Chapter 9

Stairs

Framing square--See
Roofs: Fig. 7

Unit rise
Unit run

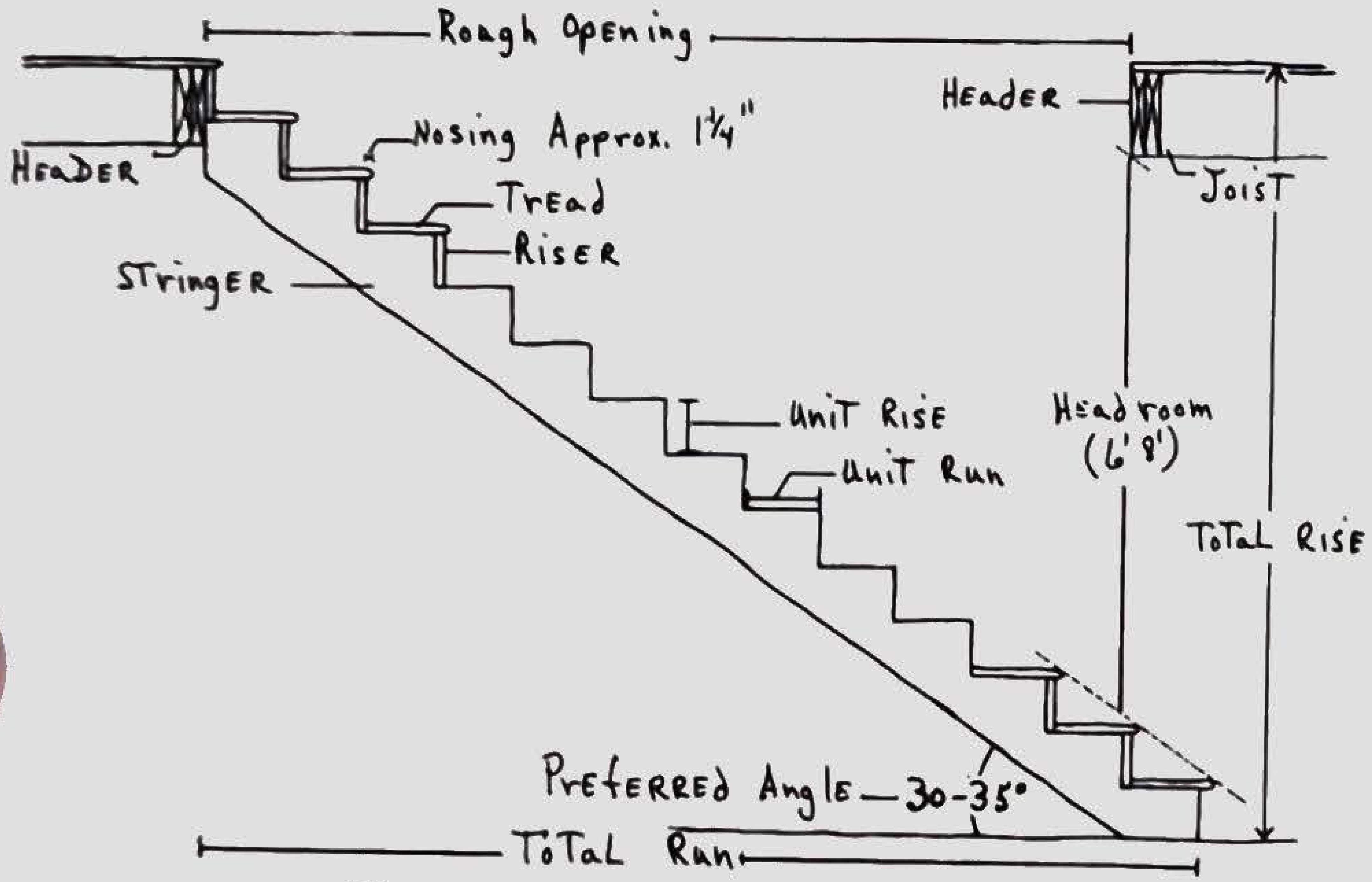

Fig. 1 – The Parts of A Stair

Riser
Tread

STAIRS

As in roof construction, the tool used to lay out stairs is the framing square, and a lot of the principles used in building roofs apply to stairs. For instance, stairs are also categorized by their unit rise and run and the relationship of the unit rise to the unit run is crucial to the quality of the stairs. If the rise is too high and the run too short or if they are not consistent throughout, the stair will be awkward and tiring to climb. A good rule to follow is

> *The sum of one unit rise (the riser) + one unit run (the tread) should equal 17"-18". An ideal set of stairs has a riser of 7" and a tread of 10 1/2".*

In stairs, the unit rise is called the riser and the unit run is called the tread. A stair that had a 6½" riser would require an 11" tread. A stair that had an 8" riser would need a 9½" tread, although this is almost too steep for compfortable climbing. Usually it's best to keep the risers between 7¼" and 8¼" and the treads between 9¼" and 11¼". On secondary or little-used stairs like basement stairs, more leeway can be taken--that is, maybe an 8" riser and an 8" tread.

CALCULATING THE UNIT RISE AND RUN OF A STAIR

Let's say we must construct a basement stairs in which the total rise is 8'0" from finish surface in the basement to finish floor on the first floor and the total run is 12'0" but variable. That is, we think we want the run to be 12' but it could be longer or shorter if that works out better. The degree to which you can fiddle with the stair layout (i.e., different rises and runs) depends on where the stair has to begin, and whether it has to end at a certain place or whether there is room to extend or shorten the total run. Usually the total rise is a fixed amount and the total run is the only distance that can be varied.

To calculate the unit rise and run, first divide the total rise (which must be changed into inches) by 7. The answer will tell how many 7" unit rises are contained within the total rise.

Calculating the unit rise

$8' \times 12'' = 96''$	Changing the total rise to inches
$\frac{96''}{7''} = 13.71$	Finding the number of 7" rises that are contained in the total rise

Since there must be a whole number of risers, take the whole number closest to this figure (14) and divide it into the total rise. In other words, you're trying to find out: if you had 14 risers, what would the individual riser height be.

$\frac{96''}{14} = 6.85''$	Finding the riser height

To find out what 6.85" is in inches and sixteenths of an inch, multiply 16 by .85.

Converting decimals to fractions

16 x .85 = 13.60" Finding out how many sixteenths of an inch are contained in 85/100 of an inch

.85" means 13.60 sixteenths or 14/16". Reducing 14/16" to the lowest denominator we get 7/8". Thus, one possible riser height is 6 7/8" when there are 14 risers.

> *In any set of stairs, the number of treads will be one less than the number of risers.*

Nosing--See This Chapt.: Fig. 1

Calculating the unit run or tread

Since in this stair case we have 14 risers, there will be 13 treads. Divide 13 into the total run of 12' to determine what the individual tread width (without nosing) will be.

12' x 12" = 144" Changing the total run to inches

$$\frac{144''}{13} = 11.07''$$ Dividing the total run by the number of treads equals the tread width

16 x .07 = 1/16"	Changing the decimal to sixteenths
11 1/16" =	Tread width

To see if a stair with a riser of 6 7/8" and a tread of 11 1/16" will be comfortable, add the two together to see if they equal 17"-18".

6 7/8" + 11 1/16" 17 15/16"	Applying the rule for a comfortable, safe set of stairs (rise + run = 17"-18")

17 15/16" barely makes it according to the rule, but the rise and run we have calculated would make a good set of stairs.

Let's see what the individual rise and run would be if there were 13 risers instead of 14.

$\frac{96''}{13} = 7.38''$	Finding the riser height
7 3/8" =	Riser height (decimal converted to fraction)

Since there is one less tread than risers, there will be 12 treads. To find the tread width, divide the total run (144") by 12.

$$\frac{144''}{12} = 12''$$ Finding the tread width

12"= Tread width

To see if the stair will be comfortable, add the tread and the riser.

$$\begin{array}{r} 12\ \ \ \ '' \\ +\ \ 7\ 3/8'' \\ \hline 19\ 3/8'' \end{array}$$

Applying the rule for stairs (Unit rise and run) equal 17"-18")

The sum is way more than 17"-18" so this combination won't work even though the 7 3/8" riser is closer to the ideal riser height. Since in this case the total run is variable, let's see what the total run would have to be if we were to use the 7 3/8" riser height with an ideal tread width of 10 1/2". Multiply 10½" by the number of treads (12).

$$\begin{array}{r} 10\ 1/2'' \\ \times\ \ 12\ \ \ \ \ \ \\ \hline 126\ \ \ \ '' \end{array}$$

Finding the new total run

$$\frac{126''}{12} = 10'\ 6''$$ Changing inches into feet

We now have two possible layouts for this stair: A riser of 6 7/8" and tread of 11 1/16", which works out to have a total run of 12'. Or a riser of 7 3/8" and a tread of 10½", which is a more perfect flight of stairs, but which works out to have a shorter total run (10' 6"). If when we go into the house and begin to build the stair, we find that having a shorter run will not interfere with anything, we will probably use the second stair layout.

