How to Build Theater Stairs
—
An Illustrated Guide

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Amateur Theater Division

Si inaptum est
parum malleo fortiter tutudisti

Please note: I created this guide as a way of sharing experience. You must not take my statements as an official specification or standard. What I say about strength and safety is based on observations, not on codes, regulations or standards. Designs and construction techniques described here, if suitable for use in theater sets, will not necessarily comply with building codes. If you have not made observations of your own that enable you to evaluate the statements in this guide, you should consult other sources of information before going any further. You will understand that I cannot guarantee your results and that I cannot accept liability for any damage that results from your work, whether you follow my suggestions to the letter or not. Follow the manufacturer's instructions when using any power tool, and observe all safety precautions found in those instructions.

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Table of Contents

Introduction 1

1. **Preparations** 2
2. **Design of Stairs** 4
3. **Quick and Dirty Stairs: Stacked Platforms** 7
4. **Unit-Tread Stairs** 7
5. **Plywood-Stringer Stairs** 8
6. **Trestle-Stringer Stairs** 13
7. **Lumber-Stringer Stairs** 13
8. **Handrails** 15
9. **Escape Units** 22
10. **Ship's Ladders** 22
11. **Turning Stairways** 24
12. **Winding Stairways** 25
13. **Ramps** 27

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How to Build Theater Stairs

Introduction

Carpenters and designers in amateur theater get more headaches from stairs than from anything else barring doors. A change of level is one of the most effective and natural ways to juice up a stage picture, but it entails careful observation and planning and it takes a good deal of care and effort to make it work right.

The set builder can produce a stairway “to code,” that is, an installation like what occurs in a home or business. As far as lumber construction is concerned, the best source I’ve found is Scott Schuttner’s *Basic Stairbuilding* (Newtown, Conn.: Taunton Press, 1998). It is the best imaginable book, an economical, well-illustrated and comprehensive handbook that will enable you to build code-compliant stairs for all kinds of purposes. Some projects may have the budget and available skills for iron or steel construction, too.

What I’m concerned with is stairs that meet the needs of an amateur theater carpenter with an amateur theater budget, i.e., not much. Stairs in the theater, like prop money, have a different function from stairs in the real world. They do have to be seen conveying people from one level to another, but they need not be rated for enormous loads (you won’t move the piano up the stairs of your set) or built to stand forever in place. And they aren’t just traffic ways; they become little stages for parts of the show too.

In most companies a stair unit will see many productions’ worth of service, so the system has to be portable, compact, light, tough, and adaptable to a variety of “looks.” And you commonly don’t have all the cash you might like to put into the stairs, because the designer is calling for some insanely expensive effect elsewhere on the set.

When you see expressions like “platform construction,” you can find many details in my paper “How to Build a Platform” on this web site. Paul Carter’s *Backstage Handbook* (3rd ed., Louisville: Broadway Press, 1994) contains a wealth of good graphics and useful tables for constructing scenery (to say nothing of half a dozen horrible, horrible gags). It’s also smart to collect theater manuals and textbooks, old and new, because every one of them offers some insight that may save you time and money. An example is W. Oren Parker and Harvey K. Smith, *Scene Design and Stage Lighting* (2nd ed., New York: Holt, Rinehart and Winston, 1968), which has a good chapter on scenery with a focus on light weight.

Finally, study stairways you see. Make yourself obnoxious by casually measuring rises and runs in your friends’ houses and public spots, maybe even sketching handrails and newels. Building to a model is the best way to make your stairs read right.

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1. Preparations

You use stairs, ramps and ladders to get from a starting point to an ending point that's at a different elevation. This paper will set out many of the choices you must make and many of the techniques you will use in constructing these articles.

1.1. Stairs in the Design

From your designer's careful work, you can get most of what you need to know. Fig. 1, for example, is a detail from a scaled ground plan, giving the "footprint" of a stair unit with tread heights. That's enough, although you may find more specifications such as concealed/exposed stringers, handrail style, molding treatments, colors, carpet/runner, and so forth.

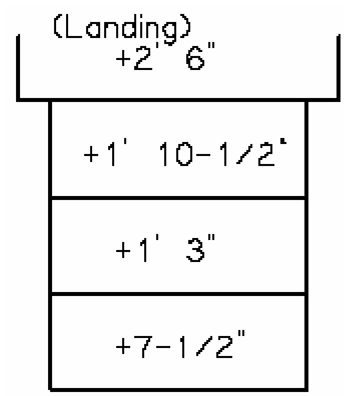

Fig. 1

Any change of level poses some hazard to performers, so you should do a check of the unit before starting to build it. Are the treads wide enough (left to right) for performers in costume, deep enough (front to back) for ordinary human feet? Is the rise (step to step) reasonable for actors who may be thinking about something else as they move? What about the steepness, presence or absence of handrails, presence or absence of risers, surface treatments and so forth? If you feel the designer has included a problem unit, ask for a meeting to hash out your concerns. No one will blame the designer if the stairs prove unsafe; they'll blame *you.*

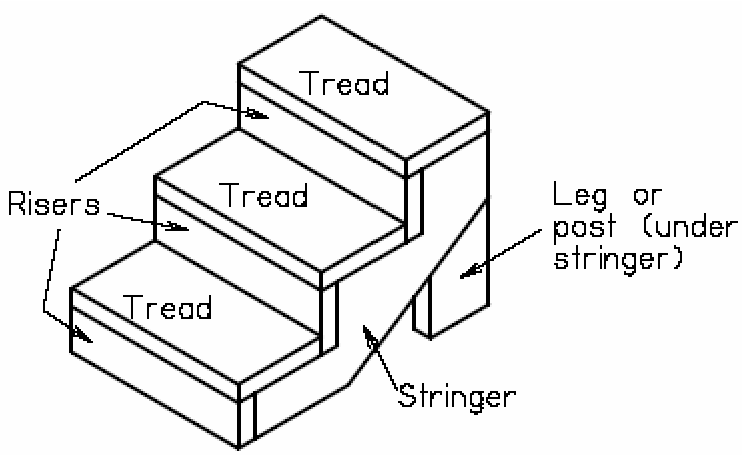

Fig. 2

Fig. 2 introduces some concepts: A **tread** is the part you walk on; a **riser** is the part you kick if your feet are too big; a **stringer** (often called a **carriage**) is the supporting part of the unit, running uphill and downhill and providing horizontal bearing surfaces for the treads and vertical ones for the risers. A lumber stringer, as in Fig. 2, has to be supported at its upper end and in between ends. In a house the walls provide support; onstage you usually put legs underneath.

Fig. 3 illustrates three key dimensions: **Width** is the left-to-right measurement of each tread; **run** is the front-to-back measurement (how far you advance from step to step); **rise** is the height from the top of a tread to the top of the next one (how much height you gain in going from step to step). Don't confuse run and rise, which are dimensions of the system, with **depth**, the corresponding measurement on the wood you cut to make the

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tread or riser. Fig. 3 shows a unit with a solid plywood stringer, a style very commonly used onstage.

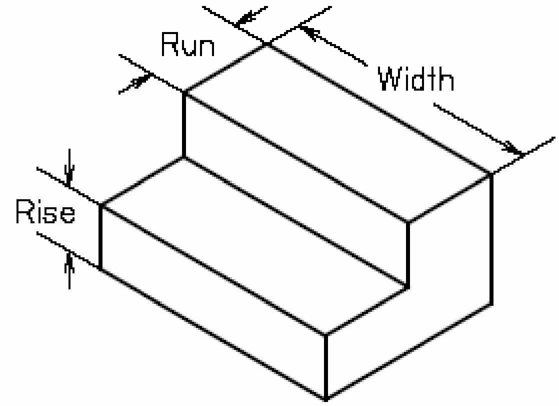

Fig. 3

A **landing** is a level that you access by going up or down the stairs. The second floor of your home has a landing, of course, and there may be other landings between floors.

Stair units for the stage often come from stock, and the inventory will describe them as **a three-step** as in Fig. 2, **a two-step** as in Fig. 3, and so forth.

Fig. 4 illustrates three more features: A **cleat** is a piece of wood or metal that's almost always invisible. You fasten the cleat to the stage floor, then attach the stair unit to it. This way of immobilizing the unit keeps it from walking across the stage and also prevents it from rising off the deck if it flexes in use. Many houses forbid you to attach anything to the floor, but Town & Gown has a stage that's designed for it. Stair units with their landings and other equipment run pretty heavy, and the dead weight is quite likely to be enough to keep everything in place.

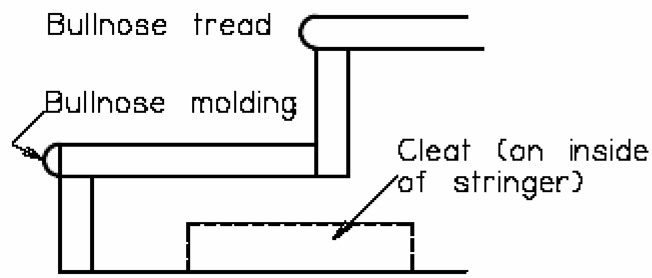

Fig. 4

Your designer may want the stairs to look highly realistic, and in most homes the treads (if uncarpeted) are not cut off flush but project a little bit. You can achieve this effect by building flush and adding **bullnose molding** or **half-round molding** to the tread edges, or you can buy or make **bullnose treads** in which the rounded front is part of the tread.

