found in this type of plaiting. I have included here what I think are the most useful and decorative ones, but there are plenty of variations on the theme and anyone with a good knowledge of plaiting can work out others for themselves.

Crocodile ridges of from 8 to 10 strands are useful for hat bands but are really too narrow for belts. The best ridges for belts are those 14 strands and up. These belts should be done in fairly narrow lace to get the best effect.

Crocodile ridges are an old traditional form of decoration on plaited kangaroo hide belts. It is very rare to find them on commercially made belts because they just take too long to make.

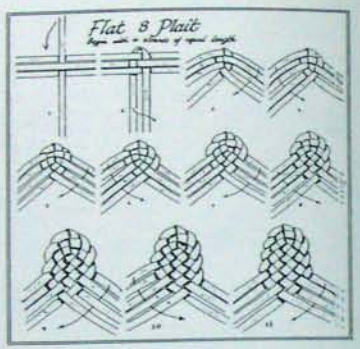
The three most common forms of crocodile ridge are the knobby ridge, the simple ridge and the herringbone ridge. My guess is that the knobby ridge was the first one to be given the name of crocodile ridge, because it is the one that most resembles the knobby ridges on a crocodile's back.

The three sorts of ridges are all equally easy to do once you understand the principle behind them, but it is a good idea to carefully study the illustrations before you begin. For instance herringbone ridges do not look very good on a narrow belt, but will make an attractive hat band.

Do not attempt double or triple ridges until you have made a few belts with single ridges, that way you will save yourself a lot of frustration. The main problem with working wide belts is finding enough fingers to control all the strands, so the beginner is advised to begin with a ten or twelve plait.

This present work deals with ridges that go down the centre of the belt, but you can also do a ridge that goes around the outer edge. One of these is shown in *Bush Leatherwork*, in the section on making Stockmen's Plaited Belts, and another way to do them is shown in *More Bush Leatherwork*, in the section Plaiting Projects 2. (*Stockmen's Plaited Belts* and *Plaiting Projects 2* are also available as separate booklets). In *Plaiting Projects 2* there is also a section on how to make a crocodile ridge after the rest of the belt has been completed.

8 STRAND KNOBBY CROCODILE RIDGE

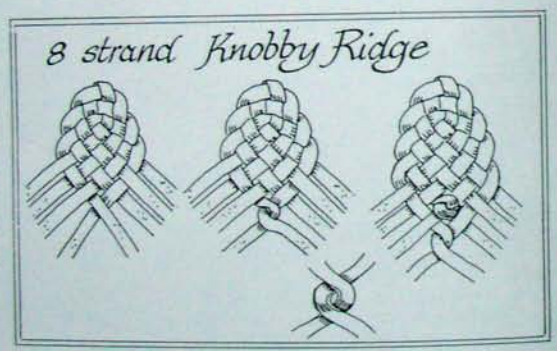


This is an unusual ridge in that it consists of a row of small knobs rather than a continuous raised section. One advantage of this sort of ridge is that it does not make the ridge section of the belt narrower than the start and finish of the belt and so you do not have to add extra strands for the ridge section.

Begin the belt with a normal eight plait. In the sketches below I have shown this section of normal plaiting very small in order to save space, but you should work the section of smooth plaiting at least 150-200mm long to give room for it to fit through the rings or buckle.

Although the knob ridge is simple to do it still requires nimble fingers because you bring the strands together from either side and hook them together as shown. The small sketch shows how the lace is never twisted to show the back of the leather, only the front of the lace is visible. Where the two strands twist around each other they lift up and so make the knob.

When you have done as much ridge as you want then just go back to ordinary flat plaiting in order to finish the belt off.

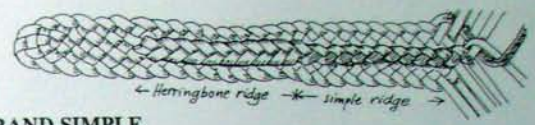


8 STRAND SIMPLE CROCODILE RIDGE

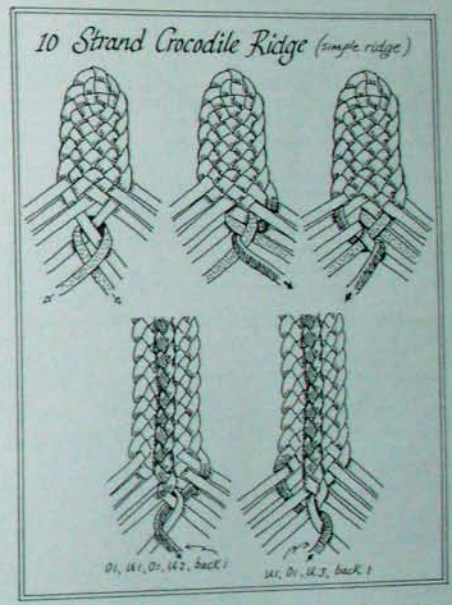
An 8 strand simple ridge can be done in the same way as the 10 strand ridge shown on the next page. However I have not illustrated it as I do not think it looks very good because the ridge is too large in proportion to the rest of the belt. But if you want to try it then begin with a flat 6 plait and add the extra two strands when you begin the ridge.

10 PLAIT KNOBBY CROCODILE RIDGE.

A ten plait knobby ridge can be worked in just the same way as the eight plait one described here. The advantage of the knobby ridge is that you do not have to add in extra strands.



10 STRAND SIMPLE CROCODILE RIDGE



This is one of the easiest of the crocodile ridges to do, and although it does not stand up as much as the herringbone crocodile ridge it still looks good and is very popular.

I am giving instructions first for the simple ridge and then for the herringbone ridge, and the sketch above shows a section of belt in which I plaited first a herringbone and then a simple ridge.

Notice how in the herringbone section the whole belt becomes narrower than the section done with the simple ridge. A 10 strand herringbone is quite suitable for a hat band, but does not look so good as an ordinary belt. The simple ridge is much better looking for an ordinary belt.

BEGINING.

Begin with a an ordinary eight plait, not a ten (a flat 8 plait is shown on the previous page) and start the strands off as shown. If you begin with a ten plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, so plait about 150-200mm of flat plait.

ADDING AN EXTRA PAIR OF STRANDS.

Work in the extra length of lace as shown in order to make an extra pair of strands. When it is firmly in place you can begin the crocodile ridge. Each side is done slightly differently as you can see from the drawings. The letters U1 and O1 on the sketch mean under one and over one:

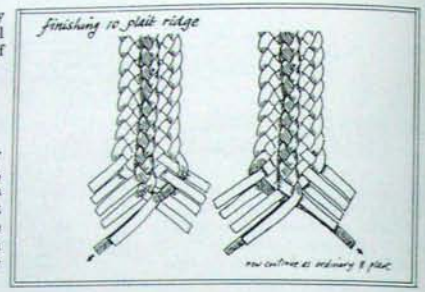
The first sequence is over 1, under 1, over 1, under 2, then bend back over 1.

The second sequence is under 1, over 1, under 3, then bend back over 1.

FINISHING OFF.

When you have done enough of the ridge you must lose two of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown in the drawings on the next page. Lay the two centre strands on top of the ones next to them and then begin ordinary plaiting, treating these doubled strands as if they were just ordinary strands.

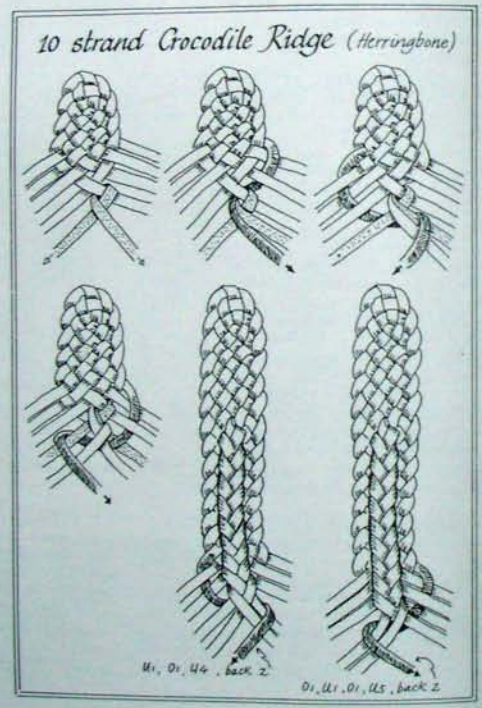
Continue plaiting in the usual way and attach the buckle using the normal method for plaited belts, shown at the end of this chapter



10 STRAND HERRINGBONE CROCODILE RIDGE

BEGINNING. As I said earlier herringbone ridges look better in wider belts, but a ten strand herringbone ridge makes a good hat band. Begin with an ordinary eight plait, as shown earlier (not a ten) and start the strands off as shown. If you begin with a ten plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150-200mm.



ADDING AN EXTRA PAIR OF STRANDS.

Work in the extra length of lace as shown in order to make an extra pair of strands. When it is firmly in place you can begin the crocodile ridge. Each side is done slightly differently as you can see from the drawings.

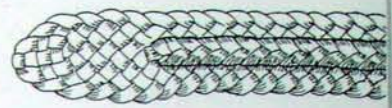
The first sequence is under 1, over 1, under 4, then bend back over 2.

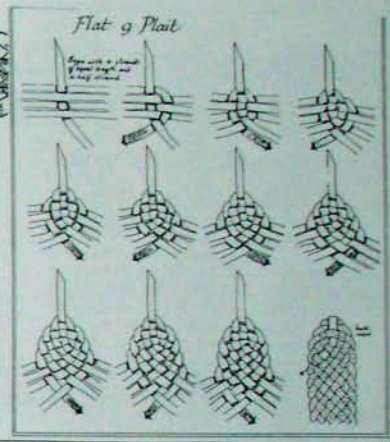
The second sequence is over 1, under 1, over 1, under 3, then bend back over 2.

Finishing Off

When you have done enough of the ridge you must lose two of the strands otherwise the belt will suddenly become wider at this point. See the top of the page for this.

Continue plaiting in the usual way and attach the buckle using the normal method for plaited belts shown at the end of this chapter.





11 STRAND CROCODILE RIDGE

BEGINING. Begin with a an ordinary nine plait, not an eleven (a flat 9 plait is shown opposite) and start the strands off as shown. If you begin with an eleven plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150-200mm.

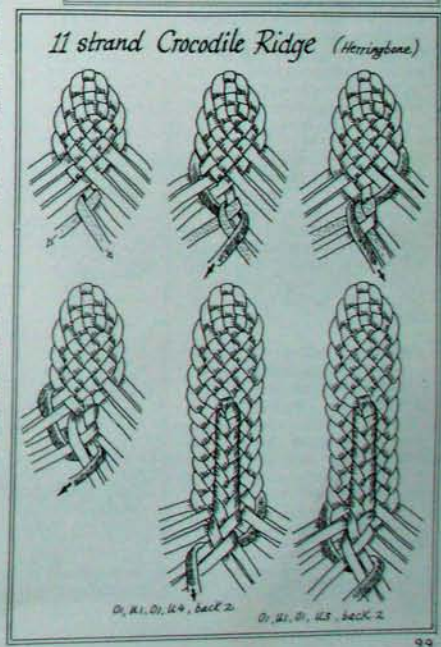
ADDING AN EXTRA PAIR OF STRANDS. Work in the extra length of lace as shown in order to make an extra pair of strands. When it is firmly in place you can begin the crocodile ridge. Each side is done slightly differently as you can see from the drawings. The letters U1 and O1 on the sketch mean under one and over one:

The first sequence is over 1, under 1, over 1, under 4, then bend back over 2.

The second sequence is over 1, under 1, over 1, under 3, then bend back over 2.

FINISHING OFF. When you have done enough of the ridge you must lose two of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown in the drawings on the previous page. Lay the two centre strands on top of the ones next to them and then begin ordinary plaiting, treating these doubled strands as if they were just ordinary strands.

Continue plaiting in the usual way and attach the buckle using the normal method for plaited belts shown at the end of this chapter.



12 STRAND CROCODILE RIDGE

There is something odd about the 12 strand crocodile ridge, and I cannot say that it is one that I like at all. I am illustrating two different ways to work it, but neither is perfect.

I have experimented and worked out three different ways of doing this 12 strand ridge, and the first is the best looking of the three. However I would suggest that you only use 12 strands if you have to, and otherwise use the 14 strand ridge which is easier to remember and also looks better.

BEGINING

Begin with an ordinary eight plait (not a twelve) and start the strands off as shown. If you begin with a twelve plait then the belt will suddenly get narrow when you come to begin the ridge plaiting. In this method four extra strands are added, but this only works with thin lace, with thick lace you may be better off to use the second method. Unfortunately the rules for adding extra strands cannot be fixed, it all depends on the thickness of the lace being used.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150-200mm.

ADDING AN EXTRA TWO PAIRS OF STRANDS.

Work in the extra lengths of lace as shown in order to make an extra four strands. When they are firmly in place you can begin the crocodile ridge. Each side is done slightly differently as you can see from the drawings.

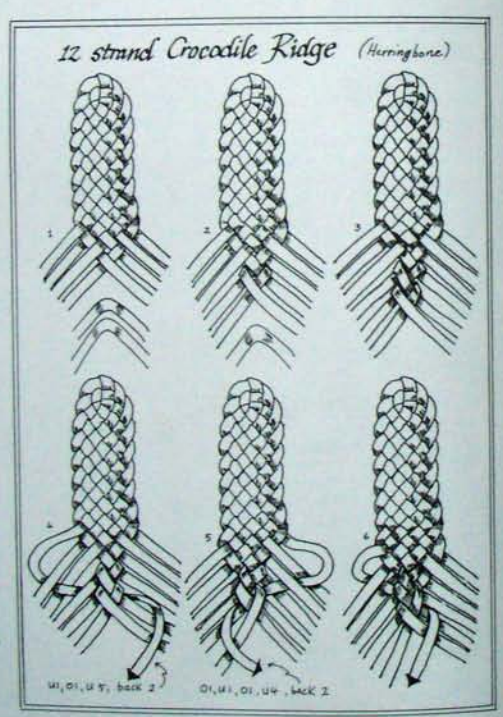
The first equence is under 1, over 1, under 5, then bend back over 2.

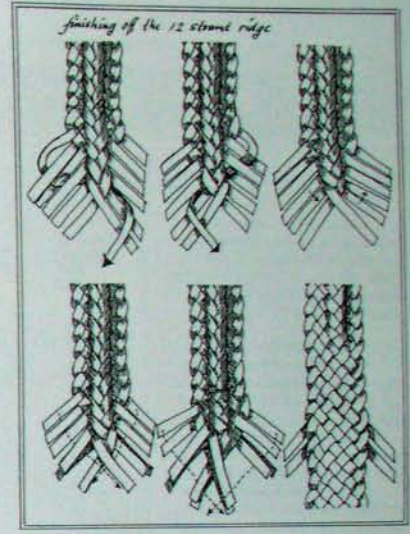
The second sequence is over 1, under 1, over 1, under 4, then bend back over 2.

FINISHING OFF

When you have done enough of the ridge you must lose four of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown in the drawings. Lay the centre strands on top of the ones next to them and then begin ordinary plaiting, treating these doubled strands as if they were just ordinary strands. When they have been worked out as shown in the last sketch then trim the ends flush.

Continue plaiting in the usual way and attach the buckle using the normal method for plaited belts shown at the end of this chapter.





12 STRAND CROCODILE RIDGE,

another method.

BEGINING. Begin with a an ordinary ten plait (not a twelve) and start the strands off as shown. In this case the plait begins by taking five strands of equal length and starting them off as shown in the small sketch below. If you begin with a twelve plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

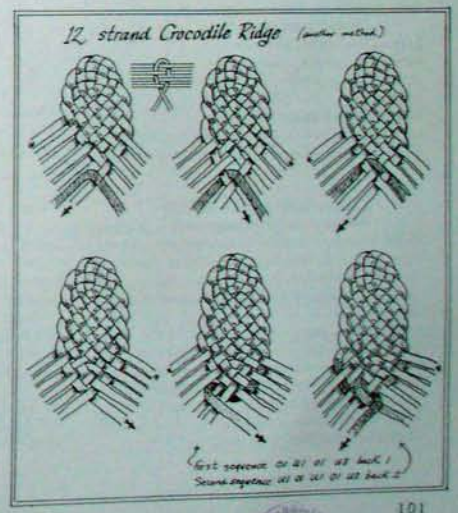
Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150mm.

ADDING AN EXTRA PAIR OF STRANDS. Work in the extra length of lace as shown in order to make an extra pair of strands. When it is firmly in place you can begin the crocodile ridge. Each side is done slightly differently as you can see from the drawings.

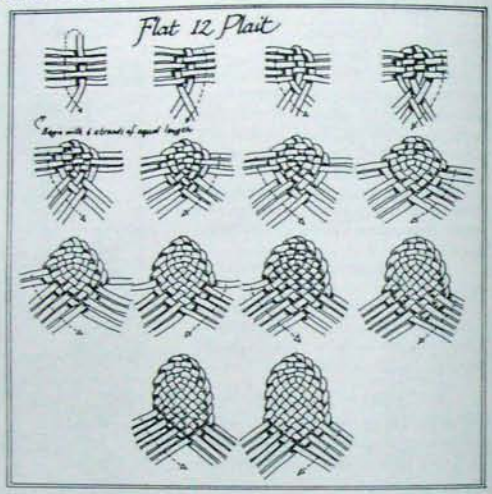
The first equence is over 1, under 1, over1, under 3, then bend back over 1.

The second sequence is under 1, over 1, under 1, over 1, under 3, then bend back over 2.

FINISHING OFF. When you have done enough of the ridge you must lose two of the strands otherwise the belt will suddenly become wider at this point. Lay the two centre strands on top of the ones next to them and then begin ordinary plaiting, treating these doubled strands as if they were just ordinary strands.



13 STRAND CROCODILE RIDGE



This is one of the crocodile ridge plaits shown to me by Jim McDowall of Cairns in 1990. He had learned it from his father on Lakefield station, on Cape York, in 1932.