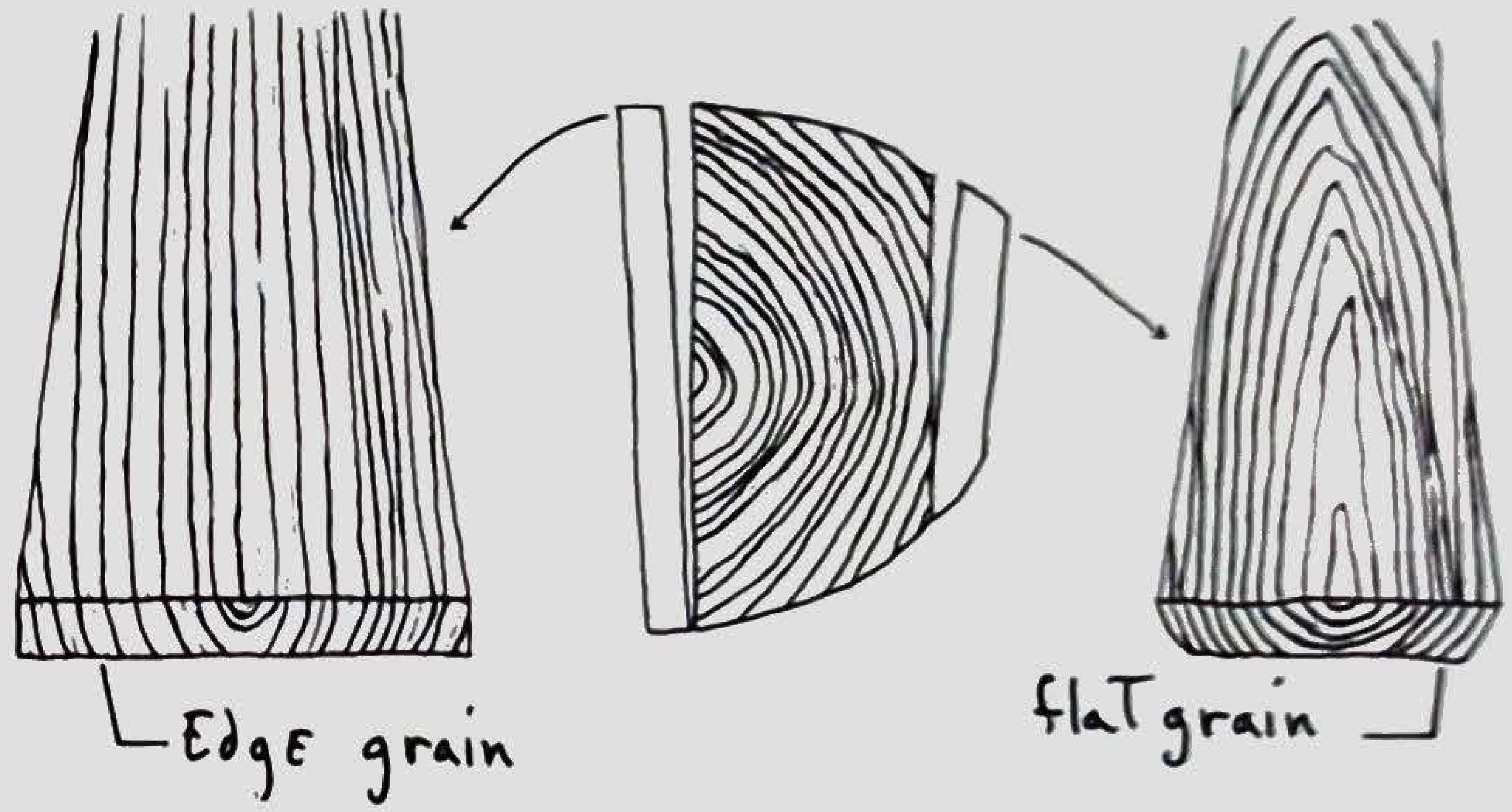

Fig. 2 - Cut Determines Grain

STAIR MATERIALS

Stringer material should be of clear, straight stock, with few if any knots. It is usually 1½" thick for basement stairs and 3/4" material in semihoused stairs and small interior stairs.

Treads can be made of 1½" plank (2x10" or 2x12") for basement stairs. There is also 1 1/8" finished tread material which is manufactured for this purpose. 3/4" boards (1x8", 1x10" etc.) are usually used for the risers. The FHA, which sets minimum (and I mean minimum) standards for federally funded houses, requires that stair treads be made of hardwood, vertical grain softwood, or flat grain softwood covered by a suitable finish floor material (carpet, tile, etc.). Fig. 16.

Federal Housing Administration

Semihoused stair–See This Chapt.: Fig. 8

Hardwood

Hardwood

oak*	maple	american elm
ash	white ash*	beech
birch	mahogany*	sweet gum
walnut*	cherry	basswood

Softwood

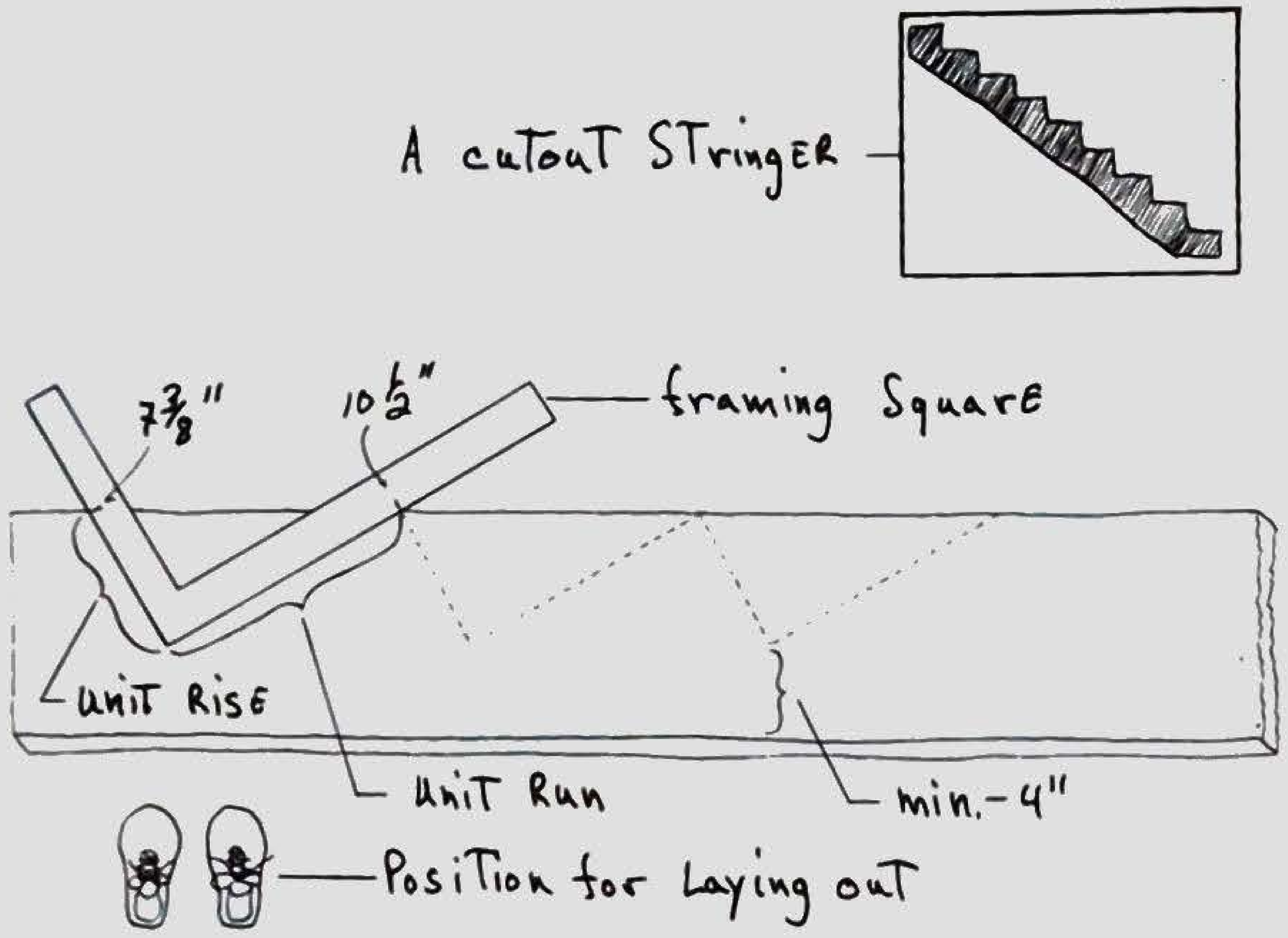

Fig. 3 - Laying Out a Stringer

Stringer

Framing square--See Roofs: Fig. 7

Nominal size--See Using This Book

Softwood

yellow pine	redwood	cypress
douglas fir	ponderosa pine	white fir
hemlock	white pine	western larch
spruce	western red cedar	

* Open grain woods--require extra operations in finishing because of their large pores and open cellular structure.

LAYING OUT THE STAIR STRINGER

The stair stringer is the slanting member that supports the risers and treads. Laying out the stringer consists of using the framing square to mark the locations of the risers and treads on the width dimension of the stringer.

The reason all these mathematics have to be done first is that the two numbers we arrived at (riser height and tread width) are the measurements held on the tongue and blade of the framing square and aligned with the edge of the stringer during the layout. Fig. 3.

The method of laying out a stair stringer is similar to laying out a rafter except that the marks for unit rise and run are made on the top edge (edge furthest away from you). For basement stairs the stringer should be 2x12" material or whatever nominal width will yield at least 4" left in the stringer if it is to be cut out for the risers and treads.

Four inches must be left in the cutout stringer so that there is enough strength in the 2x12" to support the weight the stairs will carry.