Terminology for stairs that don't go in a straight line is unsettled. In Section 11 I'll say **turning stairs** for an installation made up of straight-line flights with an angle between flights; in Section 12, **winding stairs** for a stairway that fits into a cylinder rather than a box. Some designers call these "spiral stairs," but building codes define a spiral as a unit where all the treads connect to a central pole or column.

In a **ramp,** the stringers are straight and the **deck** serves the functions of treads and risers both. Fig. 5 shows a perilously steep ramp. Because the stringer must run all the way to the lower end of the ramp, it has a **bevel** at the toe. The deck can also have a bevel, or it can be left bluff and finished with a piece of quarter-round molding. Like the lumber stair stringer, the ramp stringer requires one or more legs as well as some extra braces.

Brace is a general term for any part of the unit that isn't a tread, a riser or a stringer. A tall stair unit commonly has cross-braces to help it stay rigid, and a riserless escape unit

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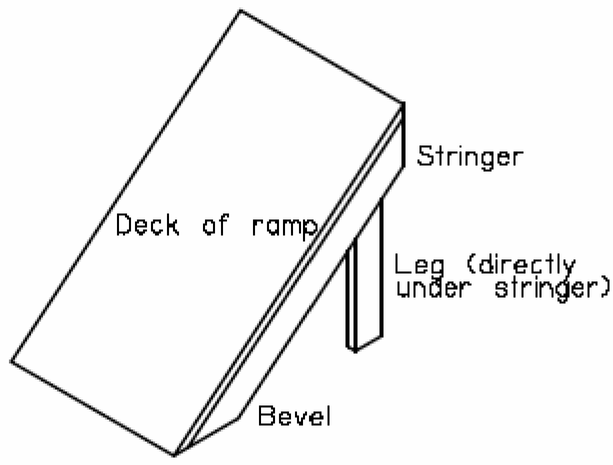

Fig. 5

must always have braces to keep it from collapsing (unless one stringer is solidly attached to a wall). The drawings in this paper will not show braces.

1.2. Safety

Stairs in a home typically have stringers of two-by (2x10 or 2x12) supported at the top end by nailing to a wall; either one stringer is nailed to a side wall, or a stud wall runs under the full length of the stringer. The treads are 1-1/8 inch thick and the risers are from 3/8 to 1 inch thick. Usually there are three parallel stringers. It's hard to imagine a stronger construction . . . or one that's harder to hump into the scene warehouse.

Theater stair units commonly have two or three stringers, not more than 2 feet apart. Everything is made of 3/4 inch (actually 23/32) plywood and assembled with drywall screws; it's common to glue the joints as well in order to keep them from making noise. A good solid unit will hold two performers to a tread without causing alarm, though anything beyond a three-step really should have a system of braces inside. Unit-tread stairs can be built even more strongly.

If your treads tilt in any direction, there's a special name for your stairway: Widowmaker.

It's considerate to leave the "skin" off a new stair unit until the talent has had a chance to look underneath. Uprights and braces make for happy performers.

Whenever you can, enhance the visibility of your stair units. Offstage (escape) units can be painted white; dots of glow tape at the tread edges, whether onstage or off, help actors descend safely. You can also make the front inch of each onstage tread a slightly different color from the rest; this will be easy to spot from the performer's position but hard for the audience to make out.

1.3. Professional Carpentry

If a "real world" carpenter offers to build your stairs, one good answer is "Yes." But be aware that you may have to destroy the unit in order to strike it.

2. Design of Stairs

2.1. Calculations

If the design doesn't reveal all the details, you have some decisions to make before you order lumber. How many steps will you place between landings, how big will the treads and risers be, where will the stringers fall? Let's begin with the simplest question. Given a lower landing and an upper landing, how many steps does it take to get between them?

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This table suggests some ways of ascending 4 feet 2 inches (i.e., 50 inches). Count the upper landing as a step; when you plan a four-step, divide the total height by five, not four.

To access a landing 4 ft 2 in high, you could build	
a 3-step	with a 12-1/2 inch rise
a 4-step	with a 10 inch rise
a 5-step	with an 8-1/3 inch rise
a 6-step	with a 7-1/7 inch rise
a 7-step	with a 6-1/4 inch rise
an 8-step	with a 5-5/9 inch rise
a 9-step	with a 5 inch rise

You don't want to look the performers in the eye after giving them a 12-1/2 inch step to climb. Young talent in good condition can manage 10 inches, but even this is brutal. On the other hand, an 8- or 9-step eats up a big part of the stage, and a 5-inch rise is more dangerous than you might think. Aim somewhere in the middle, say 5 to 7 steps, or construct a turning or winding stairway.

A digression: If the risers face downstage, they look outsized to the audience, especially from low viewing angles. Any angle or change of direction will help, as will nosing (which throws little shadows).

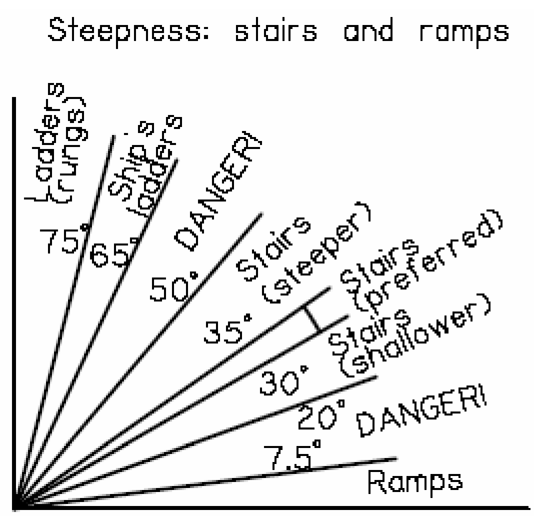

Fig. 6

Once you've decided on the rise of your stairs, you have to determine the run. You can work with angles, consulting Fig. 6 (based on Carter's handbook), or you can use rules of thumb. The chart shows that the safest and most comfortable stairs go at an angle of 30-35° above the horizontal, but angles from 20° to 50° are not out of the question. Stairs that are too steep pose a danger of falling, while those that are too shallow can lead to stumbles and strains. You may have good reasons for choosing a different angle, though: Stairs planned for a Grand Entrance may want to have big treads, while a cramped set may force you to adopt a shorter run.

Numerically, the rise should be in the performers' comfort range (say 6 to 9 inches, 6 to 8 for players with sore knees) and the rise plus the run should be between 17 and 18 inches. For example, you may choose a 7-1/2 inch rise; then the rule gives a run of 9-1/2 to 10-1/2 inches. A 7-1/2 x 10 step makes an angle just a couple of degrees over the 35° guideline; 7-1/2 x 9-1/2 is worse (steeper), so go with between 10 and 10-1/2 inches. Or you may be working with stock units that are multiples of 6-1/4 inches high; the rule gives a run of 10-3/4 to 11-3/4 inches. A 6-1/4 x 11 step is a hair shallower than the 30° guideline, so a run of 11 or 10-3/4 inches puts you just about in the ideal range.

Whatever dimensions you select for one stairway, you must use the same rise in all other stair units onstage, and preferably in offstage units as well.

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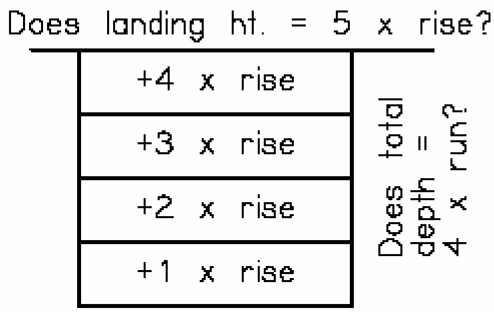

Fig. 7

Fully constructed plywood-stringer units should have stringers spaced no more than 2 feet apart. Lumber-stringer stairs with 3/4 inch plywood treads and risers should use the same spacing, because the "free span" is governed by the strength of the plywood, not the stringer. A stair unit more than 2 feet 1-1/2 inch wide should have three stringers, in other words. If you use a lumber stringer, put in a leg at the head and enough additional legs that the unsupported length (uphill/downhill) is not more than 4 feet.

Fig. 7 shows the arithmetic you must do before going any further.

2.2. Drawings

Schuttner's book tells how to figure the cuts you use to make your stringer, but there is an easier way, as Fig. 8 illustrates. First, draw the stair unit as viewed from the side. Enter the rise and run (not shown).

Second, draw the outlines of the treads and risers themselves. You must know the thickness of the stock used.

Blind riser (B) is a desirable strength feature.

Now throw away the original outline and keep the inserted one. This is a picture of your stringer. If you are using a CAD program, it will recalculate the stringer dimensions; if not, you can do it on paper. **The stringer should look all wrong,** but check your figures to be sure it's wrong the right way. The bottom "step" of the stringer should be less high than the others. The top step of the stringer should be less deep than the others.

The reason I didn't show any numbers in the drawings is that you must determine the correct allowances based on the materials you are using: 3/4 inch plywood (it's really 1/32 inch less, but disregard the tiny error), 1-1/8 inch treads, thin or thick riser stock.