BEGINING

Begin with an ordinary twelve plait and start the strands off as shown in the series of drawings on the right. (I should mention here that if you want to make an ordinary flat 12 plait belt then this is the way to do it.)

If you begin with a thirteen plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, so make it about 150mm before you begin the crocodile ridge. This is shown on the next page

ADDING AN EXTRA STRAND

Work in the extra length of lace as shown on the next page in order to make an extra strand. You simply hold the new strand behind the old one as shown in the first drawing. Later you can work this loose end back into the belt or just trim it off flush.

The second drawing, next page, shows how you then fold the bottom strand over so that the good side is showing. The upper left strand is marked with a *, this is the next one to bring down.

The third drawing shows the next strand worked into place. Now take the strand on the upper right marked *.

Now we begin the actual crocodile ridge sequence, starting at the right.

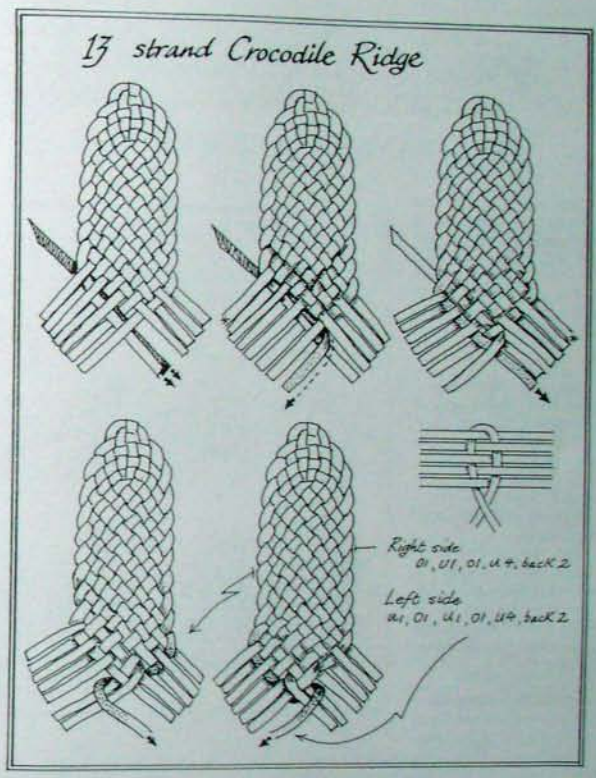
The right sequence is over 1, under 1, over 1, under 4, then bend back over 2.

The left sequence is under 1, over 1, under 1, over 1, under 4, bend back over 2.

When bringing the lace back do not twist it over, keep it always so that the good side is showing.

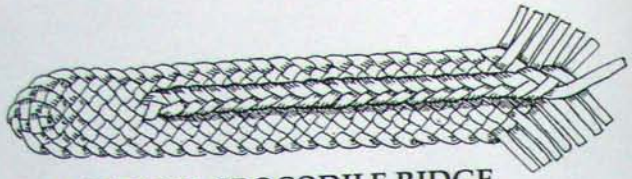
FINISHING OFF

When you have done enough of the ridge you must lose one of the strands otherwise the belt will suddenly become wider at this point. Lay one of the two centre strands on top of the one next to



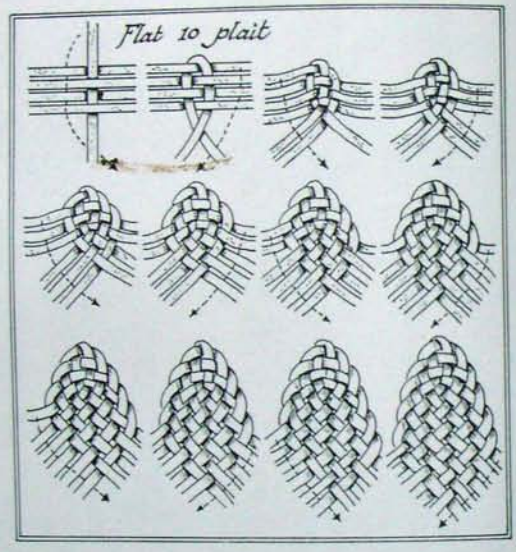
it and then begin ordinary plaiting, treating the doubled strand as if it was just an ordinary strand. (If you are not sure of what I mean then look at the drawings for the finish of the 12 strand ridge).

Continue plaiting in the usual way and attach the buckle using the normal method for plaited belts as shown at the end of the chapter.



14 STRAND CROCODILE RIDGE

You will notice in the drawing above of this ridge that it does not sit exactly in the centre of the belt. This is a problem with a few of the belts with an even number of strands, although it is not so noticeable when you get to 16 strands and more.



BEGINING

Begin with an ordinary ten plait as shown on the right. If you begin with a fourteen plait then the belt will suddenly get narrow when you come to begin the ridge plaiting. If you do not wish to do a crocodile ridge then you can make an ordinary plaited belt with this simple 10 plait.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150mm.

ADDING IN EXTRA STRANDS

What you are aiming to do is to produce a belt that is of the same width all the way along. Unfortunately a hard and fast rule cannot be given to achieve this end because some people plait the ridges tighter than others, while the thick lace bulks differently to thin lace. In other words you must be prepared to alter your style in order to get the results that you want.

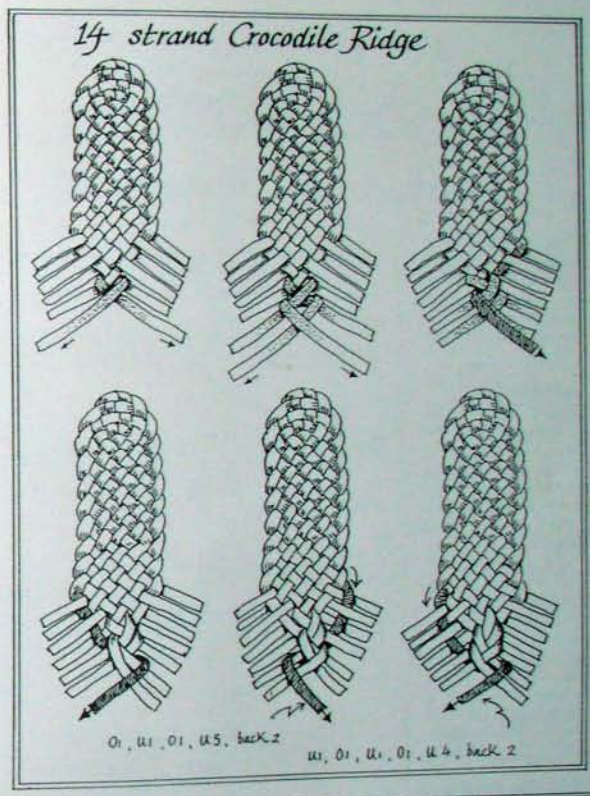
You can probably get by quite well by adding only two strands instead of the four that I have shown here. Jim McDowall, a Cairn's plaiter who does a lot of this sort of work changes the number of strands according to the lace he is working with, and will often do this one with three extra strands, while I prefer to use four.

Work in the extra lengths of lace as shown in order to make an extra four strands.

The right side sequence is over 1, under 1, over 1, under 5, bend back over 2.

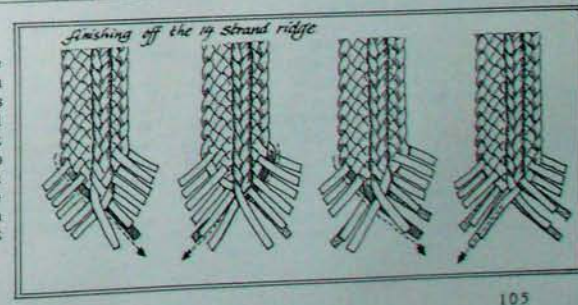
The left side sequence is under 1, over 1, under 1, over 1, under 4, then bend back over 2.

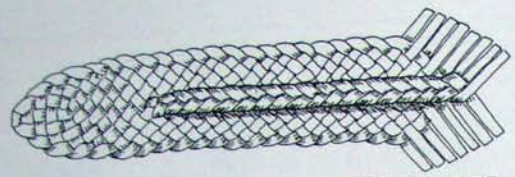
When bringing the lace back do not twist it over, keep it always so that the good side is showing.



FINISHING OFF

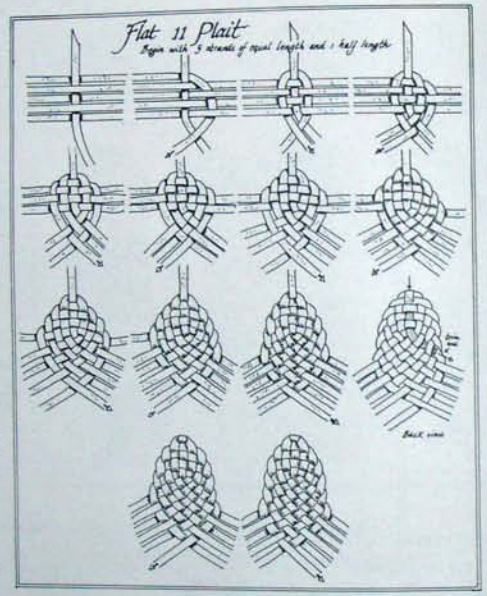
When you have done enough of the ridge you must lose four of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown here. You simply double up the unwanted strands and then continue plaiting a ten plait as you did at the beginning.





15 STRAND CROCODILE RIDGE

One problem with even numbered strand ridges such as 14 strands is that the ridge never seems to be right in the centre of the belt. This 15 strand one sits closer to the middle.



BEGINING

Begin with an ordinary flat eleven plait and start the strands off as shown in the drawings. (This same pattern can also be used to make an ordinary 11 plait belt without a crocodile ridge.) If you begin with a fifteen plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

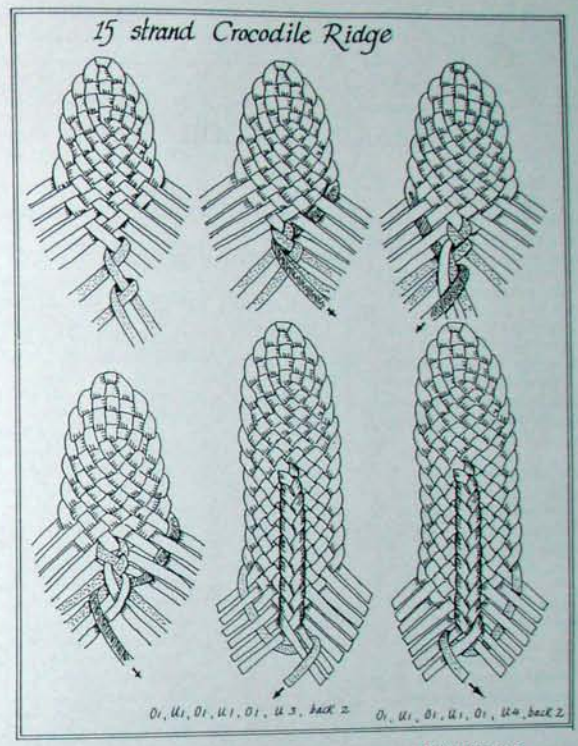
Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150-200mm.

ADDING IN EXTRA STRANDS

What you are aiming to do is to produce a belt that is of the same width all the way along. Unfortunately a hard and fast rule cannot be given to achieve this end because some people plait the ridges tighter than others, while thick lace bulks differently to thin lace. In other words you must be prepared to alter your style in order to get the results that you want.

You can probably get by quite well by adding only two strands instead of the four that I have shown here. Jim McDowall, a Cairn's plaiter who does a lot of this sort of work changes the number of strands according to the lace he is working with, and will often do this one with three extra strands, while I prefer to use four.

Work in the extra lengths of lace as shown on the next page in order to make an extra four strands.



The first sequence is over 1, under 1, over 1, under 1, over 1, under 3, then bend back over 2.

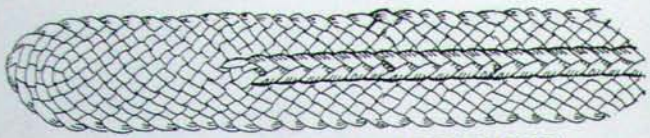
The second sequence is over1, under 1, over 1, under 1, over 1, under 4, then bend back over 2.

When bringing the lace back do not twist it over, keep it always so that the good side is showing.

FINISHING OFF

When you have done enough of the ridge you must lose four of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown in the drawings for a 14 strand ridge. You simply double up the unwanted strands as shown and then continue plaiting an eleven plait as you did at the beginning.

Continue plaiting and attach the buckle using the normal method for plaited belts as shown at the end of the chapter.



16 STRAND CROCODILE RIDGE

BEGINING

Begin with an ordinary fourteen plait and start the strands off as shown in the small centre drawing. If you begin with a sixteen plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150-200mm.

ADDING AN EXTRA STRAND

Work in the extra length of lace as shown in the instructions for a twelve strand ridge in order to make an extra pair of strands.

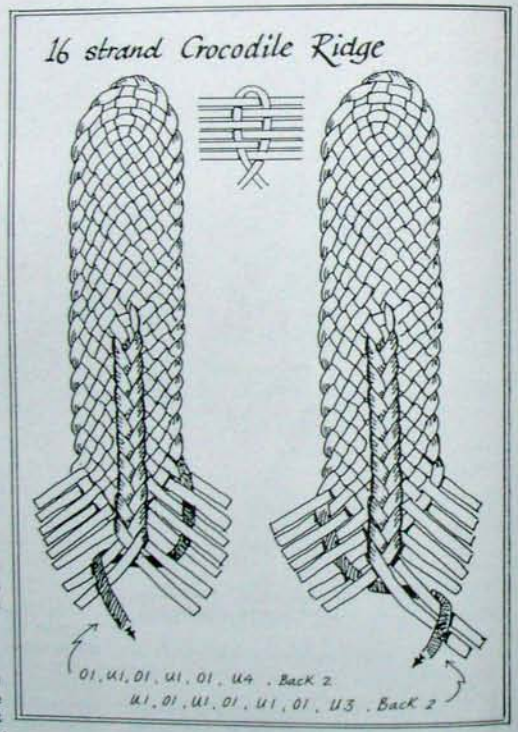
The first sequence is over 1, under 1, over 1, under 1, over 1, under 4, then bend back over 2.

The second sequence is under 1, over 1, under 1, over 1, under 1, over 1, under 3, then bend back over 2.

When bringing the lace back do not twist it over, keep it always so that the good side is showing.

FINISHING OFF

When you have done enough of the ridge you must lose two of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown in the drawings for the 12 strand ridge.



18 STRAND CROCODILE RIDGE

BEGINING. Begin with an ordinary sixteen plait and start the strands off as shown in the small centre drawing. If you begin with an eighteen plait then the belt will suddenly get narrow when you come to begin the ridge plaiting.

Work the belt down for as long as you wish, I have shown it very short in the drawings but this is only to save space, you would have to take it down long enough for it to go through the buckle later, about 150-200mm.

ADDING AN EXTRA STRAND. Work in the extra length of lace as shown in the instructions for a twelve strand ridge in order to make an extra pair of strands.

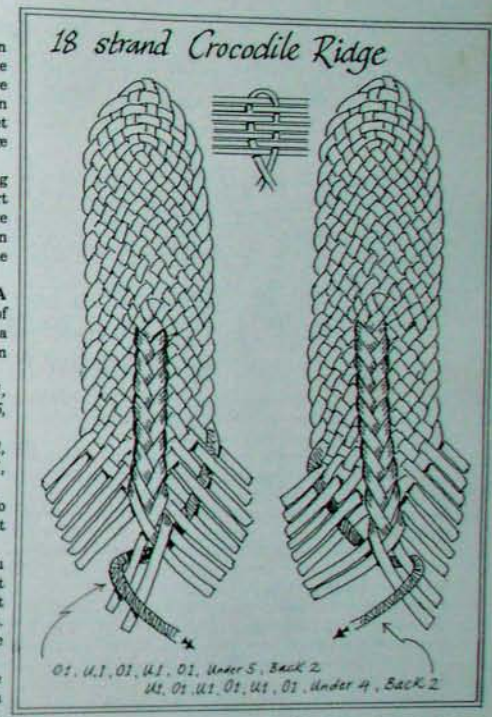
The first sequence is over 1, under 1, over 1, under 1, over 1, under 5, then bend back over 2.

The second sequence is under 1, over 1, under 1, over 1, under 1, over 1, under 4, then bend back over 2.

When bringing the lace back do not twist it over, keep it always so that the good side is showing.

FINISHING OFF. When you have done enough of the ridge you must lose two of the strands otherwise the belt will suddenly become wider at this point. This is easy to do and is shown in the drawings for the 12 strand ridge.

Lay two of the two centre strands on top of the ones next to them and then begin ordinary plaiting, treating the doubled strands as if they were just an ordinary strand. Continue plaiting in the usual way and attach the buckle using the normal method for plaited belts.



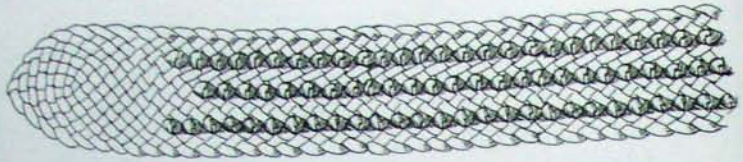
First sequence under 1, over 1, under 1, over 1, under 5, back over 3.

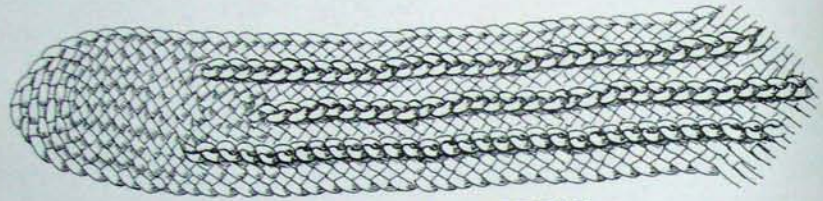
Second sequence over 1, under 1, over 1, under 1, over 1, under 6, back over 3.