Lay the 2x12" on two sawhorses and begin laying out the stringer at the end that is to be the top of the stair. Lay the framing square on the material and align the unit rise on the tongue and the unit run on the blade with the edge furthest from you. Now draw a fine line along the outside of the framing square. Move the square on down the board, aligning the unit rise of the second step with the place where the tread line of the first step intersects the edge. Continue in this way until you have laid out (in this case) 13 risers and one fewer treads.

The stringer begins with a riser at the bottom, so extend the last tread line laid out to the back edge of the stringer. The length of the stringer must be shortened along this line by the thickness of the first tread (usually about 1 1/2" in basement stairs). Fig. 4.

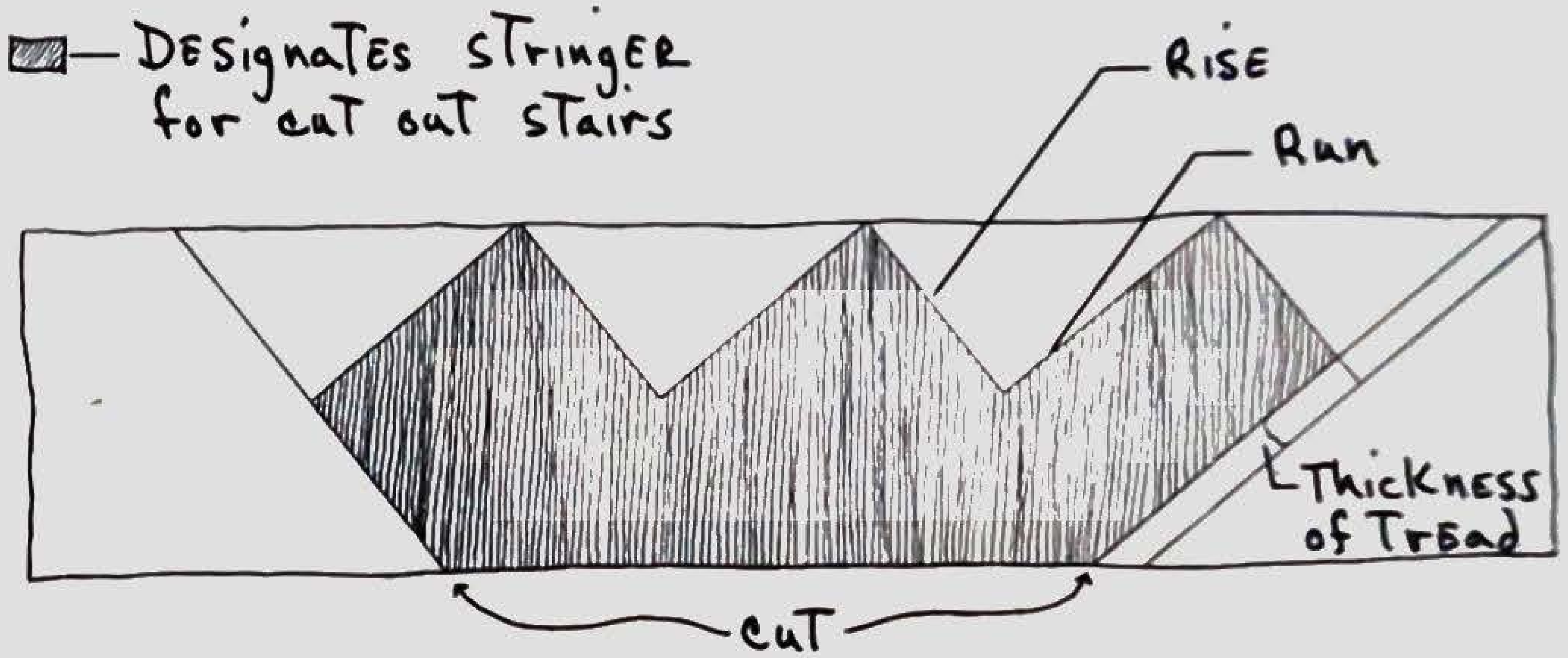

Fig. 4 – Stringer Corrected for first Tread Thickness

The reason for this shortening of the stringer is that if the first rise of the stringer weren't shortened by the thickness of the first tread, when all the treads were in place, the first rise would be greater than all the others by the thickness of one tread. Fig. 4. In other words, the first step would be a lulu--it would be $1\frac{1}{2}$" higher than all the rest. When the treads are nailed to the stringer, the unit rise of all the steps except the first one remains the same because each rise is shortened by the thickness of the tread below it but lengthened by the tread above it. The net result is constant. Fig. 1.

All risers and treads of a stair must be the same height and the same width or the steps will be dangerous and hard to climb.

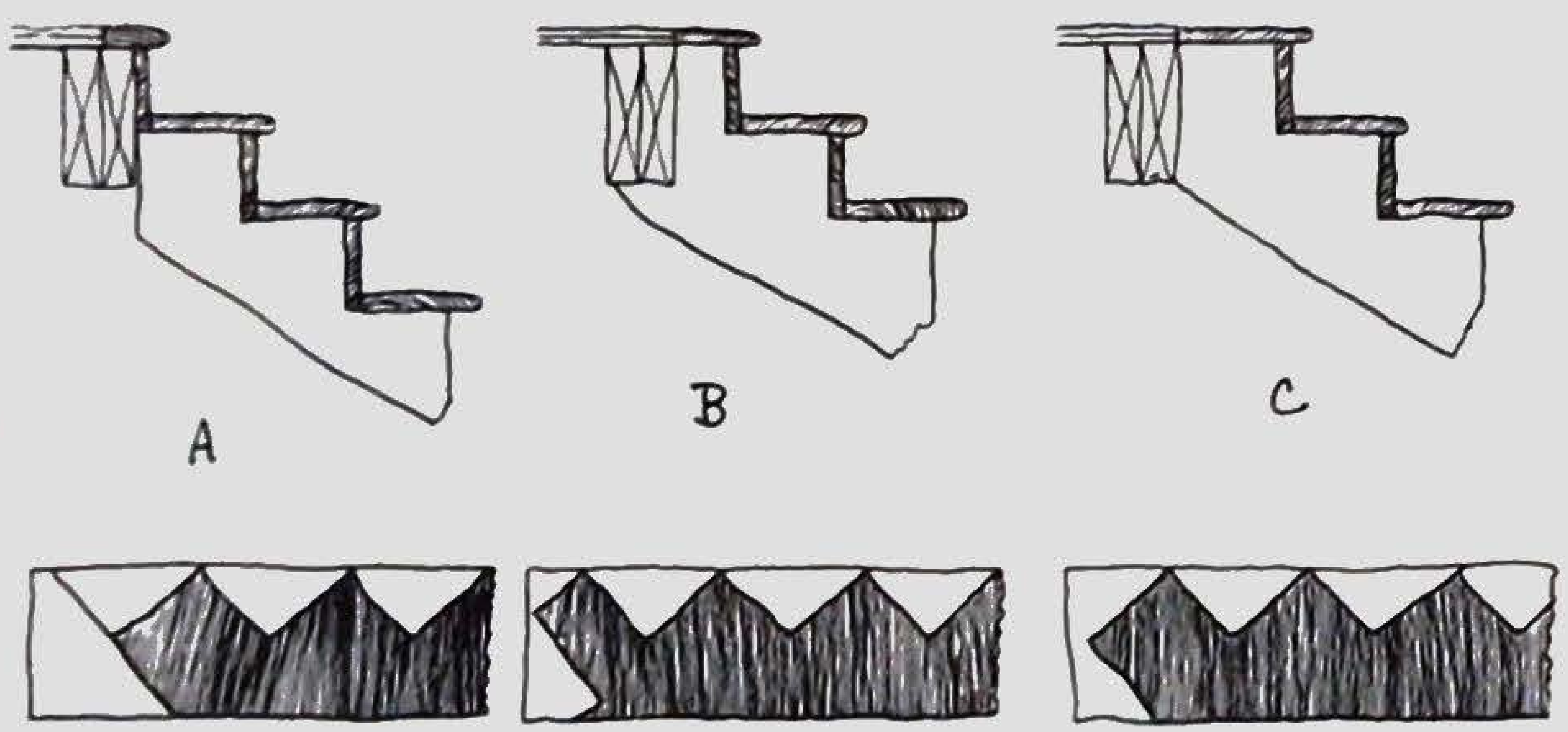

Fig. 5- Three Ways of Attaching Stairs at The Top

Cutout stringer–See This Chapt.: Fig. 6

Extend the first rise line at the top of the stringer to the back edge of the 2x12". The way the top end of the stringer is laid out depends on the method of attaching it to the header in the stairwell. Fig. 5. If the stringer is to be attached as at Fig. 5A, the first riser line is extended to the back edge of the stringer and the top end cut of the stringer is made along this line. If the stringer is to be attached as at Fig. 5B or 5C, more stringer material must be left at the top and the stringer is cut off along a line parallel with the first riser line.

The other stringer is laid out similarly to the first. Be careful to mark the layout on the second stringer so that when the stringers are placed parallel to each other in position to receive the treads and risers, the layout markings are toward the space between the stringers. (This isn't important in cutout stringers.) This facing layout can be assured if the layout of the second stringer is done with the tongue and blade of the framing square being held in the opposite hand from which it was held when laying out the first stringer. Check the layout of the stringers for accuracy by laying them next to each other as in Fig. 6.