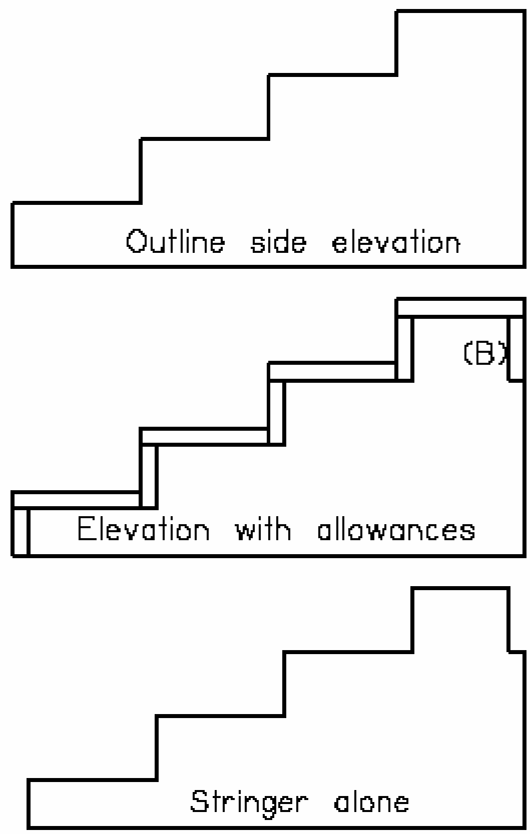

Fig. 8

Your stringer drawing directly gives the dimensions of your risers. The bottom one is shallower than all the others. Usually all the treads will be the same, with a depth equal to the run of your stairs. If you are building in an overhung nose, calculate the tread depth as run plus overhang but **don't change the allowance** figured into the stringer.

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3. Quick and Dirty Stairs: Stacked Platforms

The next five sections will describe some specific construction techniques. The first one may seem bizarre. You make a staggered pile of stock platforms.

3.1. Selection

You can use stacked platform units if

— the rise of your planned stairway is the same as the height of your company's stock platforms
— you have a ton of platform units you don't need for other parts of the set
— your design allows a lot of wasted space, say beneath a high level
— the budget contains literally nothing for stairs
— there's no need for anyone to get underneath the stairway to work effects and such
— the top unit in the stack will still be partly above the bottom unit

3.2. Execution

Fig. 9 illustrates the simple principle. A leg goes at each unsupported corner. To cleat the unit together, work as a team of two. Collect some scrap 2x4. Preassemble units 1 and 2

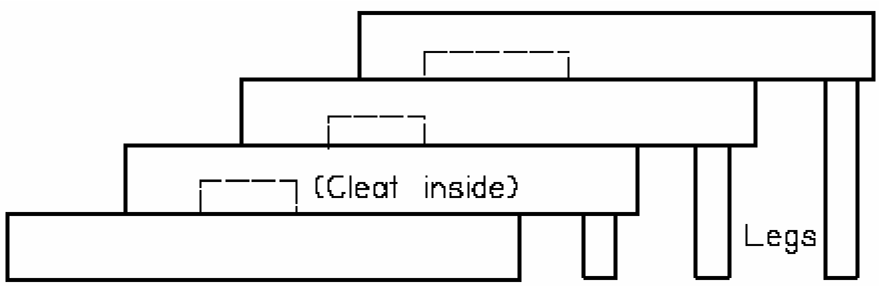

Fig. 9

and trace the front edge of 2 on the top of 1. Remove unit 2. On unit 1, mark a second line 3/4 inch behind the front edge line, and draw further guidelines 3/4 inch in from the left and right sides. The outside face of a cleat matches up with each guideline. Flip unit 1 on its side. While one team member holds each cleat in place against a guideline on the top, the other drives two 2-inch screws up through the deck of the unit. Repeat these steps for every unit except the top one. Now put unit 1 in place on the stage, set 2 on top, and drive two 2-inch screws through the frame of unit 2 into each cleat. Repeat till done. It's a good idea to secure the legs to the deck too, unless your company forbids it.

Caution: If the stock platforms are old and squeaky, building them into a stairway will cause the noises to add together, not cancel out.

4. Unit-Tread Stairs

This style is named because you build each tread as a single unit, then lock all together to make the stairway, as Fig. 10 shows.

4.1. Selection

Unit-tread stairs have great advantages in two situations:

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— when the footprint of a flight of stairs is not a rectangle
— when you need to be able to knock the stairway down into easily carried pieces

This construction uses a lot of lumber and may be frustrating to erect, but it is quite strong.

4.2. Tread Units and Legs

My paper titled “How to Build a Platform” gives most of the details of the units and legs. Each platform unit is exactly one tread wide and deep and should be slightly taller than the rise of your stairway unit. (The lowermost unit has to be just the height of the rise, no more.)

The winding stairway, using a special form of unit-tread construction, gets its own section later in this paper.

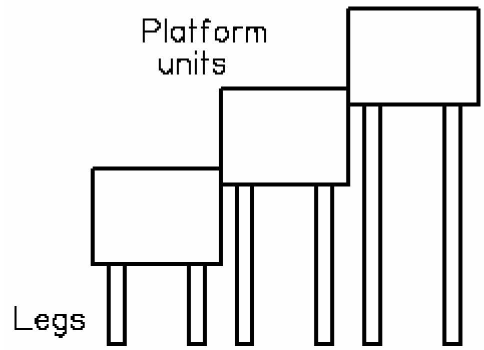

Fig. 10

4.3. Unitizing the Stairway

In Fig. 10 you can see that the units don’t want to be attached to one another. The trick in making the stairway hold together is to insert battens between the frame of each platform unit and the legs of the unit above it. If the battens are fairly deep, they will serve the secondary function of bracing both units against side-to-side motion. After attaching the legs to all units, cut dimension lumber or plywood as long as the treads are wide. Using 2-inch screws, attach a batten to the front legs of each unit except the lowest one; see Fig. 11. The batten can butt against the bottom edge of the frame. Assemble the stairway starting at the low end. Secure the batten of step 2 to the frame of step 1 with several 2-inch drywall screws. You want a firm attachment that extends right across the width of the unit. If you have many C-clamps on hand, you can use them instead of screws.

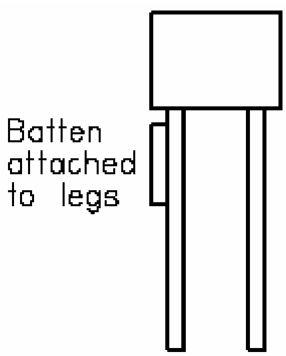

Fig. 11

Any tread unit where the legs are longer than twice the height of the frame should get bracing. Use the back (uphill) legs for bracing. A horizontal brace of, say, 1x4 is all right for the lower treads; for the higher ones, cut 1x3 or 1x4 to make diagonal braces. If the brace on one step goes northwest-southeast, let the next brace run northeast-southwest.

5. Plywood-Stringer Stairs

The fully constructed (i.e., with risers) plywood-stringer style is the one our company uses most often.

5.1. Selection

The plywood stringer is the construction of choice when
— you have carpenters of at least an intermediate skill level in the crew

— economy is important
— your design calls for a solid side
— you mean to strike and store the stairway as a unit
— each stringer is small enough to be cut from one sheet of plywood

5.2. Design and Materials

The design procedure in Section 2 was written up for a plywood stringer. Here is an example with numbers:

I want to build a three-step with a 7-1/2 inch rise and 10 inch run; the width will be 3 feet. My material is 3/4 inch (23/32 inch) CDX or sheathing grade plywood throughout, and I'll use drywall screws and glue to assemble the unit. I do want the blind riser (B) from Fig. 8.

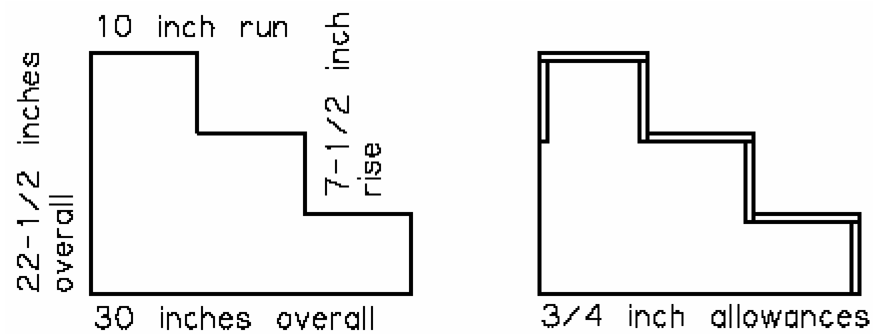

Fig. 12

I begin by drawing the side elevation in the left panel of Fig. 12, reflecting overall dimensions of three times the rise and three times the run. This shows how big the finished unit will be.

The right panel of Fig. 12 shows how much of that outline is going to be occupied by the plywood risers and treads (and in this case the blind riser). I allow 3/4 inch rather than 23/32 because the difference is virtually invisible (and inaudible).

I've entered the figures in Fig. 13. You won't be surprised that several measurements are less than the corresponding ones in the first elevation.

I should note that the blind riser might well be replaced by a solid back to the staircase. This would add weight but make the stringer easier to cut.