18 STRAND CROCODILE RIDGE WITH A WIDER RIDGE

You can make an even wider ridge by crossing over 3 strands each time. I do not think this looks as good as the previous one, but if you ever have to use it the sequence is as follows.

This is what the triple ridge looks like. Note how the belt narrows at this point, it should really have had four extra strands added instead of two.





MULTIPLE ROW RIDGES

Multiple row ridges are not for the beginner, so if you have not already mastered the single ridges shown earlier please do not decide to begin here. It is not that the principle behind them is so difficult, it is rather that they require a certain amount of skill with the fingers which just cannot be picked up without a lot of practise of ordinary ridge plaiting.

The best looking crocodile ridge belts are those made with just a single colour of lace, at least that is what most old time plaiters used to think. However when working these complex patterns for the first time I think you will find it more convenient if you use two tones of leather. In that way it is much easier to see when you make a mistake, you can see which lace to pick up more clearly, and finally the two tones do create some quite attractive patterns.

It is hard to get even tension on the lace when you are beginning a multiple ridge job, and it is a slow business trying to even up the lace later on when the job is completed. For that reason you will find it best to plait about 25mm of the mutiple ridge and then stop and tighten up the first section before continuing.

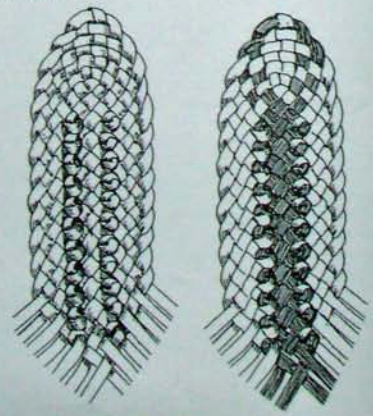
14 STRAND DOUBLE ROW CROCODILE RIDGE

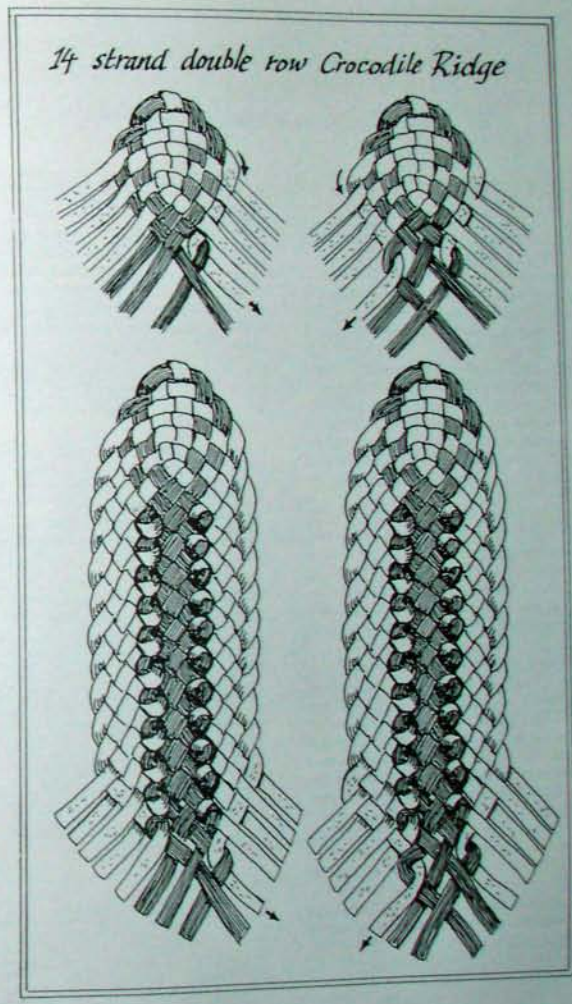
Jim McDowall came into our saddlery one Saturday morning and while we were talking about crocodile ridges he mentioned a triple ridge that he saw his father make in the 1920s. Unfortunately he was too young at the time to remember how his father did it.

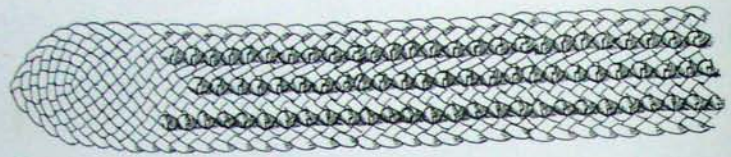
I decided to try to work out a ridge of this type, and in the course of my experiments I evolved this double row ridge as well as the triple.

The sketches show what it looks like if done all in one colour and how it looks in two colours. With a single colour the double row ridge stands out well. With two colours the ridges are not so obvious, but an unusual pattern is created.

The principal of this plait is simple and is based on the same style of ridge as the 8 strand knobby ridge, with a few extra touches to make it interesting. A beginner would be well advised to begin with the 8 strand ridge and not bother about this one.







16 STRAND TRIPLE ROW CROCODILE RIDGE

As I said in the notes to the previous ridge the old timers used to prefer to work crocodile ridges in a single colour. However they are much easier to understand if you do them in two tones as shown in the illustrations of the method, and this also creates quite an attractive pattern.

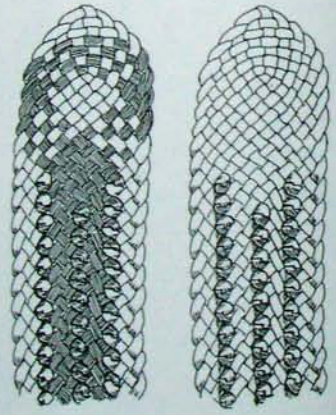
One word of caution when using two tones of lace. You must always check carefully that both lots of lace are the same thickness and that they also have the same amount of bend and stretch in them. It is very annoying to try and work two colour jobs if they have slightly different amounts of stretch in them or if one strand is thinner than the other.

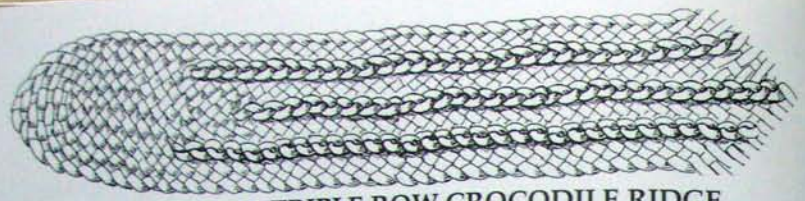
If you cut your own lace, as some plaiters prefer to do, then is is a good idea to stain up one section of the hide to a different colour before you cut it out, and in this way you will have the two tones from the one hide and by doing this you will be sure that the lace is even.

Some plaiters even go to the extent of making up a little splitter to pare the lace down to one even thickness so that they get a very uniform finished belt. In its most simple form this can be nothing more than a little notch in the edge of a piece of wood. You hold a very sharp knife across the top of the notch and pull the lace through the space. Any extra thickness is pared off as the lace is pulled below the knife blade.

The two illustrations here give some idea of how this triple ridge looks when done in a single colour of lace and when worked in two tones. The ridge in this case is a knobby ridge, but triple ridges can also be worked with a simple ridge as can be seen a couple of pages on.

The principle of these multiple ridges, once you understand them, can then be used for any number of strands, you do not have to stick to 16 for this one, or to 24 for the next. You can also work it so that you have a wider section on the outside of the belt by simply beginning the ridges closer to the centre.



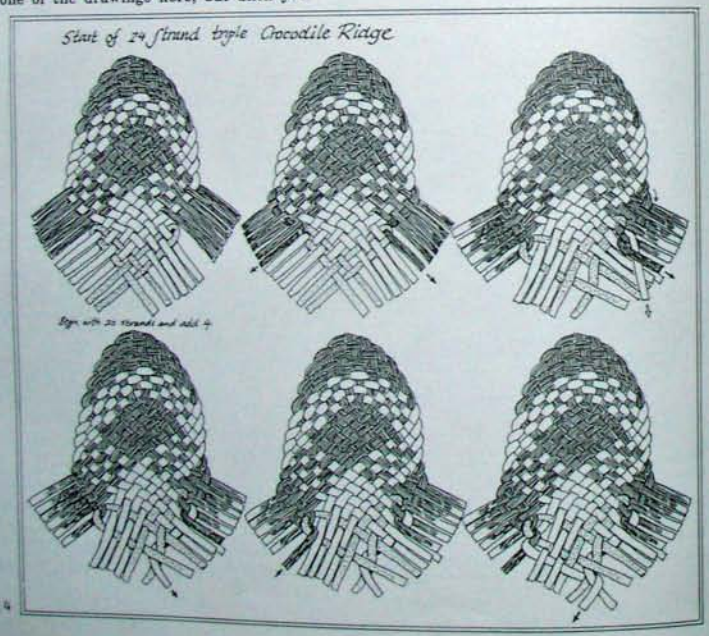


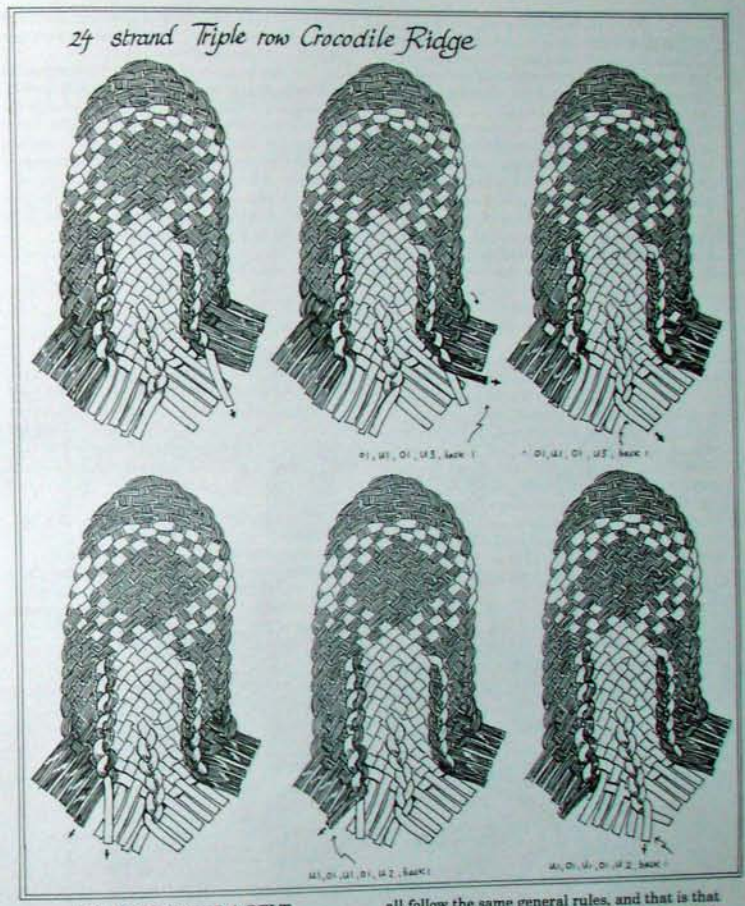
24 STRAND TRIPLE ROW CROCODILE RIDGE

This is a very complex plait and is made more complex by the fact that in the first lot of sketches showing the start of the plait I have begun with a 20 plait and then added in four extra strands. This is done in order to prevent the belt becoming narrower at this point. I have also done the same plait by beginning with 18 strands and adding in 6, but this is generally too much.

Until you get used to working the plait I would suggest that you ignore the beginning given here and just worked with 24 strands from the beginning. Most bushmen would probably prefer to have the belt all in one shade of leather, as shown in one of the drawings here, but until you understand the principle behind it makes life much easier if you use two tones of leather as shown in the drawings on the next page. This allows you to easily see if you get our of sequence, and also creates an attractive pattern at the same time.

Pass over the drawings that show the start of the plait and go to the next batch which shows how the main plaiting is done. The key to doing this plait easily is in the first drawing and the fourth of this batch. These show a simple crossing over action, and this is essential in order to get the ridge right.





FINISHING OFF A BELT

The same method is used for belts of any number of strands

There are several ways to finish off a belt, and every plaiter has his own favourite, but they all follow the same general rules, and that is that the strands are worked into the back of the belt. You may start on the outside left or the outside right, or the middle, it all ends up looking the same. The method I have shown here is the easiest for a beginner to work with.

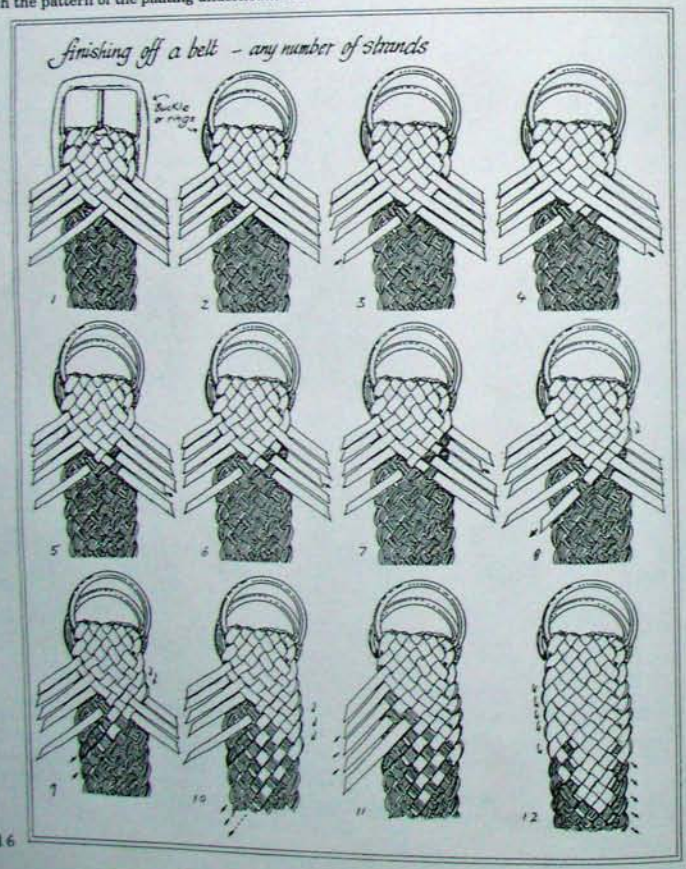
When the belt is completed to the desired length plait a little bit more and fit the buckle or rings as desired. If using a buckle the tongue of the buckle is pushed between strands of lace, you do not punch any holes. The first two drawings show both buckle and rings with the end of the belt turned over and ready to begin.

Tuck one of the centre strands in place as shown in fig.3. Now you can put the belt down and look at it, for this one strand will lock all the rest of the plaiting in place and it cannot come undone.

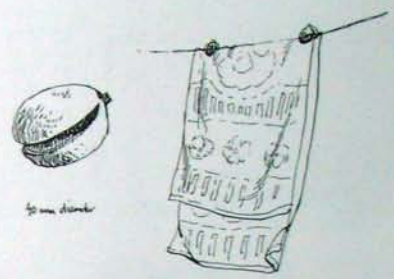
The secret in finishing off is to make sure that the strands you are working with exactly match the pattern of the plaiting underneath. Now that you have the end locked in place you can afford to look closely before you begin to make sure that all your strands match those below.

For a start you will find it convenient to tuck each strand on the right hand side in first. Notice in fig.8 that when you get to the edge the strand is worked across to the opposite side, this is because it is following the direction of the strands below it. Fig.10 shows how all the right hand side strands have been tucked in securely and cut off.

Now begin tucking in the left hand side. This is worked in the same way and trimmed off to give the result shown in the final sketch.



IN THE YARD AND GARDEN



CLOTHES PEGS

In some outback parts of Queensland clothes pegs used to be made from the nuts of the beefwood tree. After they they had fallen from the tree, the nuts opened halfway and were the ideal shape to do the job.

This was collected by Barbara Hightower from Delmi Bolton, Mareeba, Qld, 13 August 1989.

BUTCHER'S SHOP, SPRING VALLEY STATION

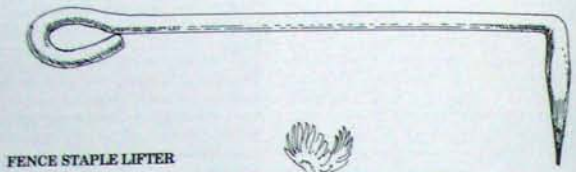
Even today most station properties have their own butcher's shop where animals are slaughtered and processed for station use. But the introduction of electricity and refrigeration has changed the distinctive architectural features of the old buildings, which are becoming increasingly rare.

Without refrigeration the old butcher shops were built with one main point in mind, to keep them as cool and airy as possible. To this end the roofs were high and the verandahs wide. In this example there is only a front verandah, but it was more common to have a verandah most of the way around.

The upper part of the wall, just below the roof, was left open and the spaces filled with fly-wire, and the walls also had as many openings as possible, both windows and doors being simply frames covered with the same fly-wire. Floors were of cement.

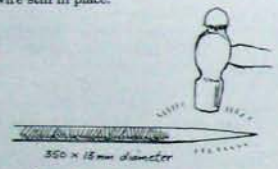
The resulting buildings were surprisingly cool even during hot weather, and the large screened open areas of wall allowed a constant flow of air through the building. This combination of coolness and air flow was a great help when salting meat, especially at the beginning of the process when the juice is running out of it. In the days before refrigeration fresh meat could only be eaten on the day the beast was killed, except in winter, and the rest of the meat had to be salted in order to preserve it for future use.

I sketched this on Spring Valley Station, Almaden, Qld, 19 June 1989.

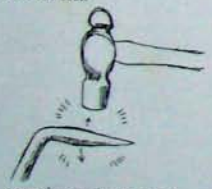


FENCE STAPLE LIFTER

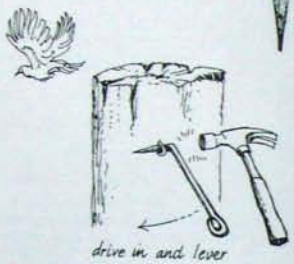
It is easy enough to hammer a fence staple into a post, but quite a different job when you come to remove it. This simply made tool can be thrown into the tin with the staples and go out to all fencing jobs. It takes up little room but is handy because it is often needed to pull out staples which have bent or twisted as they have been hammered in. It can also be used to remove old staples, even with the wire still in place.