Sometimes when stairs are especially wide, three stringers are required. If the treads are 1 1/16" thick and the stairs are wider than 2' 6", or when the treads are 1 5/8" thick and the stairs are wider than 3', three stringers are needed. The third or middle stringer is a cutout stringer. A main stair should be at least 3' wide; service stairs at least 2'6".

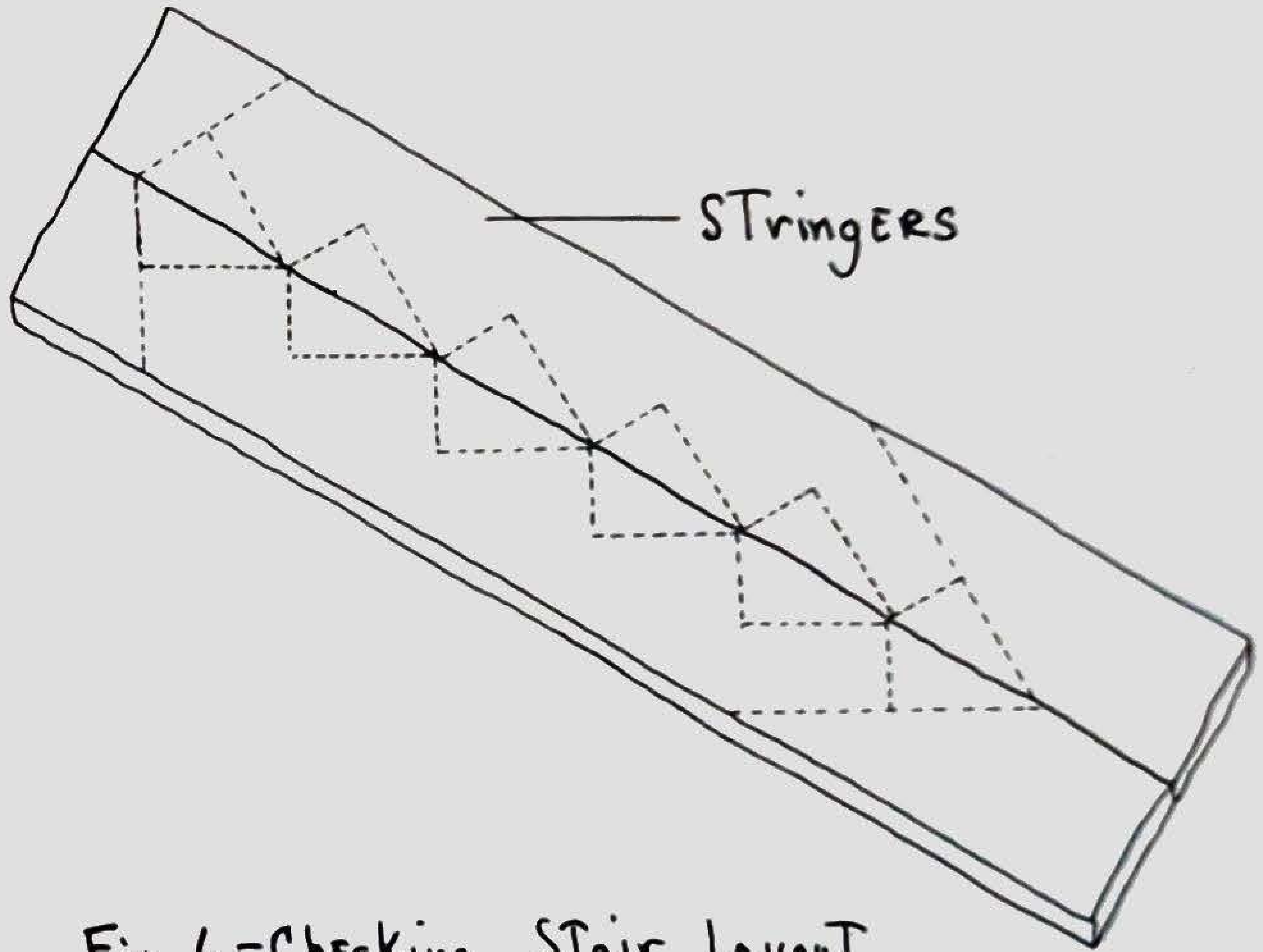

Fig. 6-Checking STair LayouT

THREE TYPES OF STRINGERS

Cutout stringer

Cutout Stringer

A cutout stringer is one in which the outline of the riser and tread layout has been sawed out of the stringer material. Cutout stringers are usually used in basement stairs or in the main stair in a house. Fig. 7.

If the stringer is to be cut out as in our basement stair, the cuts should be made along the layout lines. The cuts can be started with a hand held circular saw, but must be finished in the corners with a hand saw so as not to cut into the body of the stringer. The treads rest on, are supported by, and are nailed to the part of the stringer that has been cut out for the unit run.