Now I simply transfer the drawing to the plywood and make the cuts. Simply? No, there are more cautions and precautions. First, try to use the "mill edges" as much as possible. Those are the edges of the plywood sheet as they came from the mill, and they are usually the best straight and right-angle references you have. I mark the letter **M** all along the mill edges before laying out a complicated unit like this. Second, plan the use of the sheet. It will surprise you how little waste you can achieve. Fig. 14 is a cutting chart for my sheet of CDX.

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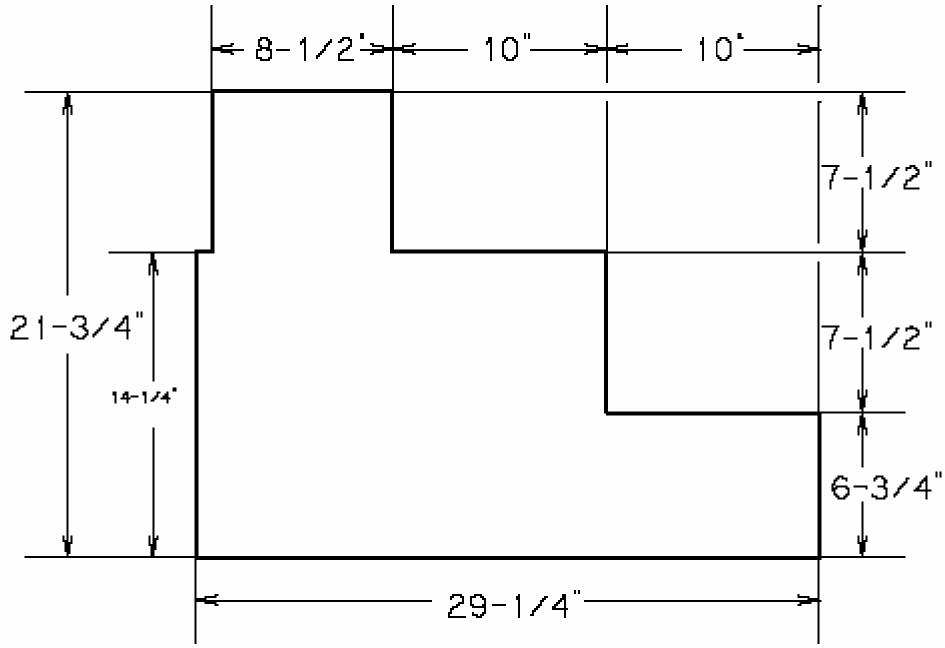

Fig. 13

S1, S2 and S3 are stringers; the R's are risers (3 feet wide by 7-1/2 inches deep except R3, which is 6-3/4 inches deep), and the T's are treads (3 feet wide by 10 inches deep). Areas marked W are waste, at least until I get started putting braces into the unit. Note that this is just one of many possible ways to plan the cutting—and it isn't the first one I tried, either.

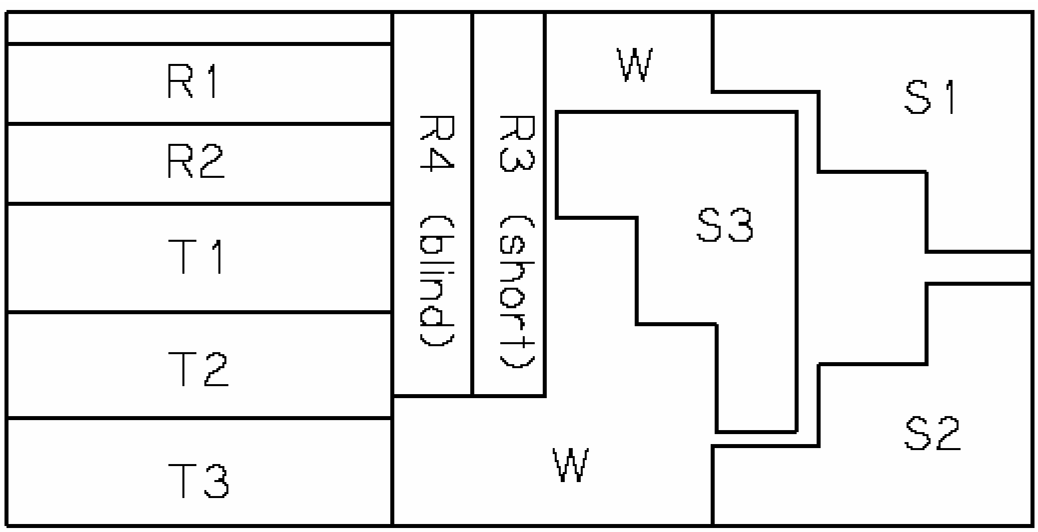

Fig. 14

CDX plywood has a more beautiful side and a less beautiful side. It's highly relative, because this grade is not beautiful no matter where you stand, but in general the grade stamps are on the less beautiful side. You should try to assemble your stair unit with the grade stamps on the inside. Of course, you have to be adaptable: The "good" side may have a big gouge right in the middle of a riser. When it comes to making stringers from

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CDX, be sure you lay two of the stringers out in mirror-image fashion (like S1 and S2 in Fig. 14). That way, you can make both outer stringers show their fairer faces to the house.

5.3. Cutting the Plywood

Try to mark your cuts on the ugly side of the material. Don't mark a whole row of treads at once, because the saw subtracts about 1/8 inch with every pass; cutting tread 1 takes away part of tread 2, so that the unit won't fit together right.

Accuracy and neatness count! Anybody can put stairs together, but it takes a steady hand to cut the pieces out. Don't hurry. You must cut squarely into the inside corners of the stringer; use a handsaw or a power jigsaw for these finishing strokes. The surfaces where the treads and risers bear have to be good and flat. And all the stringers must be alike: Stack them up to check. I won't tell if your 7-1/2 by 10 unit comes out 7-3/8 by 9-3/4, but the whole world will know if the unit rocks or groans when people walk on it.

Follow the manufacturer's directions and observe all safety practices when using power tools. Wear eye protection and ear protection, and check in all directions around you before you pull the trigger. You can scare someone with a handgun, but a circular saw doesn't give them time to be scared.

If you're building a lot of stairs, you will experience a powerful temptation to stack two or three sheets of plywood and cut several units at once. You may get away with it, too.

5.4. Assembling the Unit

Fig. 15 shows what I mean by "fixturing" part of a unit. You temporarily attach a piece of scrap to hold it upright so you can use both hands to do something else. In this case you and your partner get the stringer stood up, using a level to make sure it is plumb, and one of you steadies it while the other screws a bit of plywood to the fat end. Spending the time to fixture your stringers at the start (or at least one of them) will save a good deal of time and a wealth of swearing later.

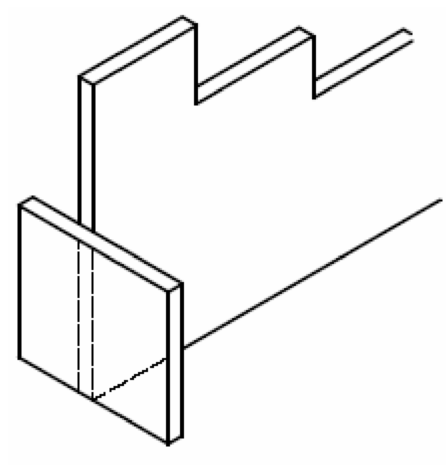

Fig. 15

Glued joints in platform and stair units are controversial; you're attaching "side" grain to "end" grain. Glue will not add to the strength of your unit but will help suppress creaking noises when it's in service.

Fig. 16 illustrates the first two steps in assembling your stair unit. Use 2-inch drywall screws to fasten the lowest riser to the stringers (only two stringers are shown). Drill countersunk pilot holes before spreading glue on the ends of the stringers. It's hard to drive screws cleanly into plywood without pilot holes, and it's messy to glue first and drill after. Two or three screws will be right for each joint. With brown carpenter's glue, you have ten minutes or so to correct mistakes. Apply the level once again to make sure the stringers are plumb.

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Caution: Get the screw heads down flush with the wood. Protruding heads can't be masked, and they will snag costumes.

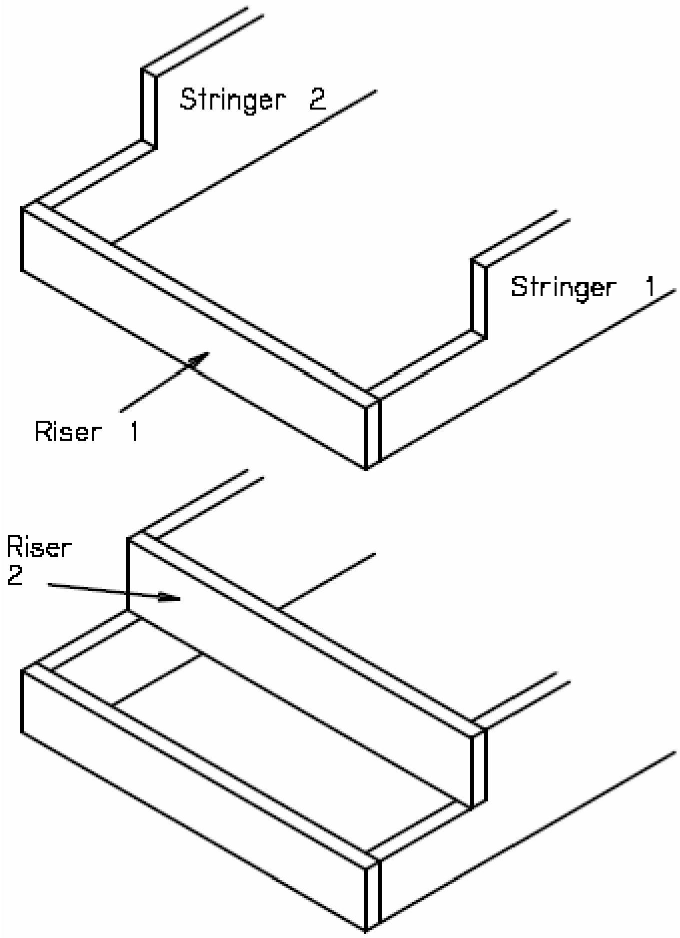

Fig. 16

Attach the second riser in the same way. If you have cut the risers to the same length, they will force the stringers to adopt the right spacing.