It can be made from any convenient scrap of steel, the measurements given here are only a rough guide. If you do not have a forge or a source of heat the whole thing can be done cold, and the point done with a grinder. If you do have heat then it is a simple job to work a point up, and this should also be flattened slightly as shown in order to get a bit more depth in the tool.



If you are using good steel then you can also temper the point and it will stay sharp longer. The loop at the end is to hang it by, and need not be done if you are in a hurry.



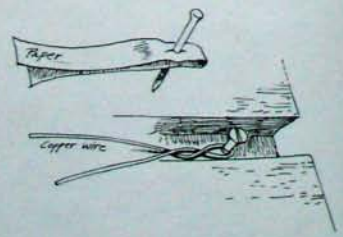
To use it the tool is hammered inside the staple, and as it goes in it pulls the staple out out of the timber. If the staple is not fully out when the point of the tool is driven fully in then a slight leverage action on the handle will do the rest.

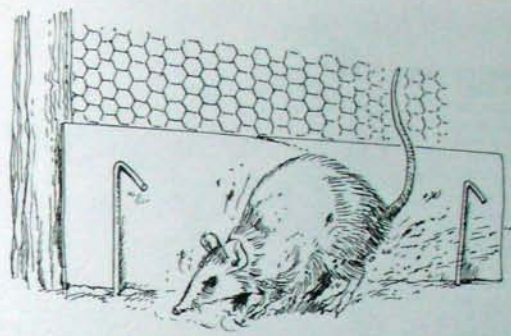
NAILING IN TIGHT CORNERS

It sometimes happens that a nail or screw has to be placed into some awkward corner where you cannot get a grip on it to get it started.

One old trick is to put the nail or screw into a scrap of folded paper, and this will let you position it in places where your fingers cannot go.

But a scrap of paper is not always to hand, and some old carpenters used to keep a piece of copper wire in the bottom of the nail bag, it took up no room and was always there when needed. One twist of the wire would hold a srew in position.





BATTLING BANDICOOTS

My battle with the bandicoots continues, and no matter what new method I adopt to keep them out of the vegetable garden it seems that sooner or later, usually sooner, they find their way in. This is especially so when I have just planted seeds, for they usually get in and dig up the new patch within a couple of nights.

In *Bushcraft 4* I described a method of wiring the bottom of the fence to pieces of timber and putting these under the ground to act as anchors and so stop the bandicoots digging under the fence. The problem has since arisen that in our humid climate of north Queensland the buried part of the chicken wire fence rots away after a few years and also there are places where there are fruit trees near the fence and the roots of these also prevent the wire being properly buried.

The latest stage of the battle is to place scraps of iron or fibro along the bottom of the fence and hold them in place with tent pegs. These scraps can often be picked up from building sites, in fact builders are usually pleased to have long narrow offcuts of various materials removed for them as they are of no use on the job.

I have found that the base doe not have to be buried more than about 25mm, and where there are a lot of roots it need not be buried at all. The material need not be very high, for some reason the bandicoots always try to get under an obstacle, even when they could climb over it

IRON HERB GRINDER

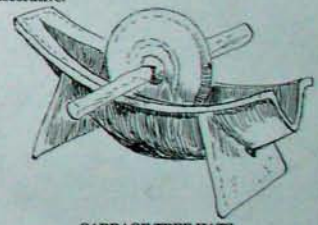
This was said to have been found by Dangerous Doug Jensen on some deserted old north Queensland mining fields many years ago. A friend of his brought it around for me to sketch, and also to try to identify.

I was not sure of its origin at the time, but now I am sure that it would have been brought to this country by Chinese miners in the 1870s, at the time of the Palmer goldrush.

I have seen similar implement in China, where they are used to crush dry herbs. The wheel is of iron with a wooden handle, and the main dish is all iron. The cut-off end allows the ground material to be poured out by simply tilting the whole thing up on its legs.

This one was 550mm long and 140mm wide, while the wheel was 215mm in diameter. I have seen them almost a metre long, and also ones much smaller than this one.

An implement like this is simple to use, easy to clean, and has nothing to wear out. It is also quite decorative.



CABBAGE TREE HATS

A hundred and fifty years ago the most popular hat in the bush was the cabbage tree hat. It was what made the bushman stand out from the city man, and all types of bush workers wore them, including stockmen, bullock drivers and miners. No bushranger considered himself dressed unless he had on his cabbage tree hat with ribbons hanging down, and there was even a song about the cabbage tree hat.

The hats were originally plaited from the finely split leaves of the cabbage palm, but other palms, such as pandanus, were used in different areas. It was a matter of pride to have one made from the thinnest possible strands, and it is said that the demand for these hats all but wiped out the stands of cabbage palms in the coastal areas south of Sydney.

The tradition of hat making in Australia has never really died and, apart from the European tradition, the Torres Strait Island people have always continued to make hats from coconut palm leaves.

However the cabbage tree hat itself has vanished from the scene, replaced in the bush by felt hats. The top sketch, taken from an old photograph, shows two miners of the last century wearing cabbage tree hats. These hats had flat brims and low crowns, and usually a ribbon tied around as a hat band.

Another sketch is of a recent hat made by Cheryl Howell of Cairns, Qld, who is continuing the tradition. However today nearly all the hand made hats are worn by women, and this example shows one popular style.

The larger sketch is of a girl at the Kuranda market also wearing a home made hat.

HORSE AND BULLOCK GEAR

THE BREAKING OF HENRY'S HORSE

Here is a story collected by Barbara Hightower from Wallace McDougall, Julatten, Qld, 11 August 1989.

I bought a horse to put in our pack team that was a very, very bad horse. Nobody could do anything with him and I tried and tried and couldn't break him and I couldn't do anything with him.

And then the Chinese pack team came along and they bought the horse and I said "What are you going to do with him?"

They said "We'll break him in".

So I thought I'd wait a while and see what they done to him. They got the horse and they put him in a crush and got a halter on him. They tied him up each leg to a corner of the yard, so he couldn't get away, so he's standing all the time. Then they all got kerosene tins with stones in them.

Half a dozen of them got around and rattled and rattled and rattled and made this terrible din And the horse fought and fought and fought but he couldn't do anything, and the noise after awhile made him just a quivering mass. They could go to him and do anything they liked with him. They put a pack saddle on him after about half an hour and took him away.

Soon as they'd go to approach him and he would start to play up again they would rattle the tins again and he'd quieten down.

MAKING BULLOCK BOWS AND YOKES

Here is some information I collected from Peter Wolfe, Ravenshoe, Qld, 18 August 1989. Peter still had a full set of bullock yokes and chains dating back from his days as a bullocky.

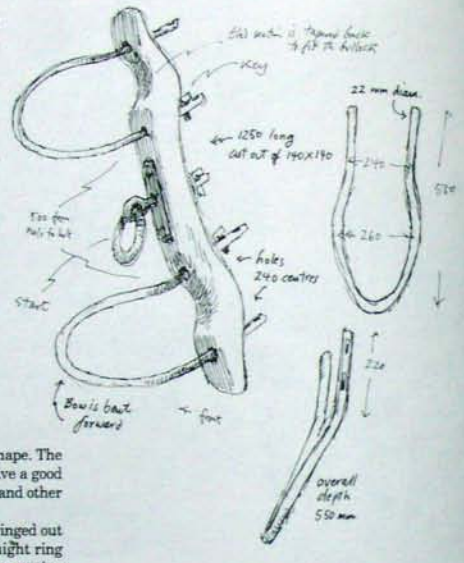
We used to make the yokes from river oak, a local timber. It was strong, reasonably light and easy to work. We could make a couple of yokes a day with the adze and a rasp. Finish them off smooth with a piece of broken bottle glass. There would be as many as thirty teams in Ravenshoe some days.

For the bows you take a piece of iron about four foot two long of seven-eighth iron bar. You heat it up and punch the holes first. You have a punch with a wooden handle. When you punch them you break off a piece of file and you put that in the hole. Then you work the bar back to the original diameter, and after that you punch the piece of file out.

Then you get a centre punch and you punch a little mark in the middle of the bar. Then you heat it up and bring it together over the anvil to get the right shape. The bows don't take too long to make if you have a good fire. My father used to make all the starts and other parts of the yoke.

When you've got twenty bullocks stringed out and they come around sometimes they might ring up, like. When they ring up they keep getting tighter and tighter and you've got to block them to try and straighten them out again and that, like.

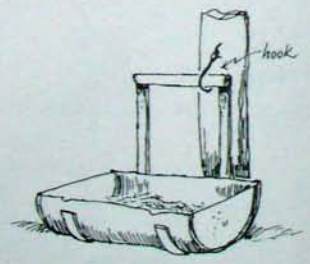
We used greenhide whips. You start from the middle of the hide and cut round and round, you have to get about twelve foot long. The handle is as tall as yourself. The fall would be about three feet. No cracker, just the fall.

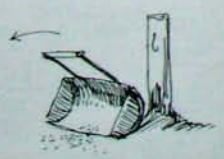


HORSEFEEDER TO SAVE WASTAGE

For many years we used half 44 gallon drums for horse feeders and found them quite effective except for the fact that there was always an amount of wastage of food which gets pulled up the sides and spills onto the ground. Some horses are worse at this than others.

These were old style drums and quite heavy, and a friend welded handles to them as shown. A simple fencing wire hook on the fence dropped loosely over which prevented them from tipping, but when it was necessary to clean them out it was convenient to be able to lift the hook and use the handle to tip them without having to bend over.

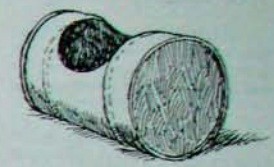




Recently I have heard of an improvement on this idea, used more than fifty years ago.

Instead of being simply cut in two the drums were sliced open as illustrated and the sharp edges bent over or smoothed.

This method means that the sides of the container curl inwards and so there is little chance of feed being spilled from it.



LIFTING A HORSE

A horse is a most difficult creature to lift without a framework and lifting tackle. A short time ago we had one of our horses go down while I was away and it took a great deal of effort by my wife and neighbours to get it back on its feet. Apart from the weight factor there is always the problem of it being difficult to get a good grip anywhere.

Later I was told about this idea. Two strong poles are manoeuvred under the horse and it is then tied firmly to them. Apart from providing leverage this also gives the helpers something firm to work with. A group of helpers is still necessary, someone to hold the head and at least one to make sure the horse does not slip down the poles, as well as those doing the actual lifting.

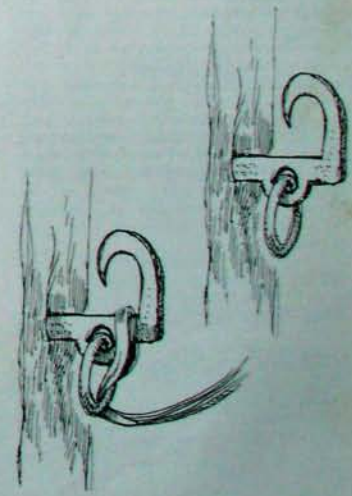
HITCHING RING

Hitching rings were as common as parking meters in the days of the horse. However today they have vanished from the streets, ending up in scrap yards or as novelty items in someone's barbeque area.

There were all sorts of hitching rings in use, and some were very decorative, especially those in use on properties belonging to the rich. Because of their craftmanship more of these have been preserved than have the plain utility models.

The one illustrated here was sketched in March 1976, in the main street of Cairns and outside the Central Hotel. By that time horses had long since vanished from the city, but no one had got around to removing the ring which had been hammered into one of the verandah posts.

This is a very good design, and also an easy one for a blacksmith to make. The reins could just be dropped over the hook if the horse was a quiet one, but if it was head-tosser then the reins could be threaded through the ring as shown and this made it impossible for them to be jerked out of the hook.

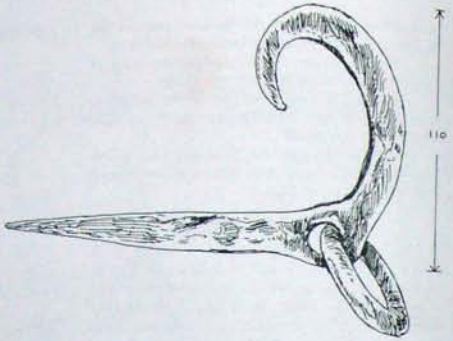


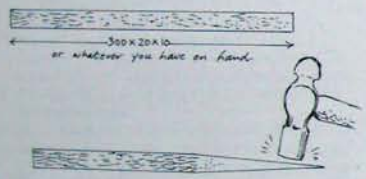
MAKING A HITCHING RING

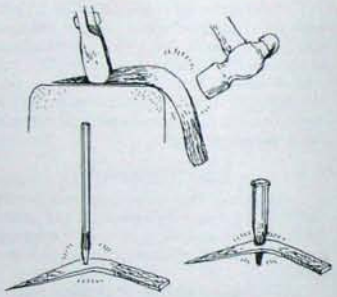
A hitching ring is not a difficult thing to make if you have a forge. If you do not have a forge you can improvise one from a fan or a hair-dryer, and this simple principle is illustrated in *Bushcraft 4* page 135, where I show a hair-dryer poked into a length of steel pipe to direct air into the fire.

To make a hitching ring such as that shown on the previous page you should cut the bar into two and then weld it together to get a good sharp corner.

However if you do not want to do this then you can work it from one piece of iron as shown. The exact dimensions can be changed according to what you have on hand.







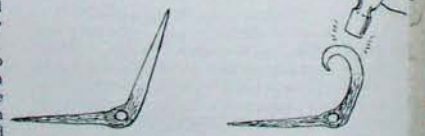
First the bar is heated and one end worked to a point. Next it is heated and the corner formed.

The hole is hammered through, not drilled, this is done because it is the traditional way, and also because it spreads the iron at this point, and you do not lose any as you do when the hole is drilled.

I use a horse shoeing pritchell to start the hole and then an old punch to enlarge it.

The other end is now worked to a point and then curled to the desired shape. This is all done by eye.

A piece of 5mm rod is heated and formed into a ring, and this is closed once it is in place. It can be left as a neat join or welded together to finish the job. Paint it with any old oil, and then heat it again until the oil burns on black and the job is finished and ready to be hammered into a post.



FOAL FEEDER

This foal feeder is a very simple answer to a common problem and the principle can be applied to other creatures besides horses, for instance variations of the idea are also used for pigs and hens. The sketch was done on Moana Stud, Myola, Queensland in January 1992. The problem here was to allow the foals to feed freely without inteference from the larger animals.

A simple timber yard was built, in this case roughly circular, of eight upright posts and a single rail around the top. The distance between each post was around 2 metres. Fencing wire with Cobb & Co hitches hold it all together.

The foals could just walk under the rail and so get at the food but the larger horses could not. The system was self regulating, for when the foal grew large enough to fend for itself it would then be too tall to get under the rail.

TYRE FOOD CONTAINERS

Old truck tyres make indestructible food containers for stock. In this case they have been made higher by joining on a tyre that has been cut in two. Both the foals and horses are feeding from them.

The kangaroo in the sketch appeared just as I was finishing the drawing.

SHELTER SHED

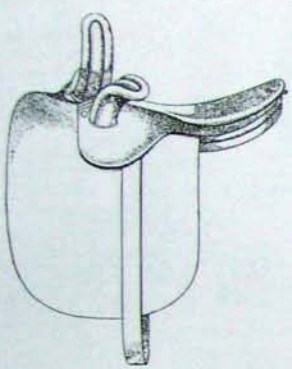
The simple shelter shed shown in the sketch was of a bush timber frame, tied together with Cobb & Co hitches in fencing wire and clad with roofing iron on the two sides where the prevailing wind and rain came from. A post and rail fence went into the shed and divided it in two. This meant that horses from the adjoining paddock could also share the same shelter, thus saving the expense of having to build two. In this area a lot of horses are lost in years of very heavy rains, so such a shelter pays for itself in the stock that it can save.

SIDE-SADDLES

Side-saddles are thought to have originated in the fourteenth century, in a rather primitive form, and they went out with long skirts in this century. At the present time I cannot find any Australian catalogue listing new ones, but there are still quite a few old ones about, due to the fact that this type of saddle did not suffer the rough usage that was the downfall of most other types of saddle.

Many old side-saddles have been restored and are used in historical re-enactments and for similar show purposes. There are a few saddlers who can do restoration work, but you would have to inquire about where to find them, we do not do any of this sort of work in our saddlery.

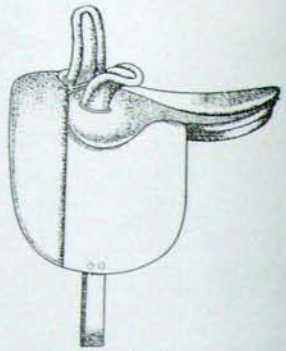
Looking through J.J. Weekes catalogue, published originally in Sydney in 1916, there are illustrations of an Australian style and an English style. Apart from some decoration there is no explanation of what the basic difference is, except that the Australian style has a longer seat. However there would be more to it than that. I have reproduced the drawings direct from the catalogue.



No. 191

Australian Style

No. **191** Saffron Stained. Hogskin Seat. Solid Safe. Complete



No. 196

English Style

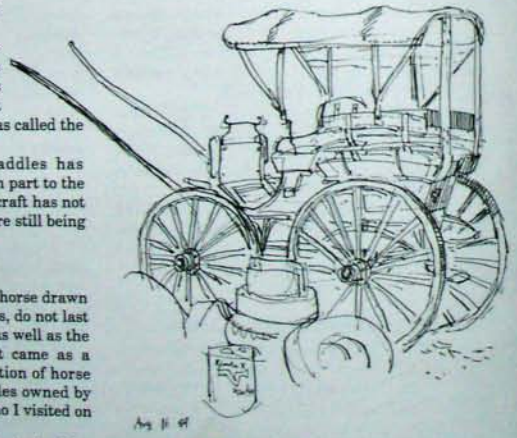
No. **195** London Color. Hogskin Seat. Solid Safe. Complete

No. **196** London Color. Hogskin Seat, but Bolstered Safe as shown. Complete.