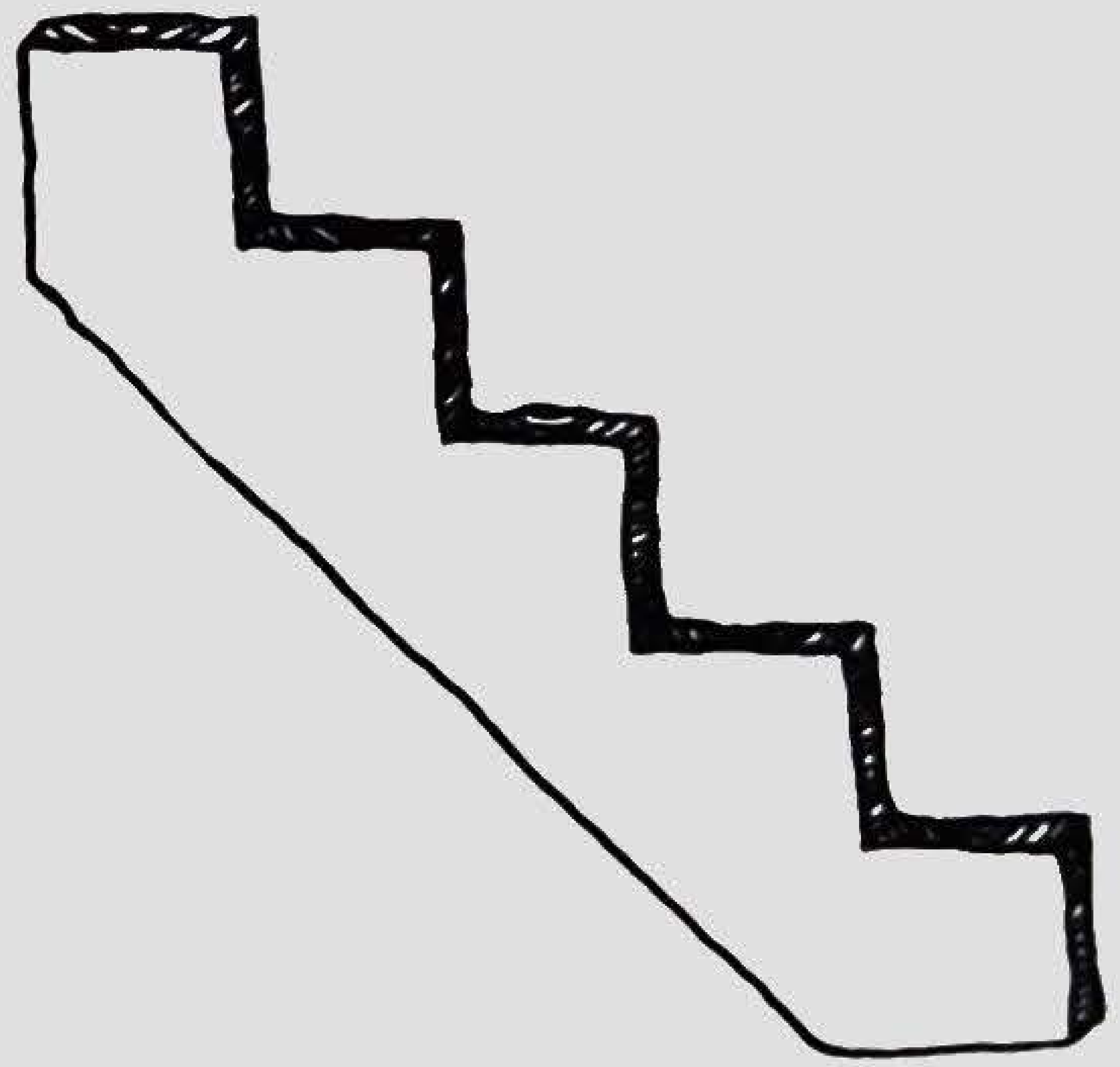
Fig. 7 - CuTout STringER

Nosing

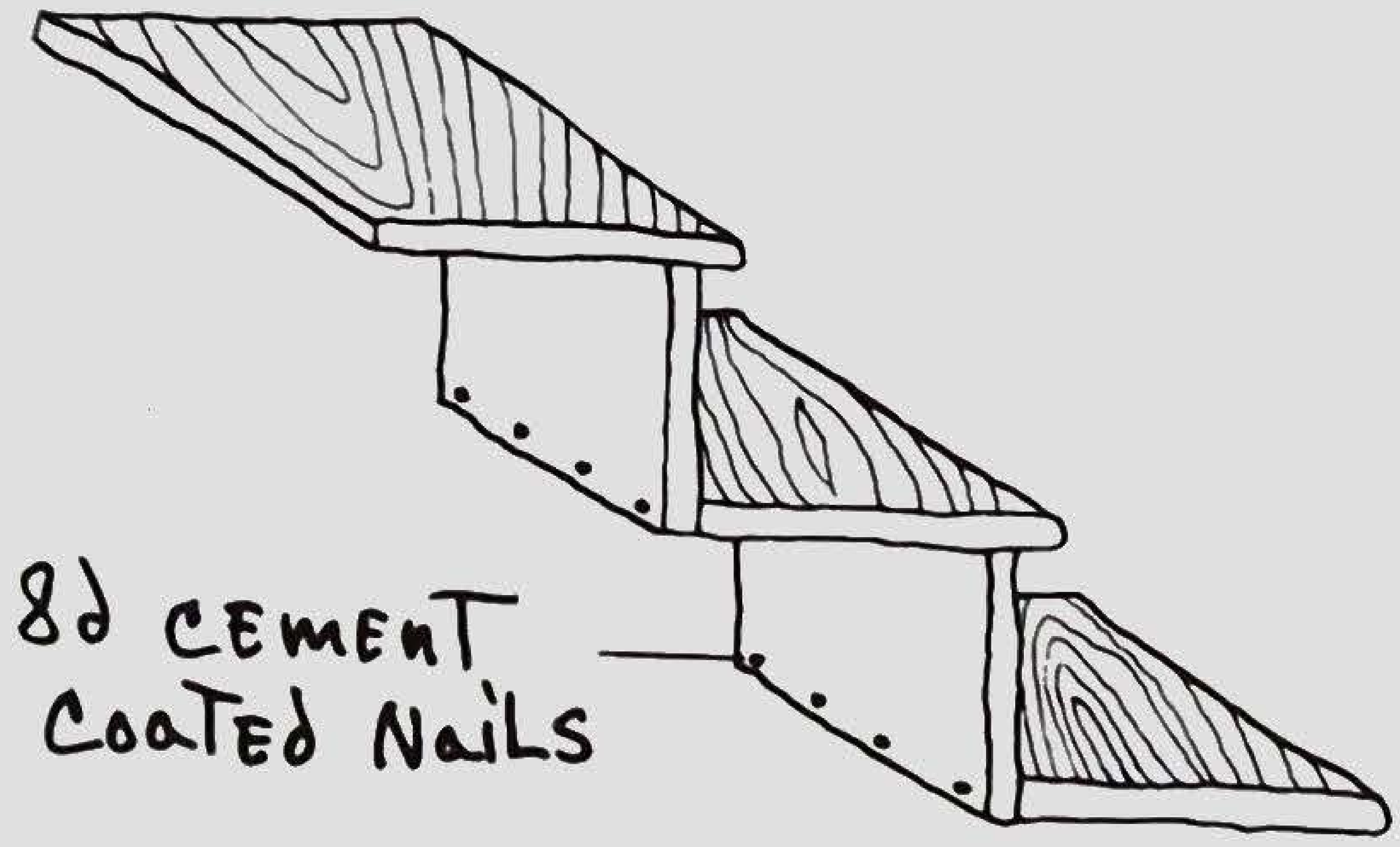

Fig. 8 - Back side view of Stairs with Stringer cut away

Face nail--See Metal Fasteners & Glues: Fig. 6

Cement coated nails

Nosing

The treads on all stairs are longer than the unit run by the length of the nosing. The nosing should be between 1 1/8" - 1 1/2". Nosing on the treads allows a necessary toe space (like below kitchen cabinets) underneath the tread so that the feet that climb the stair won't stub their toes into the risers. Without nosing, a stair would be hazardous and uncomfortable to climb.

You do not have to consider the nosing width when you are laying out the stringer. However, it must be remembered when you are buying the tread material. The actual treads of the stair will be wider by the length of the nosing than the unit run measurement. For example, if the unit run of a stair is 9¼", the width of the actual tread will be 10½". An inch and one-quarter of that tread will be sticking out over the tread below it.

Installing The Risers And Treads

Basement stairs are often constructed without risers, but most other stairs have them. In a stair with a cutout stringer, the risers are installed before each tread. They are nailed to the part of the stringer that has been cut out for the unit rise. When the tread is installed, it is butted against the riser. The riser is face nailed to the tread from the back or unexposed part of the stair with 8d cement coated or rosin coated nails spaced 8" apart. Fig. 8. These nails have been coated with a resinous substance which softens and acts as a lubricant when the nail is being driven but gives extra holding power when the nail is in place.

Semihoused Stringer

In a house the main stair that goes from one level to another is usually constructed with a variation of the cutout stringer called the semi-housed stringer. A semihoused stringer is one where a cutout stringer is securely nailed or screwed to a full backing stringer and the treads and risers are nailed to, glued to, and supported by the cutout stringer. Fig. 9.

The finish stringer is nailed to the studs in the wall with finish nails before the cutout stringer is fastened to the finish stringer. The finish stringer is usually a full backing stringer that hasn't been cut out. Both stringers can be 3/4" material. Sometimes the stringers on either side of the stairs are semihoused; sometimes only the stringer against the wall is semihoused and the other stringer is a cutout stringer. In either case the treads and risers are cut to fit snugly against the finish stringers. This is done by scribing.

Scribing

Scribing is the technique by which a board is marked for cutting so that the line exactly corresponds to the variations in the surface of the board to which it is to be fit. The tool used for this marking is a scribe. It costs around 75¢ and looks like a dime store compass.

When cutting the risers and treads for stairs with semihoused stringers on both sides, cut the treads and riser 1/2" too long. This will allow for a 1/4" scribe and cut on either end of the riser or tread. Fig. 10.