Now you're ready to put down the first tread. It will rest on the lower riser and the first horizontal surface of the stringers, and it will butt against the upper riser. The pieces fit together as Fig. 17 shows. Drill pilot holes, spread glue on all joint surfaces, lay the tread in, and drive 2-inch drywall screws. About three screws into each stringer and four into the lower riser will give you the strength and rigidity you want.

After driving the "down" screws, flip the unit over and work from the inside. Drill pilot holes through the second riser into the back edge of the first tread and drive screws. If you aren't gluing, save this step for last and do all the treads at once.

Errors in calculating and cutting the treads and risers will show up as gaps in one place or another. You can use screw power to pull the gaps closed, or you can insert wooden shims at inconspicuous spots, or—if you have providentially cut a piece too big—you can back up and correct your error. Air gaps will make the structure weaker, or at any rate louder.

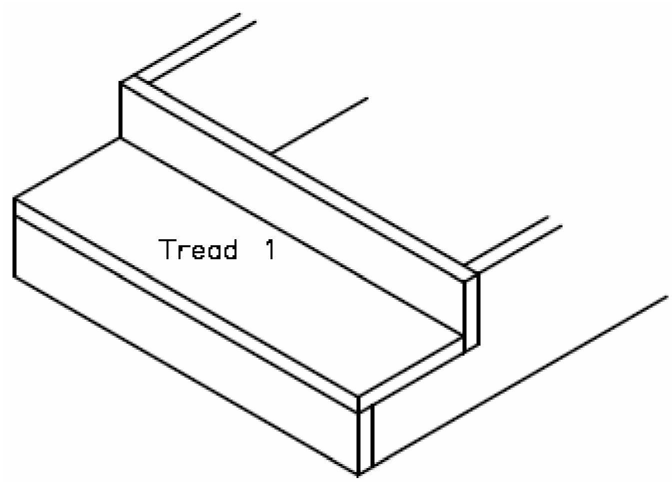

Fig. 17

Now the sequence goes riser, tread, and so forth. Attach the blind riser after putting on the top tread. (Try the other way and you'll see why.)

You may well feel the need for braces in some of the corners, especially in the case of tall or wide units. East-west braces, attached to a stringer and one of the higher treads, will add stiffness; north-south ones, catching a tread and a riser, generally won't.

If your stair unit will sit in a well-lighted part of the stage, it's worth the trouble to fill the screw holes with wood putty. Let the putty dome up just a bit, and sand it down later. If the design calls for overhung treads, attach bullnose or half-round molding with glue and finish nails.

Tip the unit on its side, give the glue time to dry, then test your stair unit. It should **feel** good under your feet. Paint it inside and out, and it's ready to install on the set.

6. Trestle-Stringer Stairs

The trestle stringer is neither fish nor fowl. It uses small stringer pieces of plywood mounted on a lumber frame at either end, the two or more trestle frames being tied together by crossrails. Fig. 18 shows a view of one frame from the inside of the unit. Parker and Smith, whose book suggested this drawing, don't make many claims for the method, and indeed it does look clunky, but it may be the very thing you need if all your plywood has been cut into small scraps.

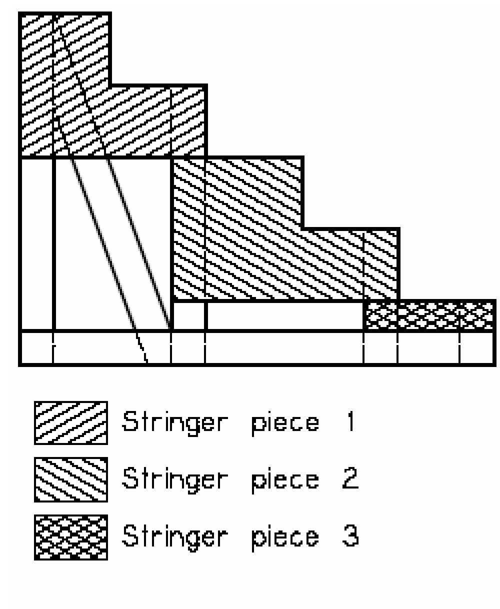

Fig. 18

7. Lumber-Stringer Stairs

Schuttner's book contains photographs, drawings, tables, and a good description of the procedure for making a permanent stairway with a lumber stringer. What follows is just a brief summary.

7.1. Selection

You should consider a stair unit with a lumber stringer when
— you are building a flight of stairs taller than 4 feet
— a set design calls for the underside of the stairs to be visible
— the installation will be permanent
— your crew includes an advanced-intermediate carpenter

7.2. Design and Materials

The first obvious difference between the plywood-stringer and lumber-stringer styles is, well, the stringer (Fig. 19). Only one end of it rests on the lower landing, and it's made of dimension lumber instead of plywood. The 2x10 or 2x12 stringer for a long stair unit is **heavy**—and it takes three.

A second difference is that the lumber-stringer unit, when used in a set, requires not only legs or posts to hold it up but also braces to keep it from collapsing sideways. (When you

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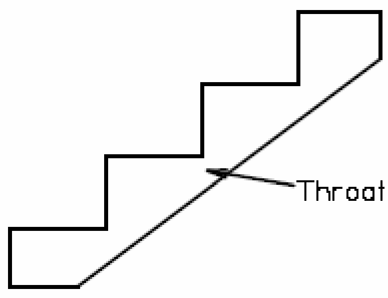

Fig. 19

build it in a house it gets side-to-side support from the walls and upper landing, but stage sets don't have that kind of stability to spare.) One good spot for bracing is between the tallest set of legs. Long diagonal braces of one-by or even two-by will make everybody feel better.

You can go to the lumberyard and buy treads made of 1-1/8 inch stock, the standard for residential construction. Once you set the rise and run dimensions, you have to rip the treads to the right depth as well as cut them off to the right width. It's all right to use 3/4 inch plywood for treads too. Just be sure you know the tread and riser thicknesses before you begin calculating (go back to Section 2).

Think about how to cut that stringer in Fig. 19: What's the proper angle, how do you make sure all the tread surfaces are parallel, and is it safe to use a circular saw in that vertical position? Last question first: **No.** As to the other two, there's a Trick.

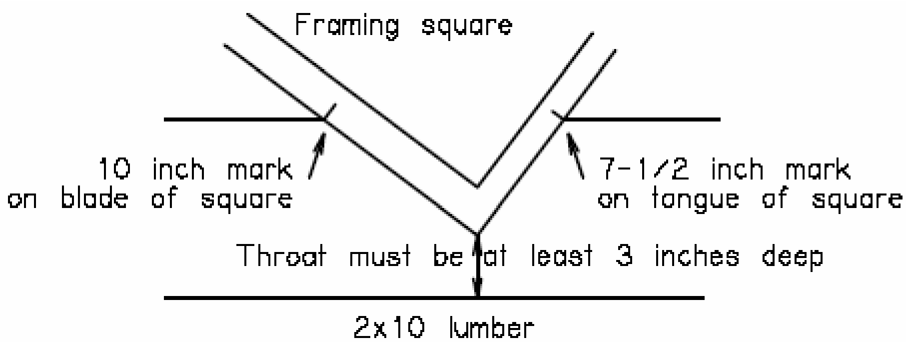

Fig. 20

Fig. 20 shows how to lay out the tread and riser cuts quickly and accurately with the lumber lying on a bench. I'm taking a 7-1/2 by 10 inch stair as my example again. Set the framing square down so that the 10 inch mark on one arm touches the edge of the stringer and the 7-1/2 inch mark on the other arm touches the same edge. Carefully draw a line at the outside edge of the square. Now move to the right until the 10 inch mark on the blade exactly hits the end of your pencil line, and repeat. You can adapt this technique to mark the bevels at the head and foot of the stringer. Make sure the throat measures at least 3 inches deep; 2x10 lumber (actually 1-1/2 inches wide by 9-1/4 to 9-1/2 inches deep) barely passes this test for 7-1/2 by 10 stairs. Check anyway.

7.3. Cutting the Stringers

Again, you get points for accuracy and neatness. Try not to cut past the corners with the circular saw; use a handsaw or electric jigsaw to finish.

Follow the manufacturer's directions and observe all safety practices when using power tools. Wear eye protection and ear protection, and check in all directions around you before you pull the trigger. You can scare someone with a handgun, but a circular saw doesn't give them time to be scared.