The panels on the near side of a side-saddle were 20-25mm deeper to help keep the seat balanced during use. The flap on the near side is also larger at the front to allow for the rider's right leg, and this extra piece is called the safe. The right leg goes around the upper of the strange looking hooks on the saddle.

These hooks are sometimes known as the upper pommel and the lower pommel, though in some versions the lower one could be adjusted to suit the width of the rider's thigh and was called the leaping head.

The craft of making side-saddles has probably died out in Australia, due in part to the difficulty of obtaining trees, but the craft has not vanished entirely and side-saddles are still being made in Britain.



A SOCIABLE

In north Queensland wooden horse drawn vehicles, or any other wooden objects, do not last long due to the destructive climate as well as the ever present termites. Therefore it came as a surprise to see the extensive collection of horse drawn farm implements and vehicles owned by Abdul Mohammed of Edmonton, who I visited on 16 August 1989.

His oldest vehicle is a sociable dating from 1898 and was made by D. Ferguson and Son of Toowoomba.

GERMAN WAGGON

Although these waggons can still be found in collections in the southern states, especially in South Australia, I was surprised to find this one on a farm near the little northern town of Garadunga in North Queensland. The sketch was made September 3 1988 when I was attending a country wedding.

The waggon belongs to Ron and Carol Martinez, and has not been used for decades. The German waggon was an unsprung waggon which could be used for all sorts of general farm work. One model was designed in such a way that the tray could be removed and the wheels moved further apart so as to carry long poles.

Some waggons were made in southern Queensland, and Peter Cuffley in *Buggies and Horse-drawn Vehicles in Australia*, Five Mile Press 1988, notes M.J.Corney of Gatton, Qld as one maker of this type of waggon around 1904.

Although the waggon in the next sketch looks much the same as the German waggon it is called simply a Farm Waggon in the old coachbuilder's catalogues. Waggons like this were still in use by small farmers when I was a boy growing up in a small Victorian township.

A SORT OF COW SHED

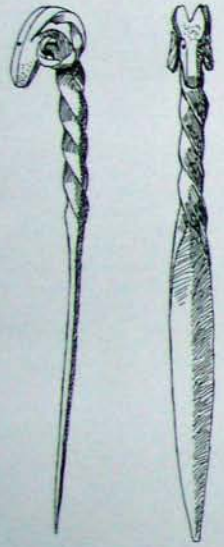
I am not sure whether this shed was originally built to house stock or whether it may be all that remains of some old miner's shack. Whatever its history it is now just a shelter for animals. It is a typical bush shelter being made of nothing but natural poles and old corrugated iron. The knobby things sticking up near it are termite mounds, known locally as ant hills, the sort which were used for floors and for mud bricks in the early days.

I sketched this at Almaden, Qld, 19 June 1989.

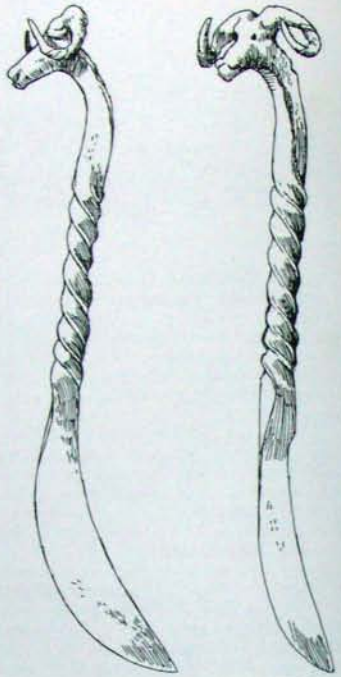
BLACKSMITHING

RAM'S HEAD BUTTER KNIFE

About three years ago a man who was working the markets gave me this small knife because of my association with the Rams Skull Press. He had got it with some other goods as part of a complicated swap with another stall holder and thought that it was made by a travelling blacksmith who came from South Australia.



The knife is only as long as a hand, 180mm, and is made from 9mm square mild steel rod. The horns have been split from the rod as shown for the next project and twisted in the same way.



SCRUB BULL CHEESE KNIFE

I decided to adapt the ram's head butter knife in order to make a cheese knife. The tradition of a ram or goat head on the hilt of a knife is a very ancient one, and may be found on old Viking knives, and on knives from other old warring tribes.

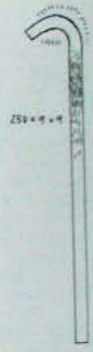
In this case I made the head more like a scrub bull, and the knife was longer than the previous one, being worked from a 250mm length of 9x9mm square rod. For a person with a welder it would be a quick job to weld on the horns, but I made them by splitting the red hot iron with a cold chisel and then working the pieces out into horns as shown. The twist in the horns is not necessary, but is easy to do, the horns are made red hot and can be twisted quite easily with pliers.

I used an oxy welder to build up the lumps on the nostrils and above the eyes, but a good blacksmith could do this by simply working the red hot metal. The eye holes are put in with a sharp pointed punch.

Twisting the metal into a spiral looks impressive but is really very easy to do. Heat to red hot the section to be twisted and then put one end in a vice and use a spanner to twist the metal around. As long as it remains red hot it will be easy to do.

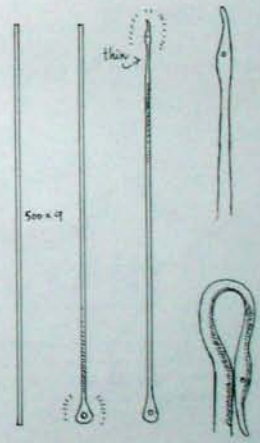
The blade was shaped with the hammer and later a grinding wheel was used to get it smooth and sharp.

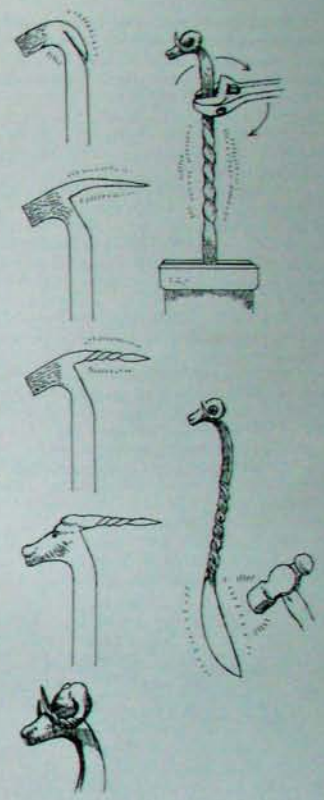
When finished the knife was given a wipe with oil and then heated just enough to dry and blacken this coating. If this is done properly the finished job will not rust and will remain black for a long time.



SOUP LADLE

As well as going out into the bush looking for old crafts I also look up old engravings and photographs to see what sort of implements the pioneers used. One old illustration that I came across of the interior of a pioneer's kitchen showed a soup ladle similar to the one here, but I could not see how the loop at the top was finished off.





I mentioned this to a friend who had been brought up in South Australia. He had not seen the illustration that I had been looking at but said without hesitation that it was probably a duck's head bent over to form the loop. I realised that he was quite right, and then remembered that as a child I had seen the same design in a neighbour's farmhouse as a child.

The choice of a duck's head was logical in that it was associated with soup and it is a relatively simple thing to shape for the home blacksmith. Another good point of this design is that even if the finished job does not look like a duck's head no one is going to know any different, and will think it is just a decorative ending. It also saves having to close off the loop with a weld, and this also suited the home blacksmith in the old days.

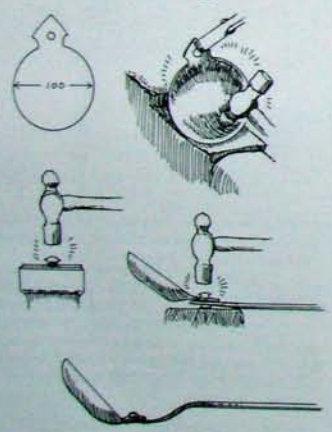
The head can be shaped first, beginning with a 500mm length of round 9mm diameter rod. Try and shape the bill properly with a slight curve in it, and mark the eyes with a pointed punch. Thin the neck down as much as possible, this makes the head look better and also makes the loop look more graceful.

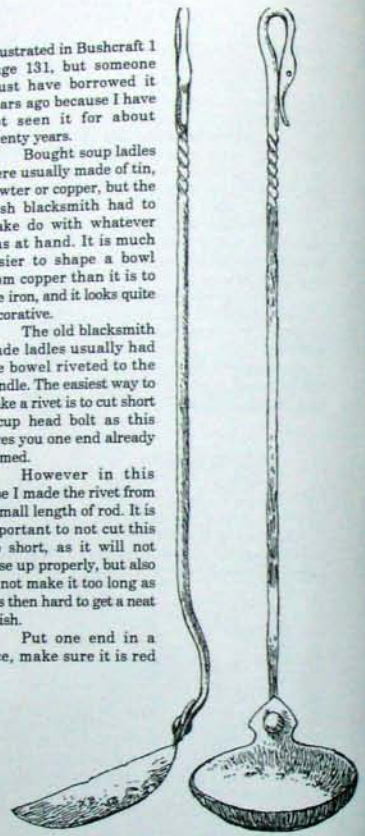
I twisted the section below the loop in the same way as described for the cheese knife, but this is not necessary.

The bottom end was heated and hammered out wide enough to take the rivet. Above this part the rod was hammered square and curved. In the old days the hole would have been made with a punch, but you may find it easier to drill it.

The bowl takes quite a bit of work to shape if you are using 1mm or 2mm sheet iron. It must be worked red hot and the best place I found to do the job was on the stepped section of the anvil.

Ladles of this weight were often used for melting lead, and we had one years ago when we used to make our own fishing sinkers. It is illustrated in Bushcraft 1 page 131, but someone must have borrowed it years ago because I have not seen it for about twenty years.





Bought soup ladles were usually made of tin, pewter or copper, but the bush blacksmith had to make do with whatever was at hand. It is much easier to shape a bowl from copper than it is to use iron, and it looks quite decorative.

The old blacksmith made ladles usually had the bowel riveted to the handle. The easiest way to make a rivet is to cut short a cup head bolt as this gives you one end already formed.

However in this case I made the rivet from a small length of rod. It is important to not cut this too short, as it will not close up properly, but also do not make it too long as it is then hard to get a neat finish.

Put one end in a vice, make sure it is red hot and hammer it over to spread the end. Now put the whole thing together and hammer over the other side to close the rivet, this is also done while red hot.

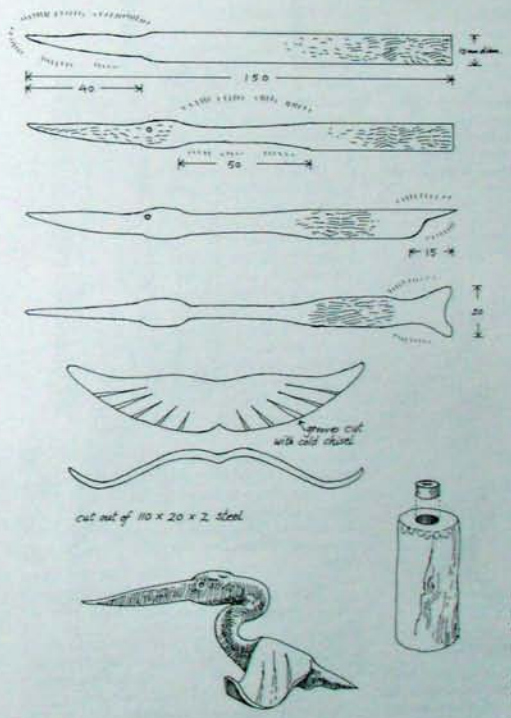
Paint oil on the finished job and heat it until the oil cooks on, so that you have a nice flat black finish. Best use cooking oil for this job if you are going to use the ladle for soup.

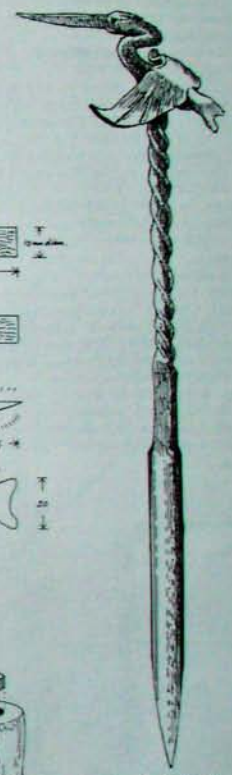
PELICAN KNIFE

This decorative knife can be used for any purpose, I left mine blunt to use as a letter opener. The hardest part of the job is getting the bill and head shaped properly and the neck neatly bent.

I made this one out of 10mm diameter rod, heating one section at a time and shaping it as I went. The eyes were put in with a pointed punch. The wings are welded on last, and the feathers in the wings indicated by making shallow cuts with a cold chisel. Only the tips of the wings turn upwards.

The grinder can be used to get the bill smooth after it has been hammered to shape.

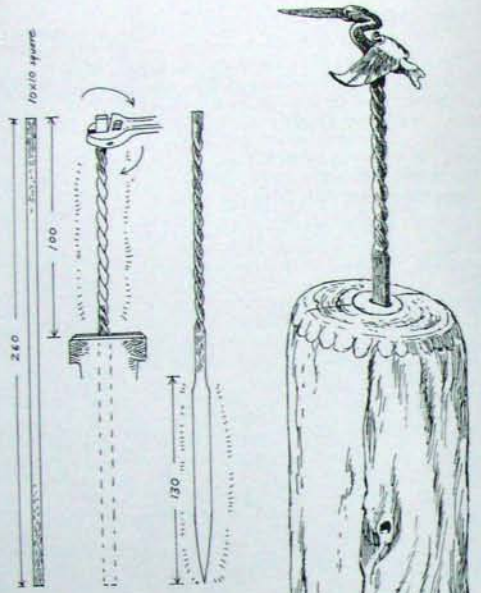


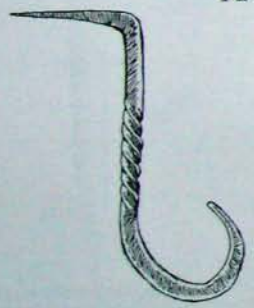


The handle is twisted in the same way as is shown for the scrub bull cheese knife. If you are using old car springs for the job, or similar steel, then the knife can be tempered and sharpened to a good edge. If however you are using only mild steel then it cannot be tempered.

The handle is welded onto the bird and the knife is complete. It should be oiled and then heated until the oil dries and form a good black surface.

I put mine into a piece of timber where it is easy to get at. It is difficult to get a narrow slit into such a log, so I first drilled in quite a large hole to the required depth. I then shaped a small plug for the top, and cut the slit into this. The plug was then glued in place. This keeps the knife upright and in the right position.

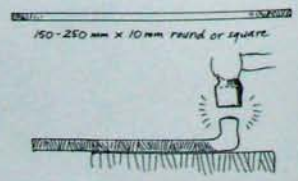


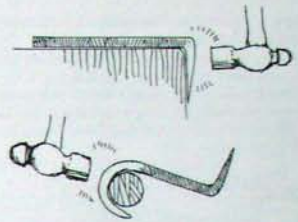


DRIVE HOOK

Variations of this hook may be found in all sorts of old farm sheds, it was the sort of thing the pioneer would knock up in a few minutes whenever one was needed. A hook like this can be beaten out cold and the point made with a grinder, but the traditional method is to work it hot on the anvil.

Any scrap of metal can be used, round or square, and the length can be chosen according to the purpose of the hook. I have made them with scraps only 100mm long, but 200mm would be more usual.



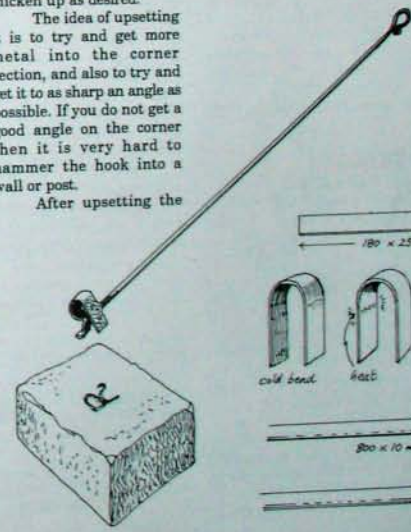


The first step is to heat one end, bend it and then try and upset it. Upsetting is the process of heating one part of the metal and then hammering it in order to try and thicken the section which is red hot. It sounds easy but for the beginner it is not, as the rod more often seems to bend and twist rather than thicken up as desired.

The idea of upsetting it is to try and get more metal into the corner section, and also to try and get it to as sharp an angle as possible. If you do not get a good angle on the corner then it is very hard to hammer the hook into a wall or post.

After upsetting the point is worked over a sharp corner of the anvil, again trying to get the bend as sharp as possible.

Now the other end is heated and the hook formed. The job is now complete, but I usually put a twist into it because it looks good and is easy to do. The middle section is hammered square, heated to red hot and then twisted with a spanner.



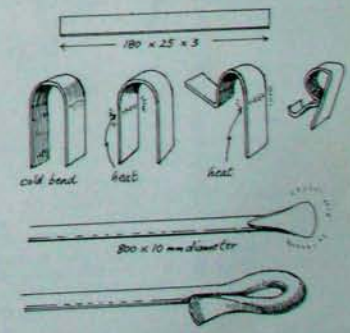
Rub it with oil or wax while it is still hot, but not so hot that the oil burns.

BRANDING IRON

This is not a branding iron for cattle, but a small version which we use for branding mud bricks. It can also be heated and used for burning your initials into bush furniture. I remember seeing wooden tool handles which some old carpenter had treated the same way, using very small letters for his initials.

This branding iron is only slightly smaller than a cattle branding iron, the letters being 60mm high when finished.