Lay the tread against one semihoused stringer

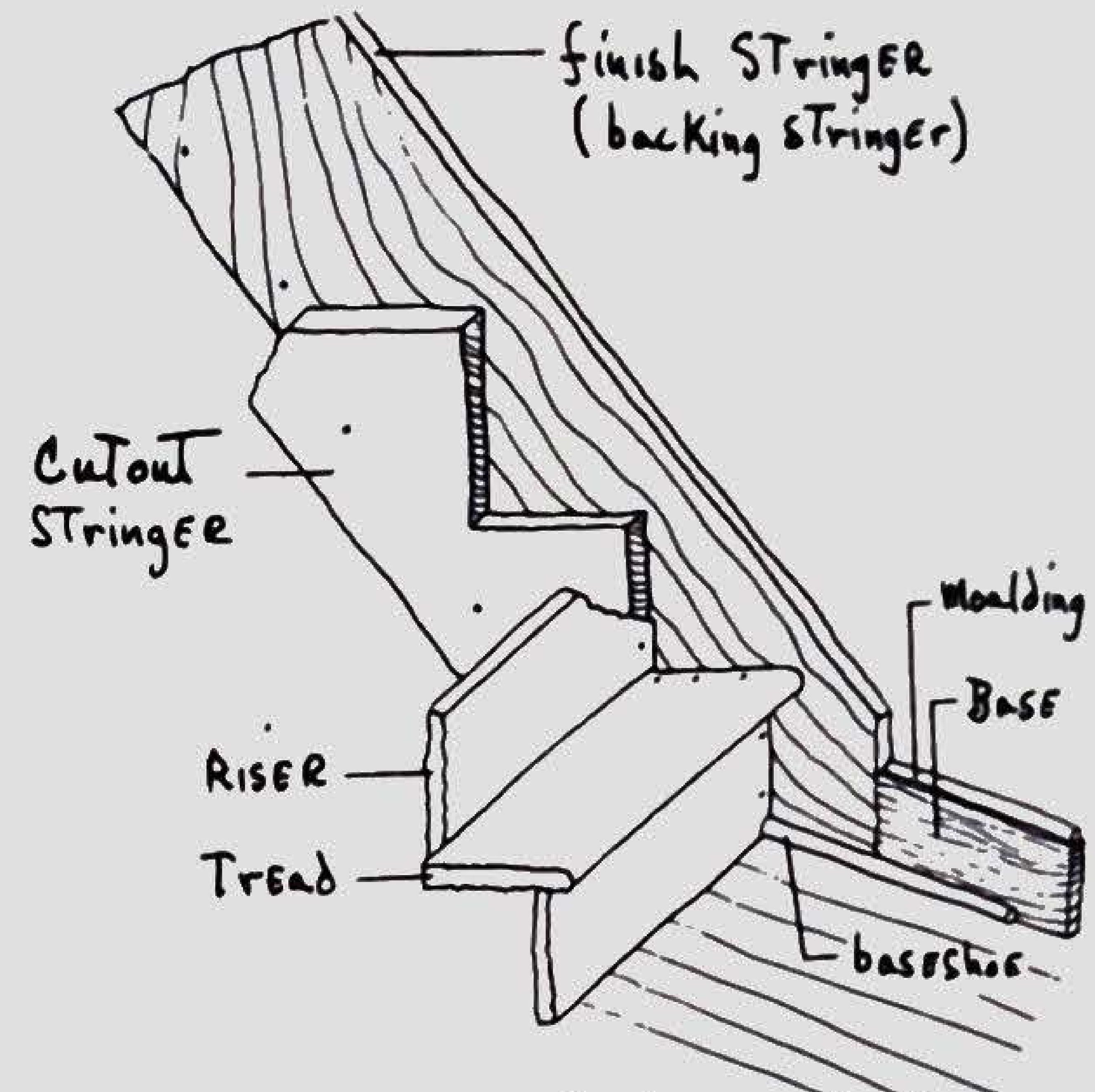

Fig. 9 - Semihoused Stringer

Backing stringer

Finish stringer

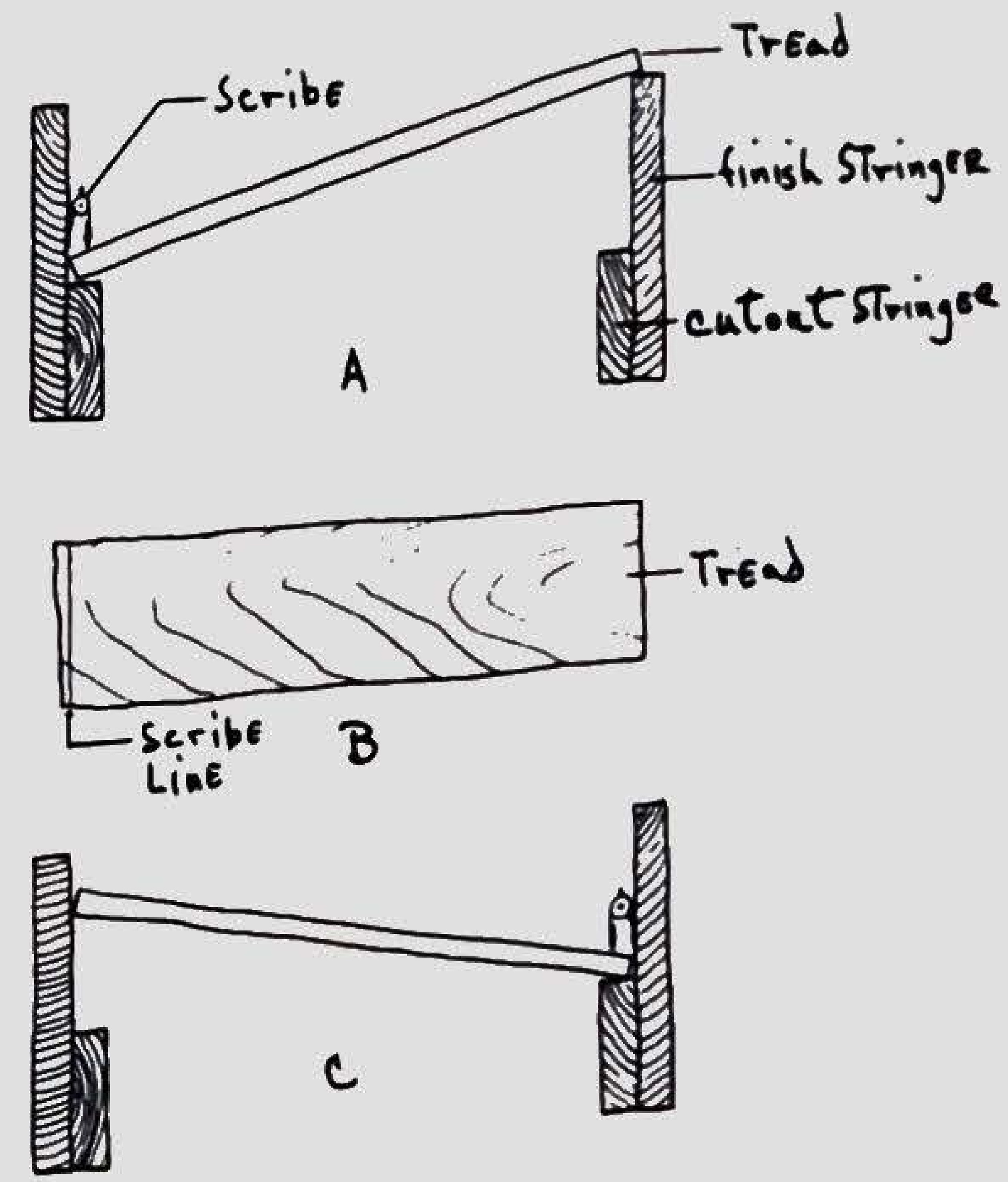

Fig. 10 - Scribing

Scribing

Belt sander

Ledger

Miter joint--See Joining: Fig. 14

Edge grain

as at Fig. 10A. Make sure that the back edge of the tread is tight against the riser. Hold the point side of the scribe snugly against the finish stringer as you draw the pencil side of the scribe along the width dimension of the tread. The spread between the point and the pencil should be such that when the pencil is drawn along the tread, a line 1/4" in from the end of the tread is drawn on the width dimension of the wood.

Cut along this scribe line with a hand or power saw, being careful to leave the line. Now sand or plane the end of the tread until the scribe line just disappears. A belt sander is a good tool to use for this if you have one. The idea is to conform as closely as you can to the scribe line which is the exact parallel of the surface of the finish stringer. If the scribing is done well, the joint between the tread and finish stringer will be tight and even.

When one side of the tread has been scribed, repeat the scribing process for the other side, taking off the remaining 1/4" as at Fig. 10C.

Another nice way to make a finish stair utilizes a cutout stringer of 3/4" material in which the riser cuts are mitered. The individual risers are also cut at a 45° angle along the two edges that will meet the mitered cuts on the stringers. The result is a miter joint along the riser line that shows no edge grain. In this same stair the treads rest on the stringers but overlap them on each side by one or two inches. The treads have rounded exposed edges which give a nice finished look. Fig. 11.

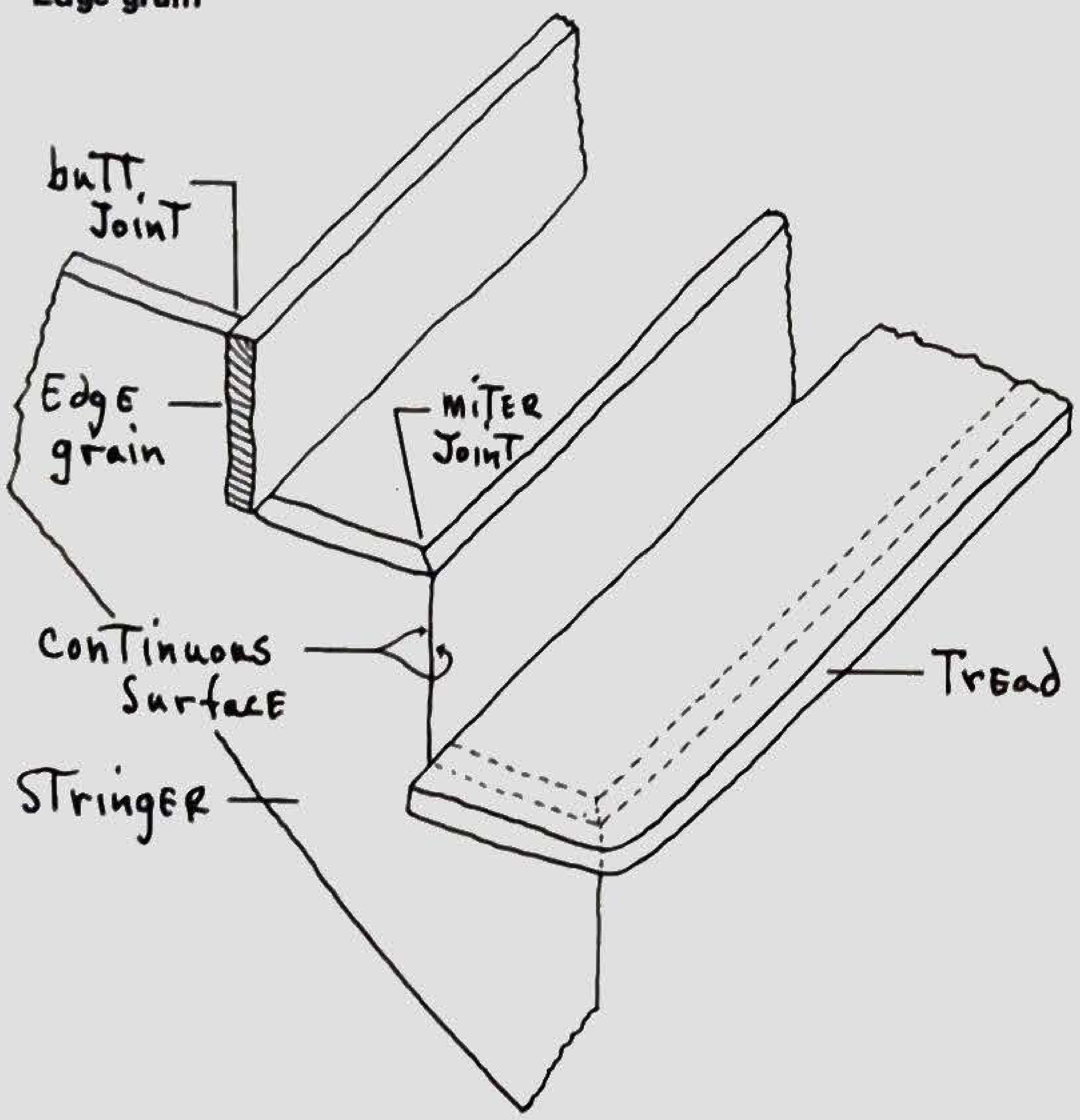

Fig. 11 - miter Joint on finish Stringer

Blocked Stringer

A blocked stringer is one in which cleats or ledgers are nailed to the stringer material to support the treads. A ledger is a board attached to any part of the framing that carries the weight of other members. Fig. 12.