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7.4. Bullnose Treads

When using bullnose treads from the lumberyard, figure the run of the stairs first and lay that dimension off on the stringers. Then add the depth of the overhang to the tread depth. Rip the stock treads to this total depth.

7.5. Assembling the Unit

Fixture the stringers. Use a level to make sure the tread surfaces are dead level. This is a good time to go ahead and install two-by legs under the stringer heads. Mark the top of the leg, working the framing-square trick again, and cut the bevel. Stand the leg upside down next to the fixtured stringer (using a level to plumb it) and mark where the head of the stringer intercepts the leg. Cut the leg off **square** at this mark. To install the leg you have to use a plate of one-by or a piece of 3/4 inch plywood, driving 2-inch drywall screws into stringer and leg. A long stringer should get extra legs.

With all the stringers standing, place them where the unit will live and attach them to whatever landings, walls and other features you have available. Now you can start putting on risers and treads, going through the same procedure as in the all-plywood unit. Drilling pilot holes is especially important if any element of the stairway is made of hardwood. Cut and install braces before testing your stair unit.

8. Handrails

Every stairway should have handrails with proper newels. (So should most levels.) Rails are a comfort element in that viewers expect to see them, a design element in that they're big so that their style becomes a dominant part of the stage picture and blocking, and a safety element in that their presence reminds the talent not to try walking over the edge of the unit. Rails are hard to design onto a system of levels and stairs that you've already built; the designer should have a "look" in mind from the very first.

If your work will be permanent, you should build to satisfy applicable codes; the Schuttner book I cited at the beginning of this paper will help. Here I'll assume you are concerned strictly with scenery.

8.1. Nomenclature

A handrail system has three or four major parts, illustrated in Fig. 21. **Newels** stand at the head and foot of every flight of stairs. Level rails have newels too. A newel not only lends strength and stability, it also makes the rail system look finished. As you walk up and down, you rest your hand on a **handrail.** The rail is attached to a newel at either end. **Balusters, banisters** or **spindles** (see Section 8.5) run vertically to support the handrail between newels. They give the name **balustrade** to the system as a whole. Balusters are most often attached to the stair treads, as in the upper part of the flight illustrated, but may be cut off at a **footrail,** as in the lower part.

A newel nearly always has a **newel cap,** which helps define the picture but also conceals the fact that the newel is hollow. The newel may stand on a **plinth,** it may be anchored directly to the tread, or it may hang over the side, with the descending part bolted to the stringer (this style not illustrated). The handrail may end at a newel or it may continue to

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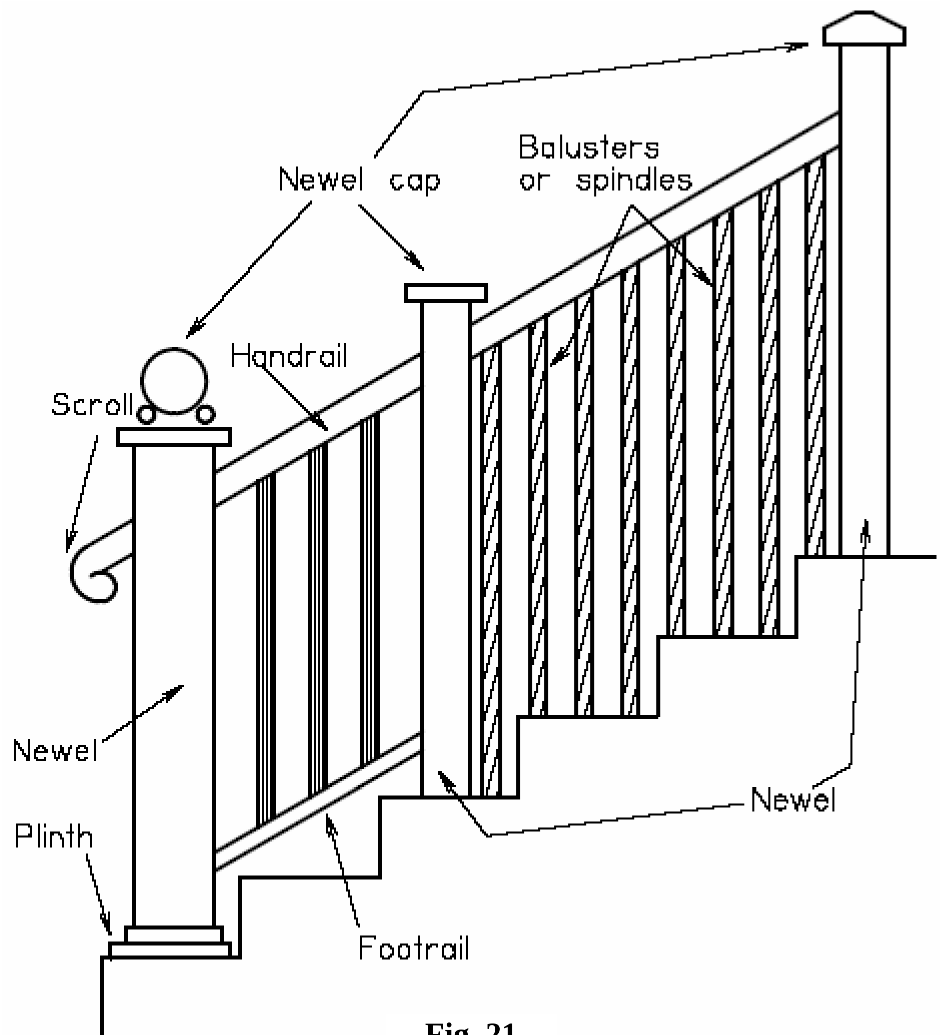

Fig. 21

a terminal **scroll** or curve around into a **volute** (not illustrated). The system may include decorative panels filling in the spaces between balusters or even taking their place.

8.2. Strength and Stability

Almost any railing system will be quite strong provided you press straight down on the handrail; it takes extra work to keep the system from wobbling if you are going to lean obliquely on it. And the talent is **certain** to lean obliquely on any rail that's there. In a strong system, the handrail ends at a wall, where it's firmly anchored; there is at least one corner, allowing the east-west and north-south parts of the handrail to reinforce each other; the "free" newel at the bottom is sunk into the tread (or hung over the side) and solidly attached to the stringer; the balusters provide minor vertical support but very little lateral resistance. The use of a volute at the free end is a clever way to add stiffness, because the balusters attached to the volute are out of line with those coming down the flight and so help resist a side-to-side thrust. The more of these features you can build into your scenery the better you will like the effect.

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8.3. Newels

You will usually build the newel separately and install it as a unit. The newel should be wider than the handrail, both for the look and for stability; you assemble it from one-by lumber. Fig. 22 shows three options: a square of four 1x6 sides, a rectangle of four 1x6 sides, and a smaller rectangle with two 1x6 and two 1x4 sides. It is very hard for the audience to tell which you have chosen. To assemble the newel, cut the sides to length, lay two of them together, and predrill and drive 2-inch drywall screws. Repeat till done. You'll end up with quite a sturdy box.

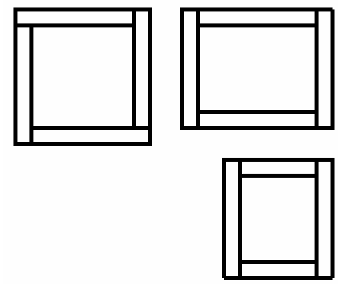

Fig. 22

Generally the newel stands taller than the handrail. How much taller depends on the cap you will set on top; the clearance between handrail and cap should not be so squinchy that people get their fingers caught in it. Here it's especially vital to study existing stairways, both in your period and out of it.

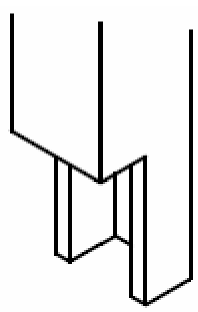

Fig. 23

You must allow extra length for a newel that extends below the tread surface. If you will bolt the foot of the newel to the stair stringer, you must notch the end as shown in Fig. 23 so that part of the strength lies against the stringer.

Every newel must stand dead plumb. A leaning newel will distract both audience and talent.

Building a cap on a newel can be as simple as screwing down a square of plywood, but you have tremendous scope to follow the architectural style—and be a little playful too. There are hundreds of fun ways to make newel caps. Fig. 24 illustrates a built-up cap that I made from three graduated squares of plywood and some 5/8 inch cove molding. It gave visual texture to the unit. You can commonly get away with leaving the molding off the upstage side of the cap.

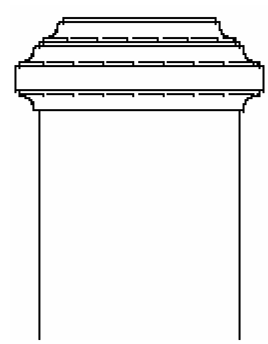

Fig. 24

Incidentally, if you want your newel to rise from a plinth, the smart way is to sink the newel into the tread (i.e., cut a hole in the tread and drop in an extra-tall newel unit), bolt it strongly to the stringer, then apply molding to build up the appearance of a plinth on top of the tread. This enables you to get a firm attachment without revealing what you have done.