While you can see the sense in branding your own bush furniture you may ask why we want to stamp our mud bricks seeing that the marks will be hidden when the brick goes into the wall. The reason is quite simple, when we are using the bricks we know who to abuse if we come onto a dud brick, and this leads to some interesting conversations.

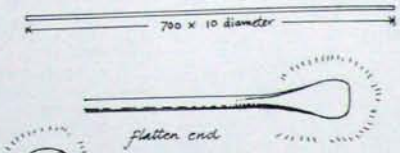


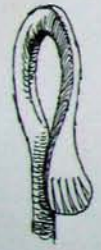
The letters can be made from any suitable steel strap. 3mm steel can be cold bent for the large curves, these include the letters B C D G J O P Q R S U.

The easiest way to do the sharp bends is to heat just that section, I find that a small oxy flame is the best, but it can also be done in the forge. The following letters can be done with only this type of sharp bend, I L M N V W Z.

Some letters will require welding on cross pieces, and these include A E F H K R T X Y.

The handle can be of any suitable rod, as long or short as you want. This one was 800mm long and was finished off as shown, this is a simple and neat way to form a loop.





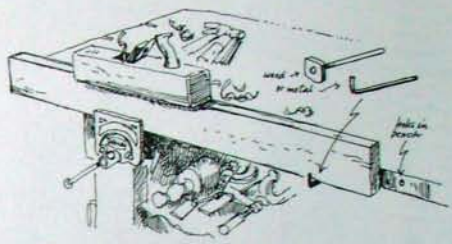
BASIC POKER

This basic pattern of poker may be found in old homes all over the country, being quick and easy to make. It can be made from a 700mm length of 10-13mm diameter mild steel rod, or any other similar material, old wrought iron would be good if you can pick any up.

The handle is heated and flattened out at the end, given an upward turn and then formed into a loop. This is the basic form, but some smiths would hammer the loop to give it a slightly rectangular cross section and then cut in a few decorative grooves with a cold chisel as shown in the next drawing.

The other end is now heated and hammered to a point, and this was often squared off, again just for appearance. The shank would also often be heated and twisted with a spanner to provide a simple touch of decoration.

FURNITURE



PLANING AID

When planing long boards along their edges they usually need to be held in the vice, but this leaves one end of the board unsupported and so makes it difficult to plane as it can move.

In order to avoid this carpenters used to drill one or two holes in the edge of their workbench. A pin could be pushed into the hole to support whatever plank was in the vice. Sometimes boards can be a bit whippy and jump off a plain pin and so the pin was made so that this could not happen.

If a length of steel rod was used for the pin it simply had a small bend put in the end.

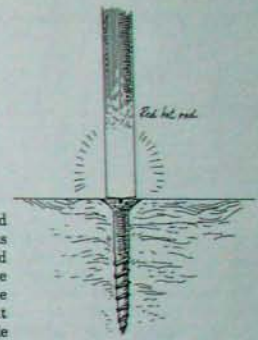
If a wooden dowel was used a scrap of timber was drilled and glued on the end to provide a stopper whichever way it was pushed in.

REMOVING SCREWS WITH HEAT

Sometimes old screws rust into timber and defy all efforts to get them out. Applications of greater amounts of force only result in stripping the head of the screw and make the problem even worse. So before doing this try some other methods.

One way that sometimes works is to put the screwdriver to one side and take a metal punch, preferably one large enough to cover the whole head of the screw, and with a hammer strike a few sharp blows downwards on the screw head. Sometimes this will loosen the rust. If some fine oil is also poured on and left for a time after doing this it also helps.

One method used by desperate old carpenters was to take a piece of iron rod about the same diameter as the head of the screw and heat the end of it red hot. This was then held against the head of the screw for at least a couple of minutes.



The heat of the rod was transferred to the screw, causing the metal to expand, but without charring the wood. With luck this broke the rust seal and so the screw could be undone.

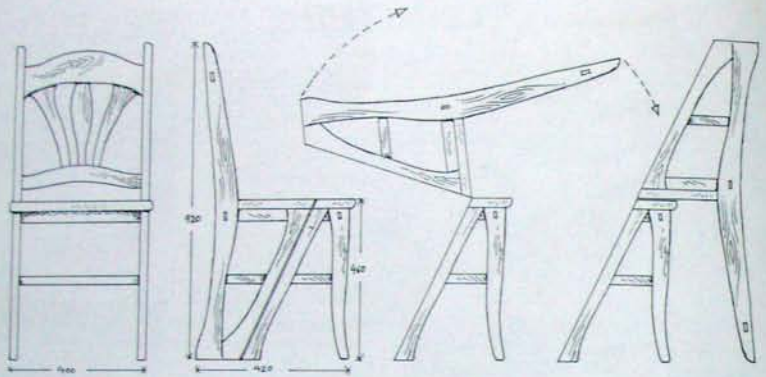
If even this failed then the screw had to be drilled out, a job to be avoided if at all possible.

CHAIR STEPS

Chair steps were a complicated answer to a problem sometime encountered where a chair was always needed but sometimes steps were also necessary, usually to get things down from high shelves.

Unless the room is very large permanent steps are often a nuisance when kept in a room and even more of a nuisance if they are kept somewhere else and have to always be fetched when needed. Chair steps provide an article of furniture which can be used all the time, generally as a chair, but turned into steps as needed.

In the old days articles such as this were never mass produced and therefore every cabinet maker worked out his own pattern. As a result there were lots of variations, some of them more graceful (-but also more complex) than the fairly basic pattern I have illustrated here. If you wish to make one yourself you could alter the dimensions



as desired. The main thing is to have the steps exactly the same distance apart, it is very dangerous to have a set of steps in which some are further apart than others.

The example given here is very simple, some versions had lots of turned work in them, the front legs were often turned and also there were often turned rods in the backrest instead of the flat piece in my example.

Sometimes small hooks or catches were fixed to the sides of the chair so it would not open when it was just being moved around.

KERO TINS AND BOX FURNITURE

In the bush in the old days people did not have any spare money to spend on buying furniture and had to make a lot of it themselves. As one old lady put it:

"What we had was handmade by dad. He made tables out of wooden boxes, kerosene boxes. We had beds too, made by dad, but they had no springs in them, only boards. We even had mosquito nets. Mum made them. She bought the material and made them. There was nothing posh in those days."

(As told to Barbara Hightower by Lucy Durso, Innisfail, Qld, 16 August 1989.)

Kerosene used to come in square tins, and these were a favourite raw material for all sorts of bush utensils. In *Bushcraft 2* I have shown how they were used for food coolers (p.41), dust pans (p.39), washing up dishes (p.39), ovens (p.12), and drawers (p.34). The tins came packed two to a box, and these wooden boxes were also popular for bush furniture, a chest of drawers is illustrated in *Bushcraft 2*, page 34.

In *Bushcraft 3* there is a water scoop made from a kero tin (p.30), a mousetrap (p.27 & 28), a fly trap (p.26), a hen's nest (p.24), a kitchen sink (p.74), a Coolgardie safe (p.72), a vegetable chest (p.73), and a stove (p.64), while both tins and boxes were used to make a billy cart (p.85), and the boxes could be used to make chairs (p.49), and as a base for saddle bags (p.74).

SHOE CUPBOARD

To make this basic cupboard two kerosene boxes were placed on their ends and a shelf was put in each on which to store the shoes. Curtains were hung in front of the boxes and a third box was placed on top on which you perched when you took your shoes off.

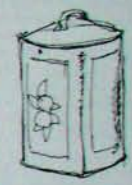
(Collected by Barbara Hightower, while on a collecting trip with me, from Dot Limkin, Mareeba, Qld, 13 August 1989.)

SETTEE OF KEROSENE BOXES

This settee consisted of one kero box longways and two standing up, with a plank nailed on for a backrest. As kerosene boxes were not all that large it must have been quite a small settee. Sue Horsley heard about this from Mrs Jenkins of Mount Kooyong, Qld 12 August 1989, and passed it on to me.

KERO TIN BREAD CONTAINER

This is very typical of bush furniture, the adaptation of whatever comes to hand in order to fill a need. In this case a bread container was needed, and the most logical thing to use was a kerosene tin. However this did not have a removable lid, but the handyman found a circular lid of about the right dimensions.



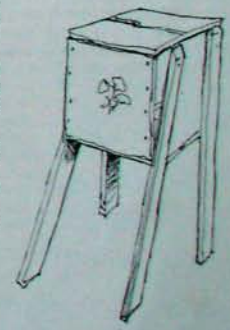
It was a simple job to hammer the top of the rectangular tin into a circle and so make the lid fit. The whole thing was then painted and decorated by pasting on cut out pictures of flowers.

This was noted at the home of Lil Kootoofa, Chillagoe, Qld, 20 June 1989, as was the next item.

BUTTER BOX CUPBOARD

In the old days country storekeepers used to buy butter by the box, and these boxes were sought after by bush people as a useful alternative to the popular kerosene box.

In this case a butter box was simply mounted on a set of legs to make a practical vegetable cupboard. A coat of paint and some cut-out flowers pasted onto the front and it was complete.

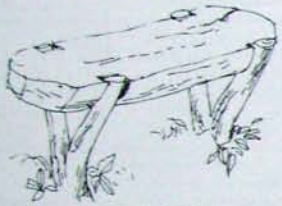


It was made by George Kootoofa of Chillagoe, Qld, in the 1950s.

BUSH STOOL

The legs of this bush stool are made from two forked branches set into the ground, the seat from a split slab of beefwood one and a half metres long. The stool is 420mm high and was noted in the garden of Bonny Prior of Chillagoe. It was made five or six years earlier by her son Tommy who had worked as a stockman and noticed such stools in bush camps. He was about 17 when he built it.

I noted this at Chillagoe, Qld, June 20 1989.



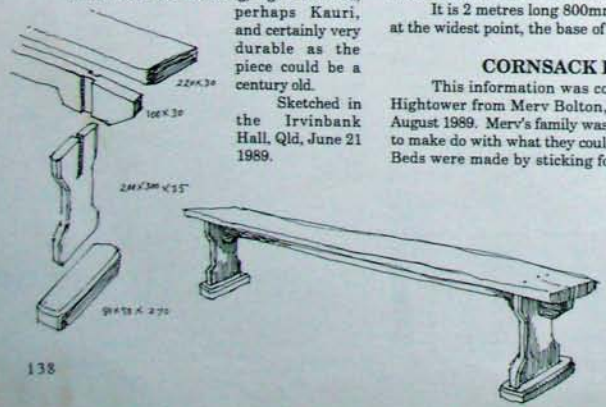
HALL STOOL

This stool, in the old Irvinebank Hall, shows a higher degree of craftsmanship than most bush furniture. It would have probably been made by one of the carpenters employed by the Irvinebank Tin Smelting Company and so would have been the work of a qualified tradesman.

As well as being made with two legs as shown here this type of stool was also made in exactly double the length so that the top plank was an unbroken length of timber 220mm wide and 4 metres long, and supported in the centre by the same sort of leg as used on the ends.

The timber was a strong, light softwood, perhaps Kauri, and certainly very durable as the piece could be a century old.

Sketched in the Irvinbank Hall, Qld, June 21 1989.



CHURCH PEW

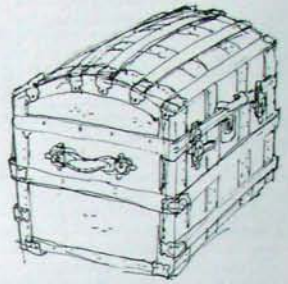
A single wooden pew from a long vanished church in the town of Irvinebank, north Queensland. It was located on the verandah of the local hall and appeared to be made of red cedar. It would be a survivor from the days when the town flourished, before the turn of the century.

The seat has a lower section at the back, which is a ledge for prayer books and hymnals for worshippers in the row behind.

It is 2 metres long 800mm high and 500mm at the widest point, the base of the legs.

CORNSACK BED

This information was collected by Barbara Hightower from Merv Bolton, Mareeba, Qld, 13 August 1989. Merv's family was quite poor and had to make do with what they could make themselves. Beds were made by sticking four forked sticks in the ground, corn sacks were stretched across the sticks and grass was put on top for a mattress.



SEA CHEST

Sea chests were always an accepted part of the furniture in the pioneer's home. In the days of long seas voyages and journeys by coach aor bullock wagon they provided the only safe and practical means of safely transporting personal belongs.

One distinctive feature of the sea chest is the curved lid, but there are still differences of opinion as to the reason for this feature.

For one thing the chest itself could not be made too heavy because it had to be regularly manhandled, and so the materials of its construction had to be both as light and as strong as possible. The curved lid provided an extremely strong top with the lightest possible materials.

A theory has also been put forwad that the curved lid prevented chests being stacked on on top of the other by the carrier, and so this feature also helped protect them from damage by heavy weights being placed on them.

Not all chests had curved lids, tradesmen's tool chests often had flat lids, and so did some seamen's chests. The reason for the latter being that they sometimes had to be stowed under bunks and were made low for this purpose.

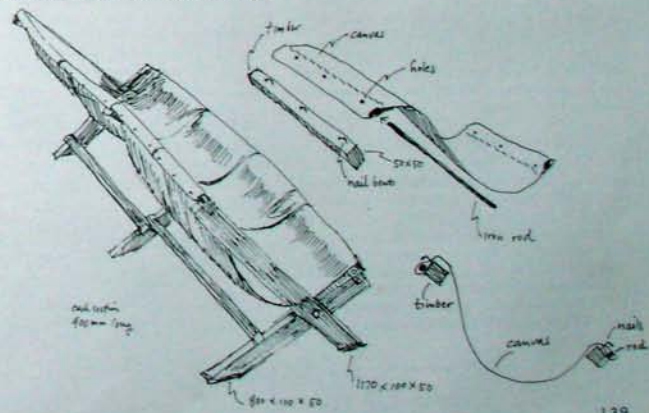
Bush carpenters and other tradesmen often made their own chests, but the one in this illustration is more elaborate than most and would have been made by a skilled craftsman. It has brass corners and the wooden panels are inset with embossed leather featuring geometric patterns.

This chest is over a century old and belonged to the Great- uncle of Jim Fitzgerald. It was sketched at his camp on Emu Creek, Emuford, 18 June 1989.

CANVAS THEATRE SEATS

This type of seat was in use in theatres in northern Australia until recent times. Until its closure in the 1970's Cairns major theatre, the Tropical, used them, and many smaller country theatres still retained them until the swing towards television closed many old theatres.

They are a very practical type of seat for a hot climate allowing the maximum coolness to the back. However in the form shown here they were not adjustable and so were not very comfortable for children or very short people. There were some styles which allowed the height of the seat to be adjusted by rolling up the canvas, but in these the



canvas was usually held by wooden laths rather than the steel rods used here.

The steel rods slipped through loops in the canvas and bent nails held both canvas and iron in position. This allowed for easy removal of the canvas for washing.

SAWHORSE

In the old days the traditional sawhorse was always made of timber. This was to be expected for the person who needed it was used to working in timber and there were always scraps at hand.

However in recent years many carpenters have changed to using horses with steel legs. These have the advantage that they can be thrown in and out of trucks without being damaged, and can also be left out in the weather without such a risk of rotting.

The one in the sketch is a good all round size, but we also have a couple that are higher and longer, and also one that is much lower and is used with certain power tools, such as the jigsaw, where you need to be above the job.

Originally, when I acquired this horse, it consisted only of the four legs, but I found that without a crosspiece they tended to wobble loose in the timber top, so I added the extra bits.

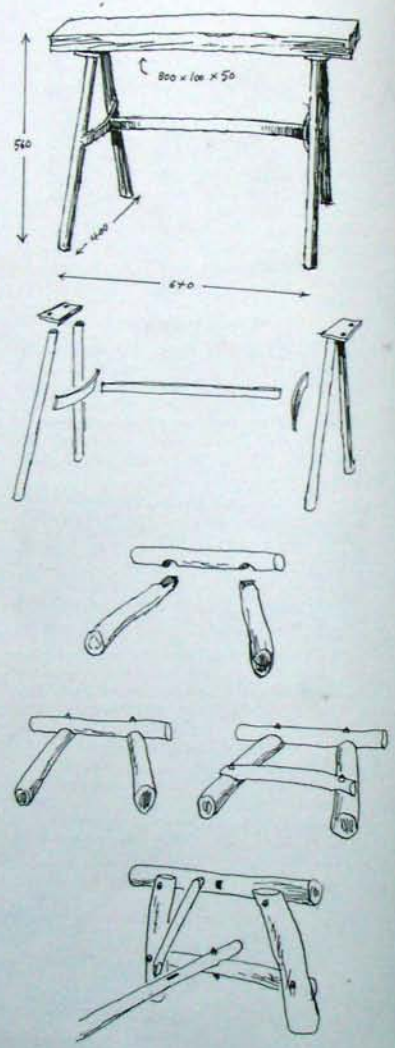
I am rather proud of the curved bits, because for some reason they look good on the finished job. But the truth of the matter is that they were not specially curved but just happen to be a couple of pieces of old car spring that I had laying by the welding table.

When making any sort of sawhorse be careful to screw the top wooden piece on from underneath only. If you have a bolt or screw head on the top of the horse then sooner or later you are bound to run a saw over it! It is always handy to make sawhorses in pairs, especially if you are house building and handling long timbers.

A SOLID BUSH TABLE

This table is really solid, and with a hardwood top over three metres long and 50mm thick it takes four people to move it. It is based on a traditional pattern and was built entirely from wood that we cut and rough sawed on the property.

The top is a beautiful rich red colour, and the timber is known locally as either red stringybark or red mahogany, but this will mean little to readers in the southern states as this is a northern timber and differs from southern stringybark and so called mahogany.



The top planks were cut on the spot with a swing saw (often called a hagen saw). This gives a rough sawn finish and it took many hours of work with the adze and then the plane to get it anywhere near smooth.

The rest of the frame was made with branches from the same tree. These do not have the same rich colour as they still retain the sapwood, which weathers to a dull colour.