The stringer in a blocked stair is usually a 2x10". The ledgers (cleats) should be as long as the tread, at least 3/4" thick and 3" wide. The cleats are nailed to the stringer one tread's thickness below the tread layout line with nails one-half inch shorter than the combined thickness of the cleat and stringer. The treads are fastened to the stringer using 16d nails which are nailed through the stringer and into the tread.

Blocked stairs are used in basements and porches and usually don't have risers.

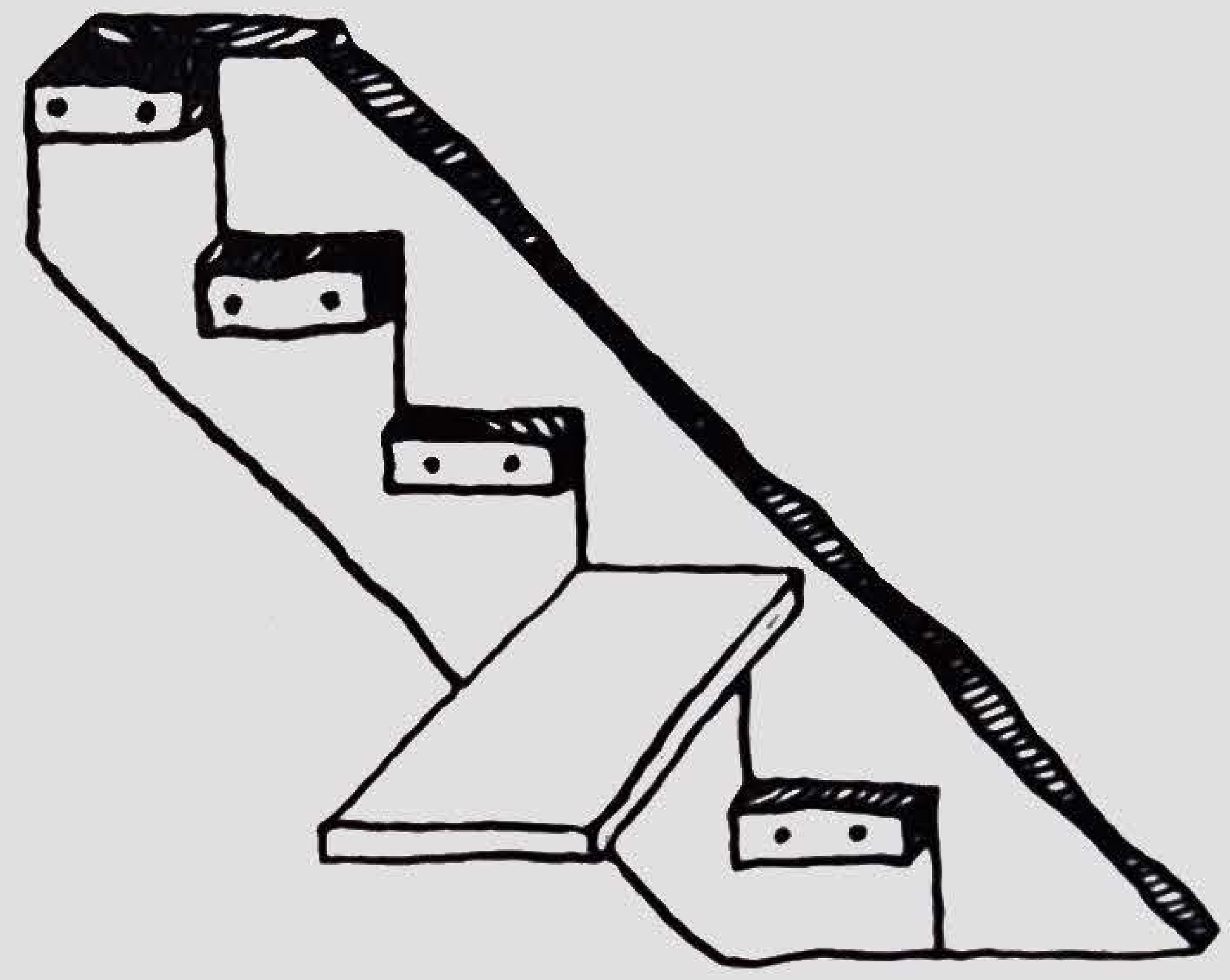

Fig. 12 - Blocked Stringer

Dadoed Stringer

A dadoed stringer is one in which the treads are set into the stringer by means of dado cuts made along the tread lines. Fig. 13. Dadoed stairs usually don't have risers. The stringer should be 2x-- material and the depth of the dado should be equal to 1/3 the thickness of the stringer. The length of the dado should be equal to the tread width minus the nosing. The upper edge of the dado cut should be right on the tread layout line; the lower edge of the dado should be one tread's thickness below the tread layout line. Glue is spread along the bottom of the dado groove and the tread is inserted and nailed through the stringer into the tread using 10d casing nails.

The stringers are dadoed out for the tread with a router or a hand held power saw which has a dado blade. A dado blade consists of two regular circular saw blades with auxilary blades that go between the circular blades to thicken the kerf.