For a more ornate look, you can apply molding "boxes" to the sides of your newels. This technique is especially appropriate for a wide newel in a downstage position, where the audience's viewing angle magnifies the featureless surface.

If you don't (or can't) drop the newel below the tread surface, use steel corners to secure it to the tread. This method is never as good, but it's often your only choice.

In most stairway situations you install the newels before the handrails.

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8.4. Handrails Proper

You can get milled handrail stock from the lumberyard or salvage store in a wide variety of sizes and shapes. If it fits the designer's look, fine. If not—for example if the designer wants quite a broad rail—you will have to gin something up. I often put in a built-up rail, using two or three sticks of lumber to get the right width as well as the right visual weight and texture. It takes some planning.

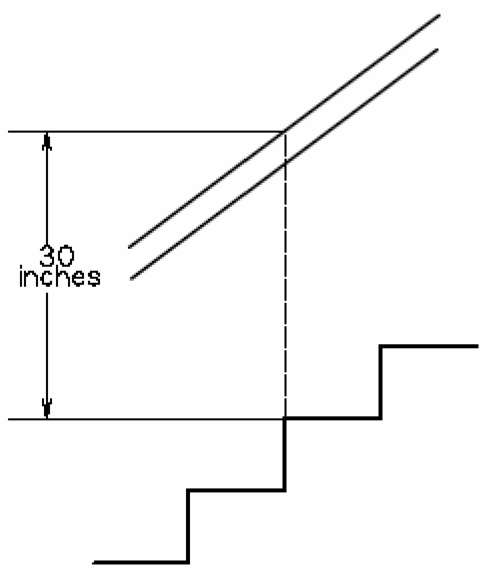

Fig. 25

Consider a short flight of stairs with newels already installed. I know the rise and run of the unit, and I want a textured look but a wide top surface. I calculate the length of the rail and cut a piece of 1x3 beveled at both ends to fit flush against the newels. As a temporary mounting, I screw some blocks to the newel faces and lay the first rail element on them. Now I add two thicknesses of one-by scrap on top of the rail and do some measuring. Fig. 25 shows what I'm aiming for: The top face of the handrail should stand 30 inches above each tread in the plane of the riser below it. (Surprisingly, this height is a "period" issue: Pre-1991 codes required a height of 30-34 inches above the nose, but recent construction is supposed to meet a standard of 36-37 inches. Adapt your design as you need to.) So I adjust the blocks until the top of the scrap pieces comes to the right level.

Next I cut a piece of 1x4 to the same length and bevel angle, and finally a second stick of 1x3. These will make up the top part of the handrail, but I don't install them yet.

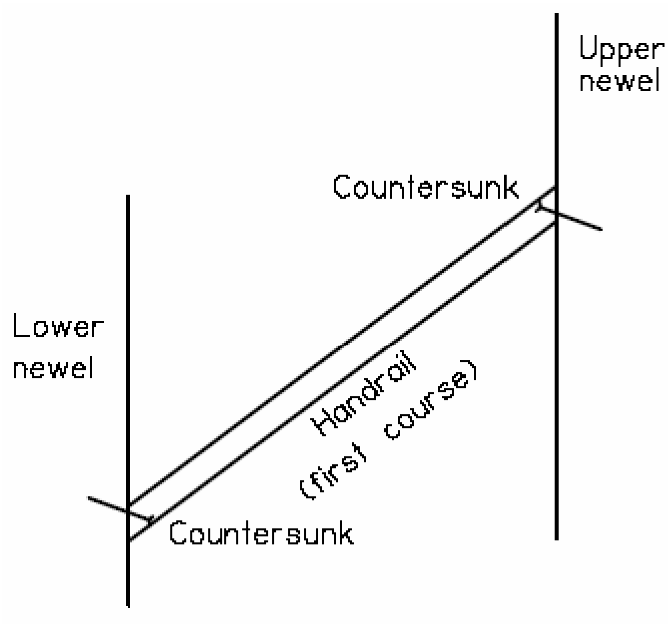

Fig. 26

If the first 1x3 isn't yet attached to the newels, that's the next step. I drill two pilot holes in each end. At the head end of the railing, the holes go obliquely downward into the 1x3 and are countersunk deeply enough that 2-inch drywall screws will not stick up above the surface. At the foot end, the screws go obliquely upward. These foot-end screws must not be visible above the 1x3. You've guessed that these are not going to be the strength fasteners; those come later. When the 1x3 is solidly in place and the blocks removed, I check the height above two treads.

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The handrail phase of the project now comes to a pause (Fig. 26). In this system the balusters come next, before the rail is completed; see the next section.

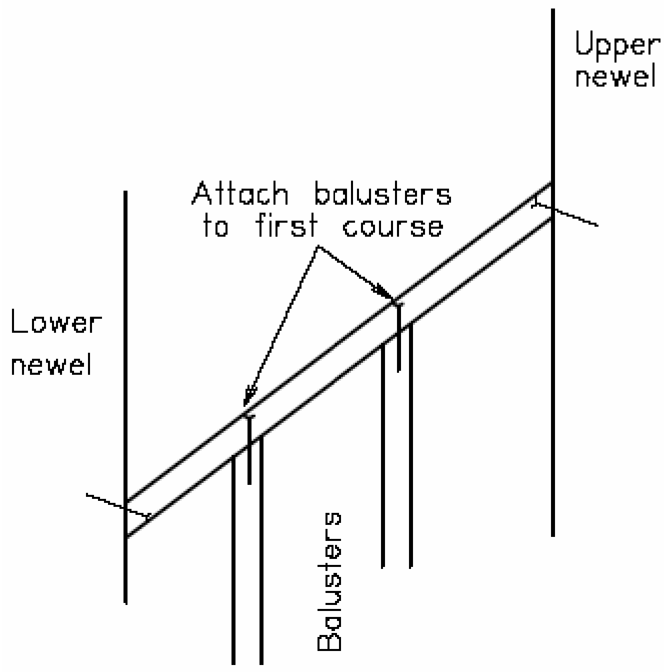

Fig. 27

Balusters in place, I drive a screw vertically down through the 1x3 into the top of each one. The baluster will want to creep uphill when the screw begins to press; you must restrain it, holding it plumb as you secure it. Carefully cut spacers will help. The railing system should feel pretty sturdy at the end of this operation (Fig. 27), though it isn't ready for a lateral thrust yet.

Next I lay the 1x4 over the 1x3, adjusting the overhang by ruler or by fingertip feel, and drive a couple of 1-1/4 inch screws to hold the two elements together. The last element is the top 1x3, and now I use a fair number of 2-inch screws to lock all three sticks (Fig. 28).

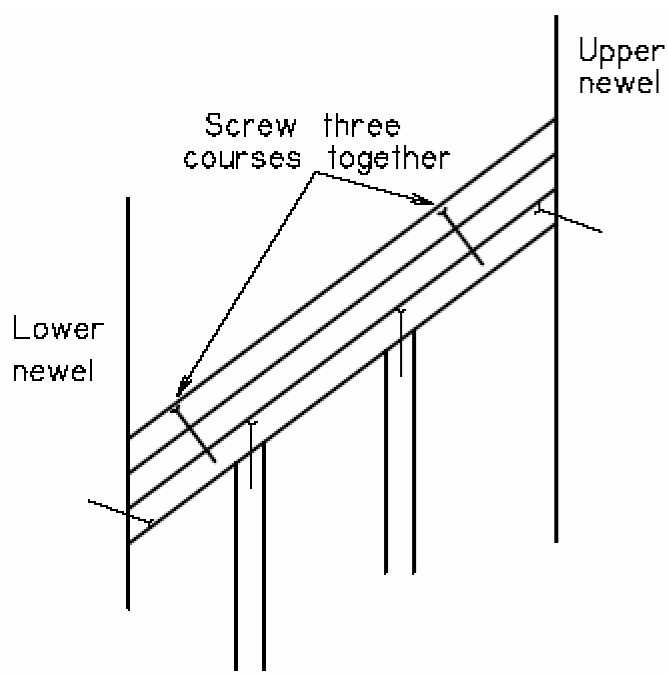

Fig. 28

To finish my handrail, I put long deck screws through it—two or three obliquely downward at the head, two or three obliquely upward at the foot—and into the newels (Fig. 29). I use wood putty to fill the screw holes where they are visible, sand, and paint. The three-part handrail, viewed from the seats, has a strong lengthwise visual texture with a look of great strength.