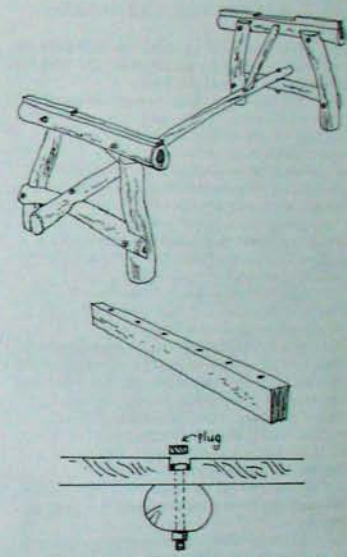
Laying out a framework of this type using natural timber is much trickier than when using milled timber, and it is best to begin with longer pieces than you need and trim them off only after everything has been put together. Chalk the shape of the frame on the floor and then lay the pieces on it and do not cut until you are sure that it will fit.

I used bolts to hold it all together, so that if necessary it could all come apart again, but in the old days it was more usual to use long hand-made nails. A craftsman would glue and dowel all the joints, or use wedges (as shown in the section on wood joints).

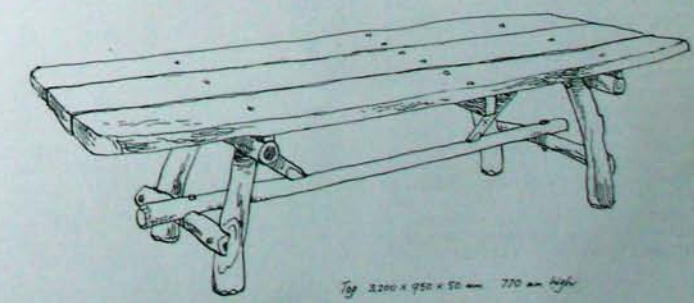
Rather than try and fit the top planks directly to this frame I found it better to plane up some lengths of timber and attach these to the top of the frame. Because the top planks had been sawn by eye and were all of a different thickness it was then necessary to lower some sections of this top piece, as can be seen in the drawing of the frame without the top.

In order to make the frame rigid the legs at each end are tilted and two short braces are fitted in at an angle. These do not have to be screwed in place as the inward thrust of the tops of the legs act to wedge them tight.

I found it necessary to put a crosspiece under the top of the table in the centre to take out a bow in one of the planks (shown centre right).



The bolts that hold the top of the table to the frame go in from the top, and the head of the bolt is sunk well below the surface. A wooden plug is then fitted into this hole and glued in place, totally concealing the bolt. This plug remains in place, and so does the bolt, even when the table is pulled apart.



STOOLS FOR THE TABLE

The stools that go with the bush table are very simple, the uprights simply lengths of log into which the horizontal plank sits.

The sapwood on these logs was a very dull and unattractive colour, so I used a technique known to old bridge carpenters, and which I described in *Bushcraft 4*.

This consists of first squaring up the log, and traditionally a broad axe was used for this, but you could use an adze or even a chainsaw.

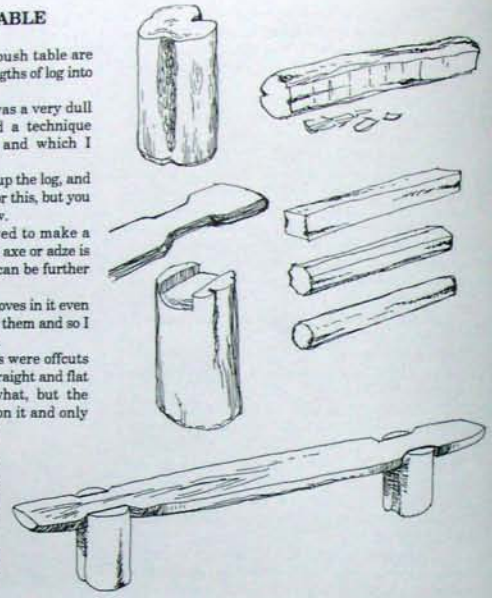
Next the corners are removed to make a roughly circular shape, and then an axe or adze is used to bring it to a circle, and this can be further smoothed as much as you wish.

Because the tree had deep grooves in it even this rounding process did not remove them and so I cleaned them out with a hand gouge.

The long planks for the stools were offcuts from logs and so they only had one straight and flat side. I evened up the sides somewhat, but the underneath was left with its curve on it and only flattened where it came in contact with the logs that formed the legs.

By cutting a simple joint as shown the top could not slip off the legs, and because of the weight of all the parts the stools were remarkably stable.

The table will comfortably seat 14, and we once had 20 around it for a special celebration.

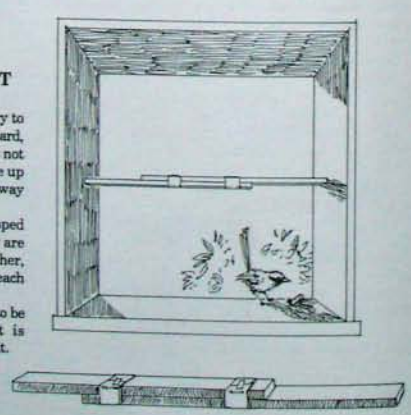


MEASURING INSIDE AN OBJECT

On building jobs it is sometimes necessary to measure the inside of a door or window or cupboard, and this can be a difficult task. Because it does not happen all that often few people bother to make up a permanent measuring stick, so this is a quick way to do the job

A couple of scraps of paper are wrapped around a pair of sticks and taped in place. They are wrapped tightly enough to keep the sticks together, but loose enough to allow them to be slid out at each end.

The device is opened up inside the thing to be measured and then held firmly while it is withdrawn and the measurement taken from it.



JOINTS IN TIMBER

There are dozens, if not hundreds, of ways of joining timber together, but this is not the place to learn about them. You will find that information in books devoted to the finer points of building and cabinet making. The Japanese have taken the process of joining one piece of wood to another and developed it to such a high art form that an apprentice will spend years before he has learned some of the more complicated joints.

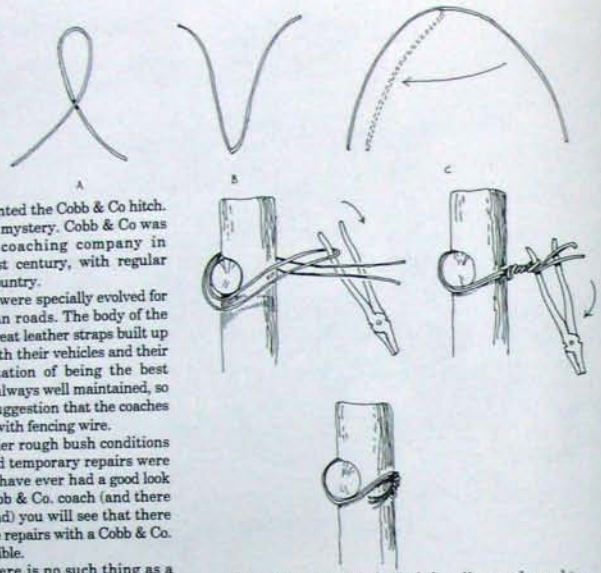
As far as the average bush carpenter is concerned the rules for joints are simple - they must be relatively easy to do and be strong when finished. The variety of joints used by the bush craftsperson will depend on the amount of building experience that person has, some people use quite a variety of techniques, while others rely on just one or two. I will illustrate some of the common ones, but you may encounter other more complex ones, especially among old bush carpenters who may have worked in the building industry in their younger days.

COBB & CO HITCH

Let us begin with the most simple joint and one that is often encountered. The Cobb & Co hitch uses only fencing wire and is twisted together with any handy length. It is strong, fast and efficient, and has been used by bush builders from the pioneering days. No one knows who invented it and how it got its name, but it seems to have been worked out soon after fencing wire replaced post and rail fences.

In the bush the simple joining together of two lengths of timber presented a problem, given that the average bush worker and pioneer had to work with rough timber and the minimum range of tools. The fastest way to join poles together was with a single length of fencing wire just twisted together . However such a joint is often loose because it is difficult to get the wire twisted together tightly, even with the help of the fencing pliers.

The answer to this problem was worked out by some bush genius and if we ever get round to properly honouring our pioneers we should erect a statue to honour the person who invented the Cobb & Co hitch. Even the name is a mystery. Cobb & Co was the most famous coaching company in Australia in the last century, with regular routes all over the country.



Their coaches were specially evolved for the rough Australian roads. The body of the coach swinging on great leather straps built up into thick layers. Both their vehicles and their horses had a reputation of being the best available and were always well maintained, so there was never a suggestion that the coaches were held together with fencing wire.

Of course under rough bush conditions things did break and temporary repairs were required but, if you have ever had a good look at a genuine old Cobb & Co. coach (and there are still some around) you will see that there are few places where repairs with a Cobb & Co. hitch would be possible.

Of course there is no such thing as a mystery in Australia, and I have no doubt someone one of these days will invent a legend about how this hitch got its name, and probably tell us that it was invented by the Man from Ironbark, or some other unlikely character. I think it most likely that some bush wit coined the name out of the blue, and because it sounded good it stuck.

The Cobb & Co. hitch is simple to do but, like everything else there are a few points to remember. First a length of wire is doubled, but there is even a knack to this, for when the wire comes off the coil it already has a curve in it. If you bend the wire downwards to double it then it will look like "A" and require further bending to get the strands to lay together. If it is bent upwards then it will look like "B", which also will need more bending. However if it is bent to the side as in "C" then both halves will follow the same curve. This makes it easier to use.

Fencing pliers are usually used to cut the wire and because of this the handle is usually also used to twist up the hitch.

If you feel happy with this then by all means do it, it is the traditional method and it works. However many people find the pliers awkward to use in this way and if this is the case then an old heavy screwdriver, or just a length of steel rod, will be found much easier to use.

Enormous leverage can be applied when tightening a Cobb & Co hitch, so be careful not to do that extra little turn at the end and break the wire - especially if you are in one of those awkward positions where you are fixing up some framing above your head and the hitch is the only thing holding it up!

One secret of the Cobb & Co hitch is to try and get both wires twisting so that the whole thing is locked together. If only one pair of wire spirals round the other then they cannot be tightened.

When the hitch is tightened always make sure to twist the cut ends out of the way, apart from looking neater it will prevent accidents.

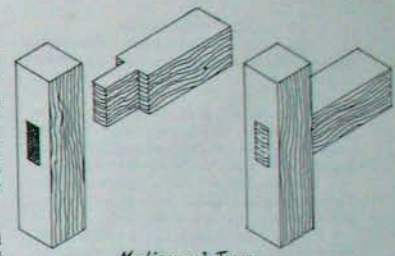
In northern Australia many bush huts are tied together with little else but Cobb & Co hitches, and the method is still in use, especially where rounded bush logs are used.

MORTISED JOINTS

In the early days, and more especially in the southern states, Cobb & Co hitches were regarded as a bit too slapdash even for bush huts, and joints were made by more traditional methods. In the same way that bush workers used Cobb & Co hitches in hut building because they already used the technique frequently in yard building, so the early southern bush worker used mortised joints because he was already used to preparing them for post and rail fences.

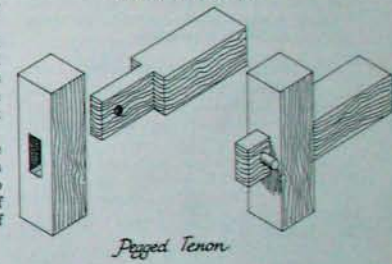
MORTISE AND TENON

Having cut out the mortise in the vertical post the tenon is shaped on the end of the horizontal timber and the two fitted together to make a strong and practical joint.



As mentioned earlier hut builders, well practised in this joint through fence building, used it a lot in frame construction. However as the skills associated with post and rail fences were forgotten so this type of joint was used less in the framework of huts.

But it was not forgotten in the building trade and was still used extensively in the construction of doors, windows and all types of furniture. So though it ceased to be part of the every day work of the bush worker it remained as one of the skills of cabinet makers and good carpenters.

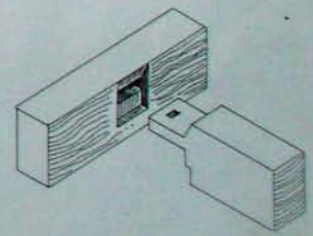


FIXING THE MORTISE AND TENON

The easiest way of fixing together a simple mortise and tenon is to make a perfect fit and glue it, but few bush carpenters have that skill. The temptation is to simply hammer a nail in to hold the two parts together but this is not considered to be the correct and traditional method.

PEGGED TENON

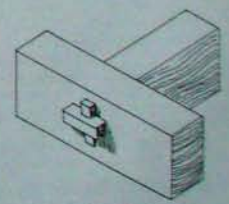
If it is possible for the end of the tenon to stick out then it can be held in place with a piece of dowel. This is simple to do and the result is strong and secure.



TUSK TENON

This is a variation of the method above called a tusk tenon, but this can be quite complex to cut out and is more in the nature of cabinet making than hut building. It was shown to me by Bill Maddock, who was a carpenter who worked in the bush, which is a bit different to being a bush carpenter. It has a few variations but here is a complex one to give some idea of its form.

As can be imagined such a joint took some skill in constructing and so was only used by skilled tradesmen and has now been all but forgotten.



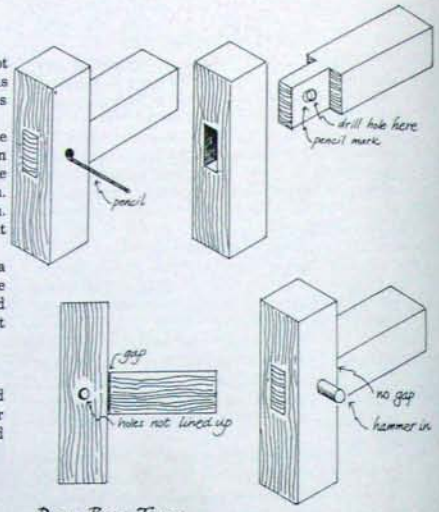
DRAW BORE TENON

One method of fixing a tenon that was not going to stick out the other side like the previous example was to use a method known as draw-boring.

In this method a hole is drilled through one timber after the mortise and tenon has been completed. A nail or sharp pencil is put into the hole and used to mark its position on the tenon section.

Now the hole is drilled in the tenon section. This is not drilled exactly on the pencil mark but just a fraction to one side as shown.

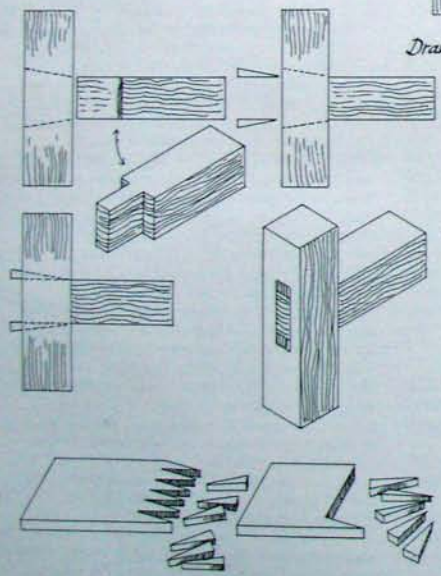
The two parts are again put together and a slightly tapered wooden pin is driven in through the two holes. This pulls the tenon in very tight, and when this has been done the ends of the pin are cut off flush and the joint is complete.



Draw Bore Tenon

WEDGED MORTISE AND TENON

This is a form of fastening well known and widely used in Australia, and still popular in other parts of the world. In 1991 I even saw it being used in the construction of furniture for a temple being built in a lamasery in eastern Tibet and an Australian carpenter with me said that the method was identical to what he had used in the past, and which Australia cabinet workers still practise.



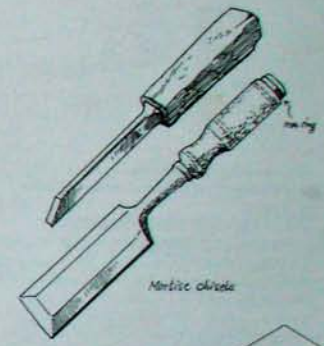
Wedged Mortise and Tenon

One important difference between this joint and the previous ones is that the hole in the timber, the mortise, is not parallel but fans out slightly on the outside edge. This means that when the two timbers are fitted together the joint is very loose.

It is tightened by the use of wooden wedges which are hammered in and cut off flush. Once the wedges are in place the whole joint is firmly locked. If a spot of glue is placed on the wedges then the whole thing is formed into a permanent unit which cannot be pulled apart.

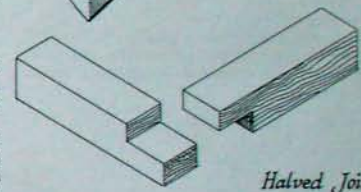
When I first saw a tradesman preparing wedges I could not imagine what he was doing. Taking a scrap of timber he cut a number of 100mm cuts into it. This produced a dangerous looking end on the timber and I wondered what it was to be used for, not realising that it was really the bits falling on the floor that he wanted. Then, when he proceeded to cut off the jagged end I was totally mystified, until he then gathered up all the small wedges and took them over to the job.

This type of joint will be often found in door and window frames as well as in furniture. The sketch shows two sorts of mortise chisels. The narrow one is over 90 years old, and I bought it from a retired builder who had in turn had it from his father. It is this narrow one that is used on this type of joint.



HALVED JOINT

The halved joint is often used in building construction and is simple to prepare and understand. If the timber is of the sort that splits easily it may be best to drill holes before nailing or screwing the two pieces together. The larger chisel is used for this type of joint.

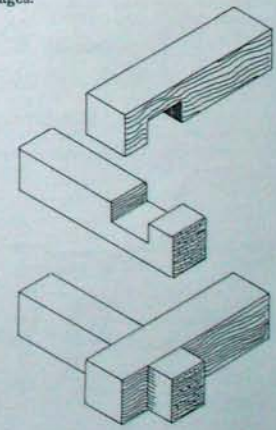


Halved Joint

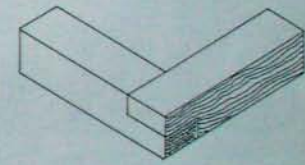
HALF LAP JOINT

A half lap joint is stronger than the previous halved joint as it cannot be so readily pulled apart, but of course it can only be used where it is possible to have overhanging ends.