Dado–See Joining: Fig. 25

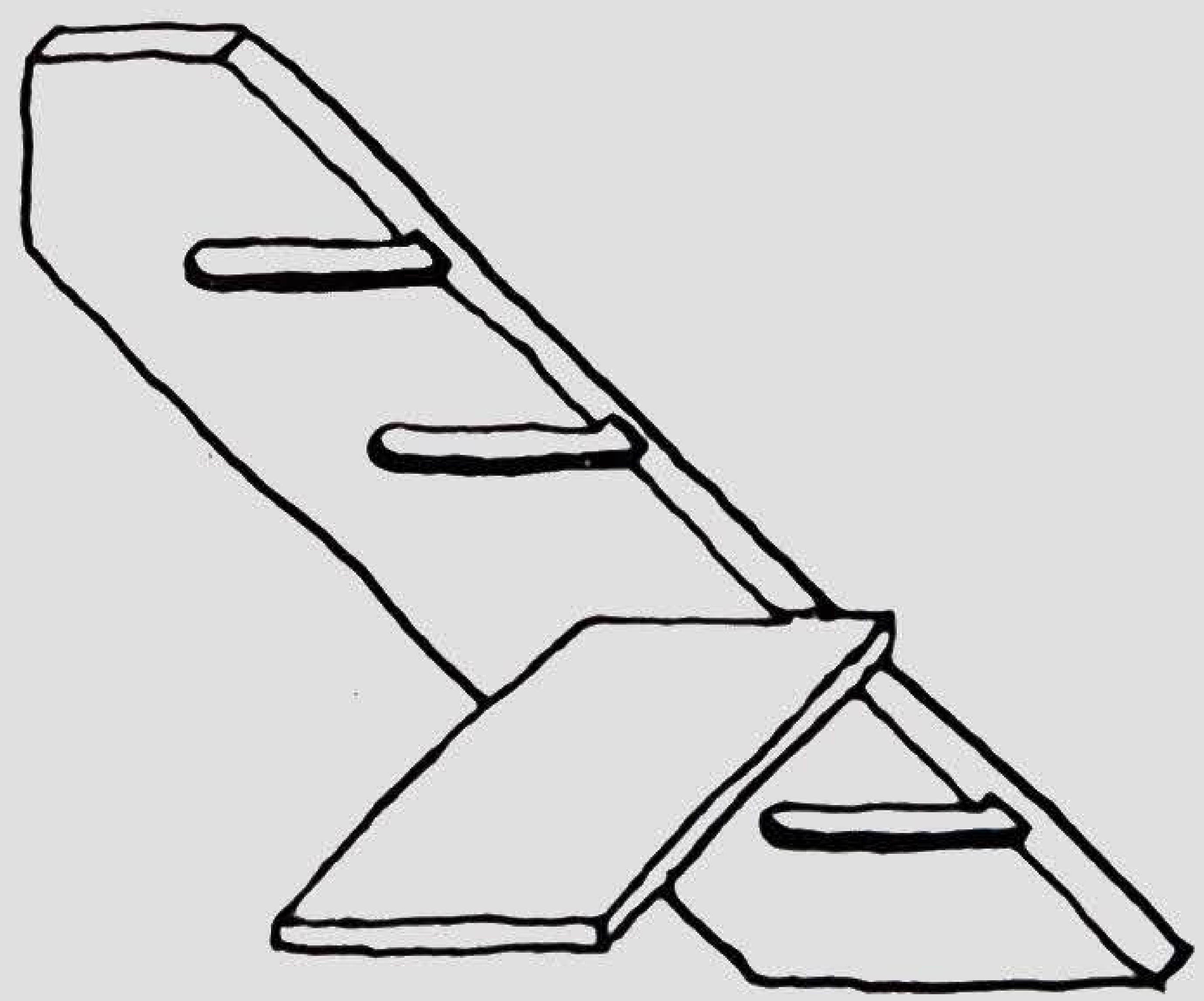

Fig. 13 - Dadoed Stringer

Dado blade

Saw kerf–See Tools: Fig. 6

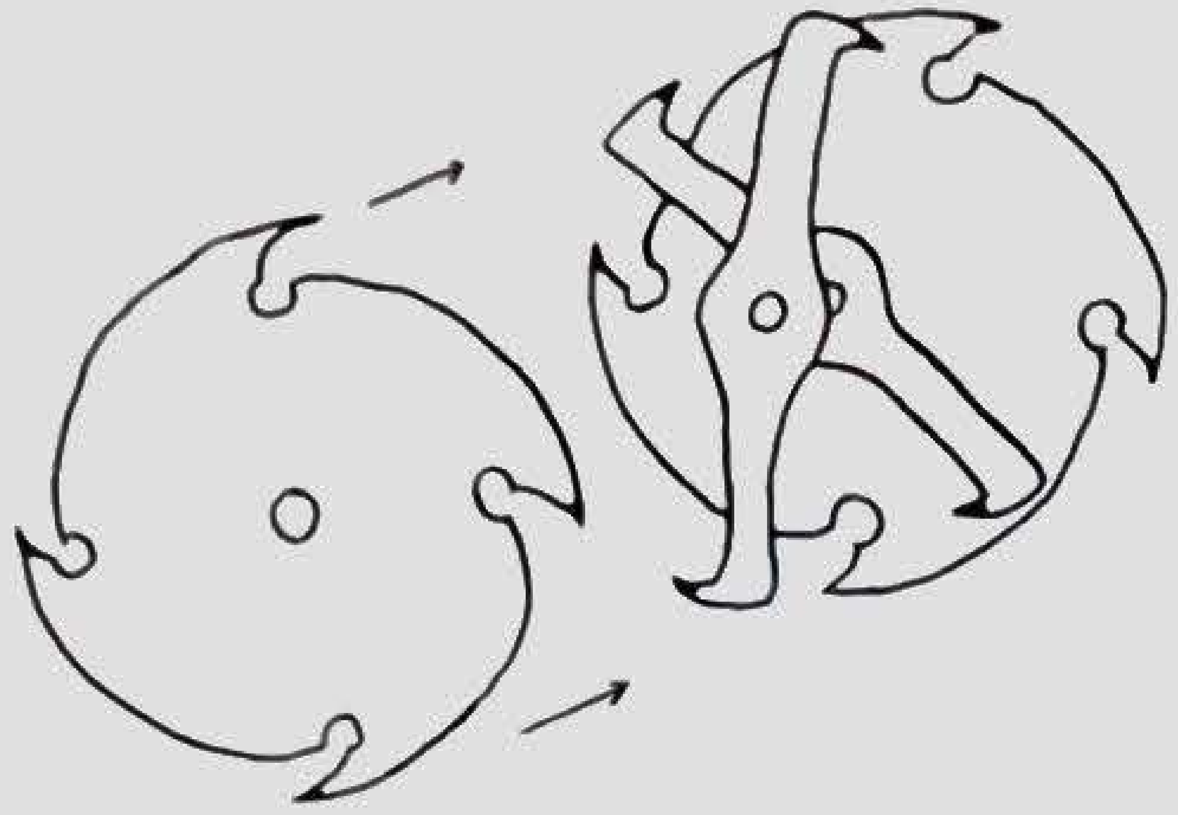

Fig. 14 - Dado Blade for Power Saw

Fig. 14.

With the blade of the circular saw cutting out anywhere from 1/8"-7/8" (depending on how many auxilary wing blades are placed between the outer blades) with each pass of the saw, the dado in the stringer is soon cut out. If you don't have a dado blade, two circular saw blades with the teeth of one blade in the spaces between the teeth in the other can be mounted on the saw at the same time to widen the kerf. The dado cuts should be very straight because they will show. Use a straight edge to guide the saw so that the cuts are not wobbly.

When sawing with a dado blade, allow only one-half the thickness of the blade to bite into the wood on each pass after the first one. Push the saw at a rate that will not overload it or overheat the blade.

Assembling A Dadoed Stair

When the dadoes are cut in both stringers, place the stringers on edge with the dados facing inward on two sawhorses. Fig. 15. A woman should stand on the outside of each stringer. Place first the bottom and then the top tread in the dado grooves of both stringers and nail from the non-dado side. If each woman nails the same tread at the same time, the going will be easier because the forces being applied by hammering from opposite sides will offset each other. The stringers will remain in one place instead of sliding around.

If the stringers are short, as in porch stairs, the rest of the treads can be installed while the stringers are on the sawhorses. The whole assembly will not be too heavy to wield when it's time to nail it in place. If the stringers are long, as in basement stairs, the stringers, which are now held parallel by the two treads, should be nailed in place to the header at the top of the stair. The rest of the treads can be installed after the stringers are nailed in place. Begin at the bottom and work your way up so that you can stand on the treads as you get higher.

The middle treads will probably not slide into their dados easily whether the stringers are on sawhorses or nailed to the header. When this happens, pry the stringers a little further apart. Start the treads into their dados and beat them in with a hammer. Put a 2x4" over the nose of the tread and beat on that so as not to mar the tread nosing.

Fig. 15-Assembling Dadoed Stairs

ANCHORING THE STRINGER

The stringers of most stairs are toenailed to the double header in the framing at the top of the stairs and to an anchor plate that has been fastened to the floor at the bottom of the stairs. If the floor at the foot of the stairs is concrete, the anchor board should be redwood or chemically treated to prevent rot. It is fastened to the floor with expansion-type fasteners. A ledger can be face nailed to the double header at the top of the stairs to help carry the weight. The ledger is usually a 2x4" and nailed to the header with 16d nails. The stringers are notched out so that they fit around and bear on the ledger and anchor

Toenail–See Metal Fasteners & Glues: Fig. 6

Fasteners–See Metal Fasteners and Glues: Fig. 17

plate. The stringers are toenailed to both the ledger and anchor plate. Fig. 16.

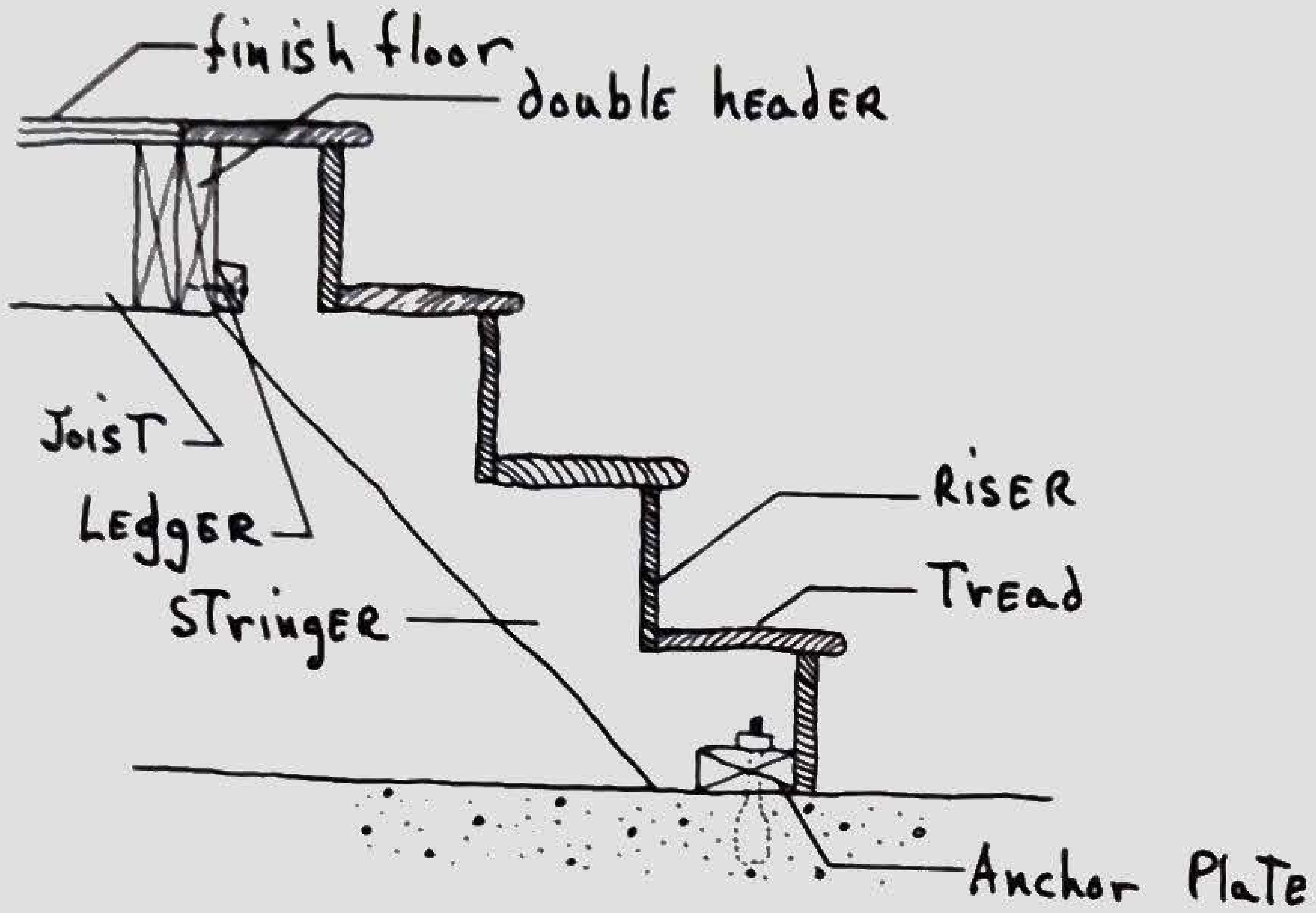

Fig. 16—Anchoring a Stringer