In hut building this one is often used with rounded bush timber and in that case a little thought is needed. It is very easy to make the joint too loose, as I have often found to my cost. This is because there is a tendency to cut the joints to the diameter of the logs instead of fitting them together in stages.



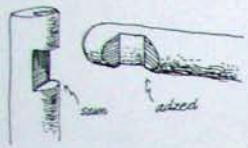
Half Lap Joint

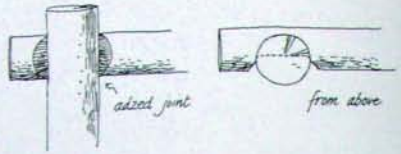


For rough work the joints can be done with an adze, or perhaps one can be sawn and chiselled and the other done with an adze. The advantage of sawing the lip on the upright piece is that it gives a firm ledge on which the horizontal piece can sit.

The advantage of shaping the horizontal piece with an adze is that it is very difficult to judge the exact shape of the joint in round timber and this allows for a little play.

Another point to remember with curved timber is that a neat sawn edge on the horizontal piece will always produce a gap at some point when the two parts come together. However despite the gap the joint is firmer, so both methods are probably used equally as much. In fact these days



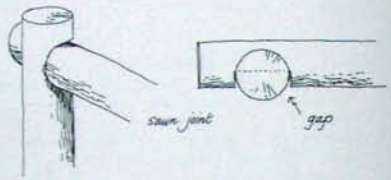


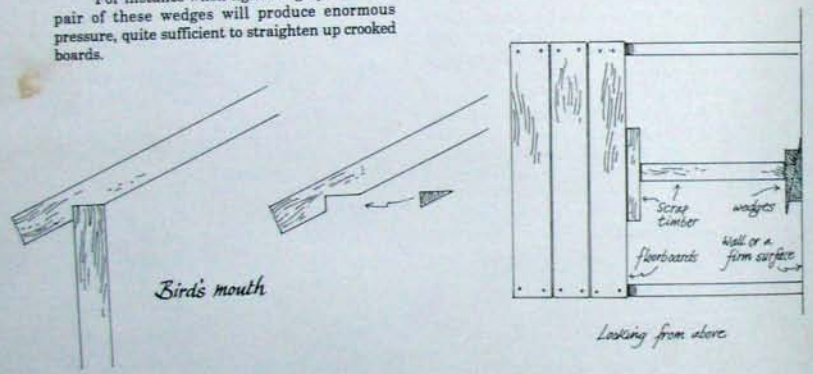
when chain saws are used so much in hut building the second method has become more common.

BIRD'S MOUTH JOINT

This joint is used to get a neat fit for rafters where they contact the top plate. When preparing rafters I always keep a few of the wedge shaped pieces which result when cutting these joints. It is surprising how handy they are for wedging other jobs together.

For instance when tightening up flooring a pair of these wedges will produce enormous pressure, quite sufficient to straighten up crooked boards.



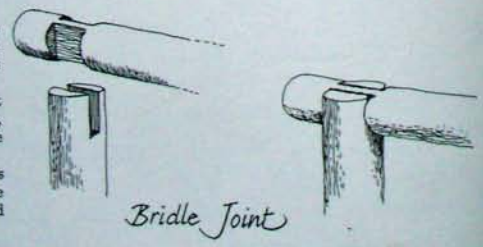


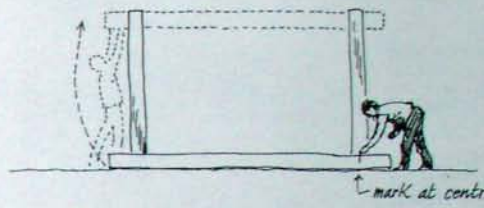
BRIDLE JOINT

The advantage of the bridle joint in hut building is that once dropped into place the whole job is locked together and requires no further fastening.

However, like a lot of other joints, it requires care in shaping and preparing, especially if you have a similar joint at the other end of the horizontal log.

When working with squared timbers the job is much easier as accurate measurements can be calculated and

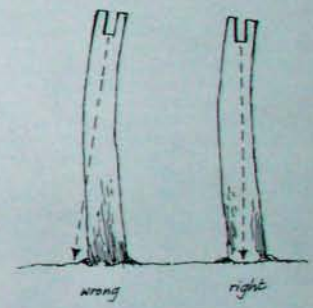




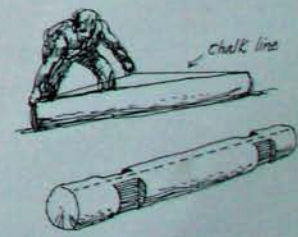
marked on the flat surfaces, but round logs can be quite a bother.

For a start don't try and lift the horizontal log up to mark it, not only is this hard work but the measurement is quite often wrong. Mark it at the base of the uprights with one single mark representing the centre of the upright. Now measure the top diameter of the uprights and transfer them to the horizontal log.

One problem I have encountered when doing this type of joint is in getting the joints in the horizontal log all at the same angle. One simple way to assist in this job is to use a couple of pieces of straight scrap timber. Lay these in the cut out sections and sight along them. You will be easily able to see if the sections have both been cut out at the same angle.



Getting the cuts in the correct place on the vertical posts can also be tricky especially if, as so often happens, there is a slight curve in the timber. The sketches show how the joint can easily be in the wrong position if it is simply cut down the centre of the log.



It is better to use the chalk line and this will give a more accurate line to work to.

The chalk line can also be used to check that the horizontal timber has the joints in line.

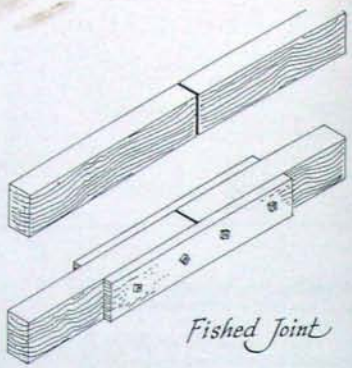
JOINING LENGTHS OF TIMBER

FISHED JOINT

It sometimes happens that a length of timber cannot be found long enough for the job and so two pieces must be joined together. The method used will most often depend on the use to which the timber is to be put and the amount of stress that is going to be put on it.

The fished joint is quite simple in principle. The two lengths of timber are placed with their ends together and then plates are bolted onto them, usually one on each side, though sometimes it it possible to just use one single plate.

In the old days when wrought iron was used for these plates a man called Seddon calculated that

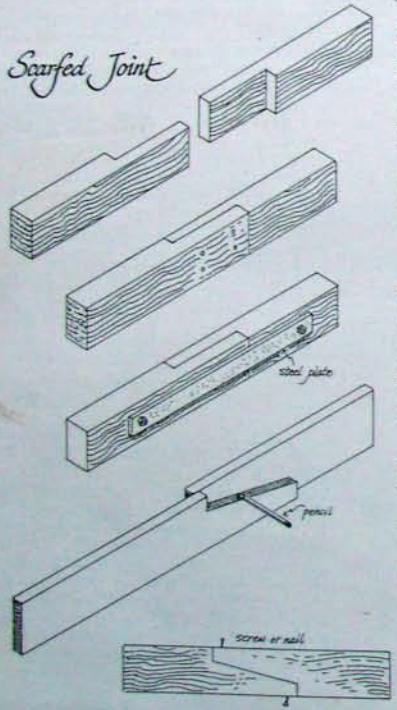


Fished Joint

if a single iron plate was used its thickness should be one twelfth of the thickness of the timber and if a plate was used on either side of the timber then each plate should be one twenty-fourth of the thickness of the timber. This would mean that on timber 120mm wide the plates would be 5mm thick when two were used or 10mm if only one was used.

When bolted together the finished joint was then thought to be as strong as the rest of the timber.

Scarfed Joint



SCARFED JOINT

In a fished joint the two lengths of timber meet at the ends, which means that if both of them are 2 metres long then when joined together they will make a 4 metre length.

In a scarfed joint the timbers overlap and so the finished job will be shorter. This should be remembered when preparing such joints.

There are a number of ways of preparing a scarfed joint, and here are the most common.

The first one is simple enough but, like all of them, requires accurate cutting to get a neat fit. This can be nailed, screwed or bolted together, bolts being the strongest.

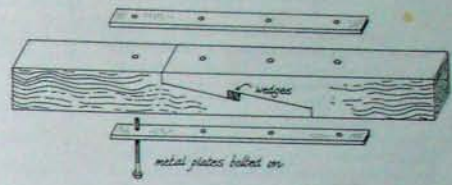
The length of the joint should be around three times the depth of the timber.

If the joint is to take any weight then extra strength can be gained by using a metal plate on one or both sides.

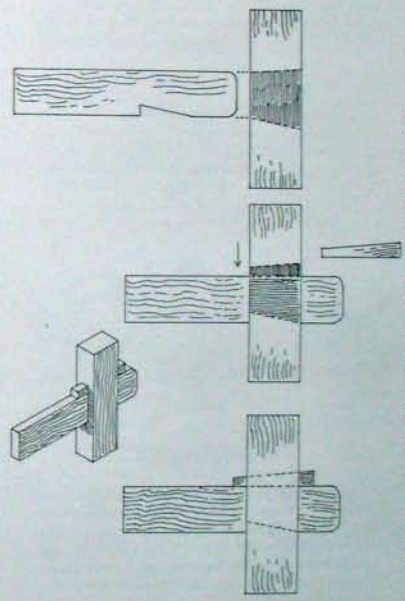
The next method is one that is used to join together long boards, such as fascia boards, which do not have any pressure applied to them. Only one side is cut at first and then the shape is scribed onto the second board and it is also cut out.

WEDGED SCARF

This is a little like the previous one, but is used where the timber is to have pressure applied to it. Metal plates are used on the top and bottom and small wedges are hammered into the centre section in order to tighten up each end of the joint.



Wedged Scarf



Wedged Rail

WEDGED RAIL

This is a very clever idea and quite traditional A friend of mine once had an old and elaborate kitchen cabinet which had been constructed with variations of this joint so that it could be totally pulled apart and turned into a flat parcel for ease in transporting. When needed again it could quickly be assembled and was as strong and firm as if it had never been apart.

Once understood the principle will be seen to be quite simple. In this case the joint is being used to hold the legs of a bench together, but the idea can be adopted for other uses.

The horizontal rail has a wedge shape cut out of its lower surface. The mortise is now cut in the vertical timber and the size of the hole on the inside surface is only just big enough to take the end of the rail. However this hole slopes downwards as shown, the angle being the same as the angle of the wedge cut out of the rail. It also slopes up very slightly on its upper surface.

As a result, when the rail is pushed into the mortise hole it drops down leaving a gap above it.

A wooden wedge is now hammered into this space to lock the whole thing tightly together.

This wedge sticks out at either end, so that it can easily be hammered out again when that is needed.

When this wedge has been hammered into place not only is the whole job firmly joined together, but there is no sign of the cut out in the rail, so that it looks as though it just goes right through the upright piece.

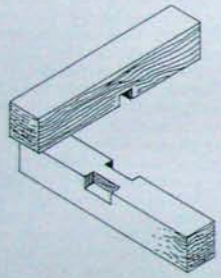
NOTCHED JOINT

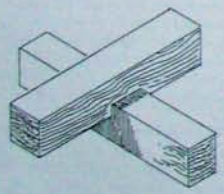
Quite often the frame of a hut may need a tie-beam to hold the centre section firm, otherwise the weight and pressure of the roof can cause the walls to spread out at this point.

A notched joint is commonly used here because it is easy to do and the joint effectively prevents the walls from spreading apart. This is stronger than relying on nails or bolts to do the job (though the tie-beam is also nailed in place for added security).

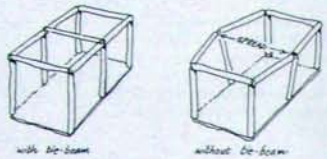
In hut building the notch is usually made by doing two saw cuts and then using the adze to clean out the unwanted timber.

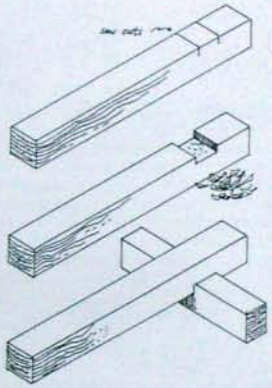
The notch should not be too deep, a quarter of the depth is ample to do the job, any more will weaken the beam.





Cogged Joint





Notched Joint

COGGED JOINT

This joint is not encountered very often today but was once used for the same purpose as the previous joint. It is far more complicated to prepare and so has fallen out of favour. Its advantage was that it not only fixed the tie-beam in place across the room but also prevented it moving sideways.

Once dropped into place the beam could not move in any direction, but with the notched joint the top timber can be slipped along the lower one unless it is nailed in place.

TABLING

There are of course many more joints than the few that I have described here, some are very complex and will join timbers securely together without the use of nails, but all of them require considerable skill to construct and so are outside the scope of bush carpentry.

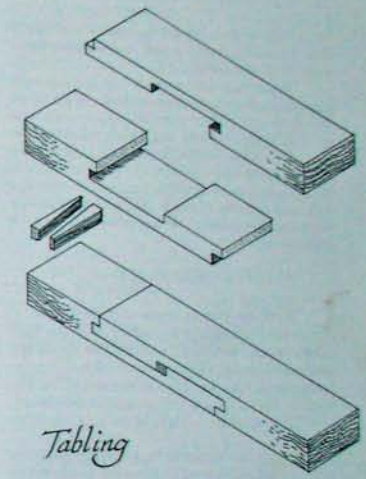
For instance here is a scarf constructed by tabling, tongued at the ends and secured by hardwood keys and wedges.

DRAWER RAIL JOINT

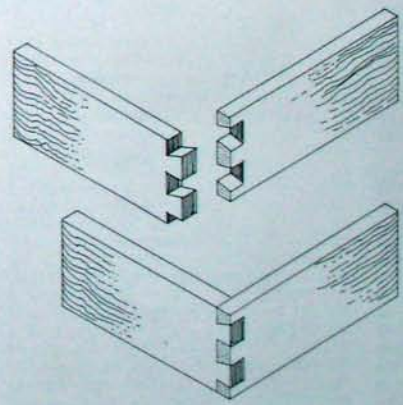
Or what about this traditional Drawer Rail Joint? Very clever but needing considerable cabinet making skills to construct.

DOVETAIL JOINT

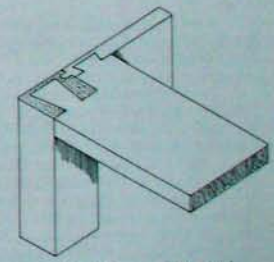
Even the common dovetail joint, though well known, was beyond the scope of most bush carpenters. Joints such as these were the speciality of the trained cabinet maker.



Tabling



Dovetail Joint



Traditional Drawer Rail Joint

DOVETAIL TENON

This tenon is beyond the scope of the average bush carpenter, but it is such a clever item that I could not resist including it.

In this joint the mortise hole does not go right through the timber, its shape is shown by the dotted line. It is very difficult to cut out such a cavity with hand tools which is why the joint is not so popular.

The end of the horizontal piece will only just fit through, it drops down to the bottom of the hole leaving a gap above. A wedge is now hammered into this, and once this is done the horizontal piece is permanently locked in place and cannot be withdrawn.

DOWELS

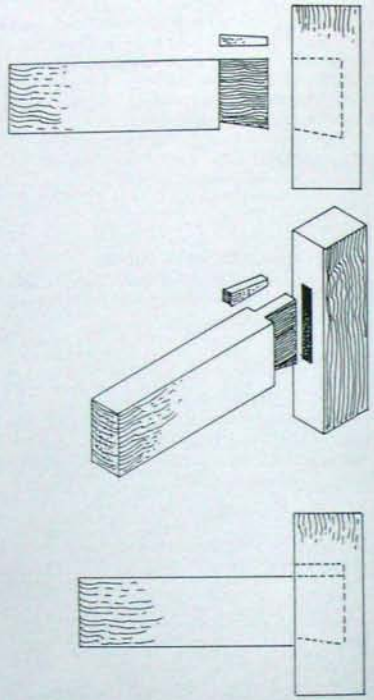
However dowels were used in the bush, particularly in furniture making, because they required less skill then the complex joints, but produced a strong job and a neat finish. It must be remembered that screws were not plentiful in the bush in the old days and so dowels provided a readily available method of joining together furniture.

Today dowels can be bought ready made, but in the past they were either shaped by hand or with the use of a dowel plate. A dowel plate was simple a metal plate with the desired size hole drilled into it. The scrap of timber was roughly shaped and then hammered through the hole and so was made round.

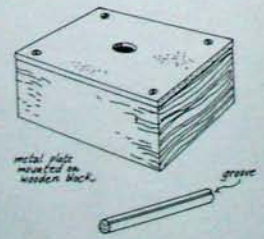
A small groove was also run down the side of the finished dowel. This was necessary in order to let the air out of the hole in the piece of timber when the dowel was finally fitted in place in the job.

For large dowels a plate was not necessary and the work could be all done by eye. I have watched Indonesian boat builders cutting hundreds of dowels quickly and accurately by eye from scraps of timber and using them to fasten together the hulls of quite large fishing boats. Such dowels have a very slight taper on them so that they tighten as they are hammered in.

In bush furniture making dowels are superior to screws as the finished surface not only looks better but can be smoothed down without any risk of damaging tools. When put in with a spot of glue on both the dowel and the joint they create a strong and permanent connection.



Dovetail Tenon



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RON EDWARDS is regarded as one of Australia's leading folklorists. He was born in Geelong, Victoria, and gained his Diploma of Art at the Swinburne Institute of Technology. He is also aware of the greater interest today of young people in survival and in getting out and learning how to live in the bush.

In 1951 he and John Manifold sparked off the present interest in Australian folk song with their publication *Bandicoot Ballads*, and since then he has published a number of important works on the subject under the imprint of the Ram's Skull Press which he founded in 1952.

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