Of course you can combine different kinds of stock, such as 1x3 plus 1x4, two 1x3, 1x4 plus 1x3 plus 1x4, 1x4 plus 1x6—whatever gives you the look and feel you want. Fig. 30 illustrates the cross section of the built-up handrail I've described. A plain stick of 2x6 may be right for some designs. You can install cove or quarter-round molding along the edges, or 1-inch lattice molding right down the middle. You can bend

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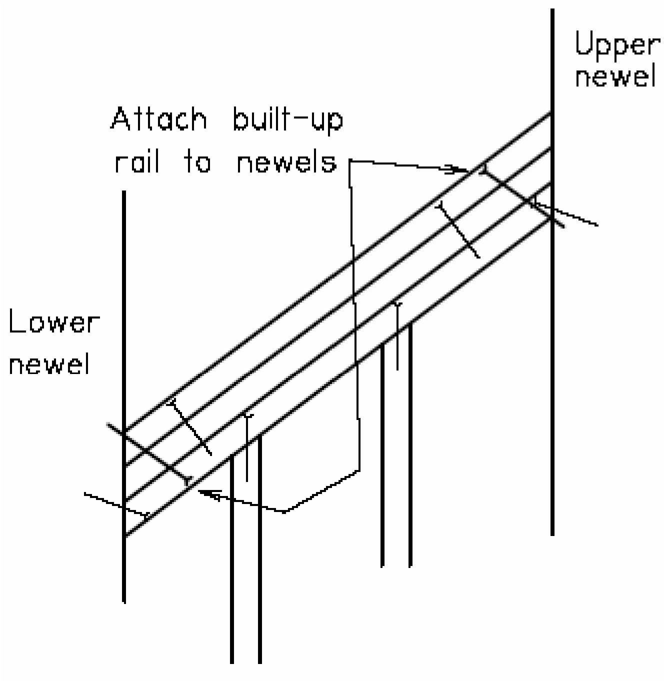

Fig. 29

steel corners and use them to attach rail to newel or baluster to rail, although you will have to work in some tight spaces.

If your design called for a footrail, you would cut it to length (with bevels), pre-attach the balusters to it, install it and screw the balusters to the handrail, then finish up the top.

8.5. Balusters

In rigorous terminology, banisters are vertical elements below the handrail; spindles are banisters made by turning; balusters are spindles with a "vase" shape. But do this experiment: cover up the labels in Fig. 21 and ask your friends to point to a banister. Four of every five will point to the handrail—the "sliding" part. The lesson we should take from this is: Don't say *banisters* when you mean banisters, say *balusters*. It rhymes with GAL-us-ters.

Besides completing the stage picture of your stairway, the balusters prevent small children from plunging to their death. In a very long flight they may add some strength to the handrail, but most flights onstage are pretty short, so you can treat the balusters as mainly a visual element.

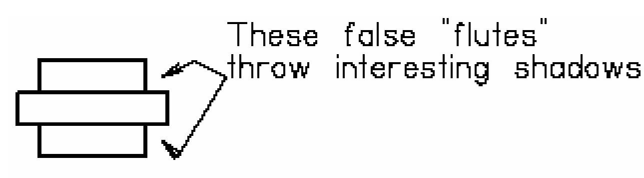

Fig. 30

There's a baluster for every look; you find them in the millwork department of the building supply store. Buy more than you think you'll need. Some railing styles allow you to use dimension lumber, such as simple 1x2, or even plywood panels.

Go back to Schuttner for the intricate process of installing permanent balusters. What I'm about to describe would give Schuttner the blue devils.

Begin by studying a real stairway that suits your period and style. What kind of balusters does it have: turned, slat, square? How fat or slender? How many to a tread? Do the balusters stand on each tread or extend down beside it, or do they end at a footrail? If the builder used stock balusters at three to a tread, are the square butts all cut to the same length or do they grade up? What's the relative weight of baluster to handrail?

To install balusters onstage, cut to length (with beveled top) and toenail to the tread, using real nails or drywall screws. You must improvise a fixture to keep the units from walking around. The fasteners go on the upstage side, of course. If you prefer, you can

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use tiny steel corners instead. Section 8.4 described the attachment of baluster to handrail. If you use one baluster to a tread—a design not too common in residential construction but often acceptable onstage—then all the sticks should be the same length. If each tread gets multiple balusters, you will cut one group to a first length, another group to a second length, and so on.

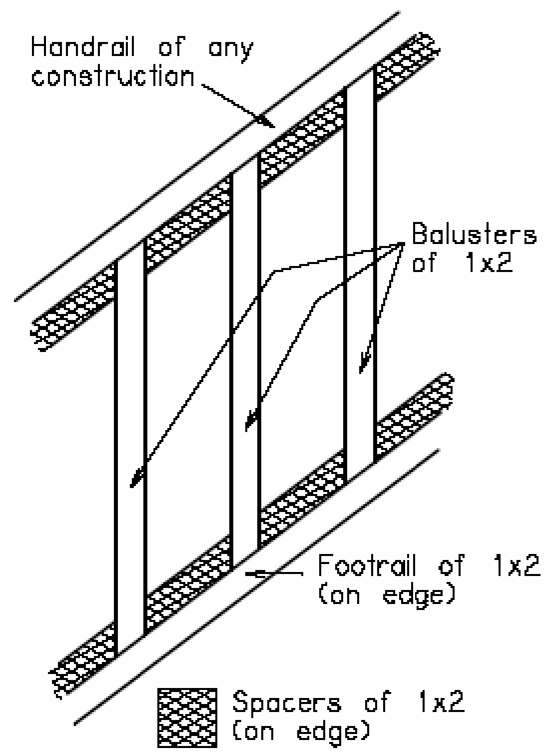

Fig. 31

Caution: You'll find stock balusters or spindles prone to split when you drive a screw into the top end. You should not only predrill, you should make the pilot hole extra-deep and a little bit over-wide.

If you have lived a chaste and austere life, the designer may ask you for "a sort of Arts and Crafts look." That means straight balusters, often of 1x2, or slats of 1/4 inch plywood, with relatively uncomplicated handrails; sometimes you can use a footrail as well, and you may decide to include spacers in the final system, as Fig. 31 suggests. But it gets better: You can achieve "a sort of Arts & Crafts" feel without installing any real balusters at all! Cut one panel per flight of 3/4 inch plywood and use steel fasteners to install it between newels. Fig. 32 shows three alternative patterns in one panel. We love our Arts & Crafts.

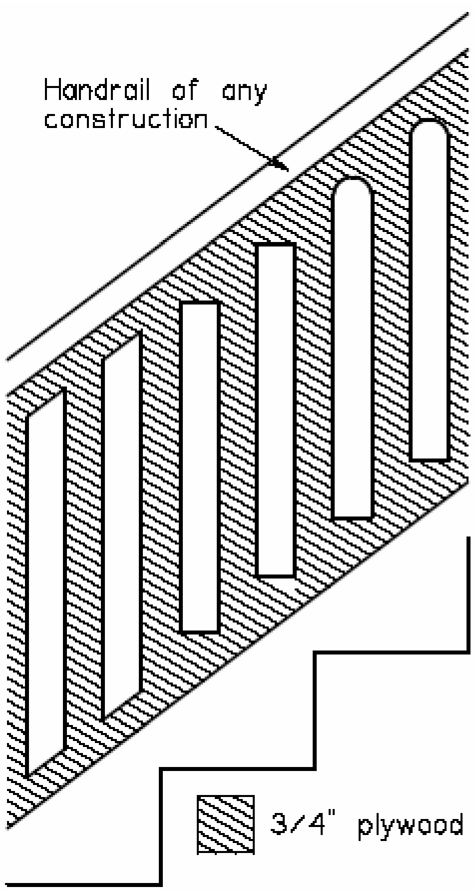

Fig. 32

8.6. Decorative Panels

Your designer may hand you a photo of a Medieval or Renaissance stairway with decorative panels suspended between the balusters, or the balusters built out to meet one another and form decorative elements. The technique is related to the plywood fakery in Fig. 32 but isn't limited to a particular look or period.

8.7. Unit Handrail Systems

Parker and Smith describe a "facing" unit, comprising newels, handrails, balusters and paneling, which is simply attached to the stair unit after it's in place. While this arrangement is not at all flexible—it only works with the flight it was built for—it does have virtues if you have to load your set in and out of a venue.

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9. Escape Units

An escape unit is a stairway, ladder or ramp not visible to the audience and allowing performers or crew to access levels backstage.

9.1. Selection

You can use anything as an escape that you can use onstage, and sometimes it will happen that the same inventory you draw on for onstage stairs also yields an escape unit.

More often, the backstage area is squeezed and you have fewer square feet for escapes than you do for onstage units. Two ways to achieve a tighter escape unit are to reduce the width and the run. Another is to construct a ladder (Section 10) instead of steps. In exceptional cases, place a stool and a bottle of water on a remote level and tell the performer to stay at "Places" till the next entrance. No one will like this solution, though.

9.2. Safety

Stumbles and falls on escape units are more likely than stumbles and falls on wide, well-lighted onstage stairs. Three safety practices will help avoid them.

First, build the escape unit with the same rise as all onstage stairs. Performers get used to stepping down 7 inches, or whatever, and a cramped, dark corner is not the best place to surprise them. (Escape ladders are exempt from this rule.)

Second, mark the stairs if you can't cast light on them. Glow tape was made for this. It's pointless to paint stairs black if they are already invisible (i.e., behind the set), so make escapes white.

Third, provide handrails so the talent can sense where they shouldn't walk. Of course, these rails should be as strong and convenient as the ones onstage, and one day you may see that happen.

The designer should tell you if full costumes are likely to make trouble on narrow escape stairs. This won't happen—I mean the disclosure—and you may have to rework the unit.

9.3. Riserless Stairs

If you build a plywood escape stair unit without risers, be sure some element performs the functions of the missing risers. Put the stringers closer together to support the back of each tread, and insert braces to lend side-to-side stiffness to the unit. All in all, there may not be any saving of time and materials with riserless stairs.

10. Ship's Ladders

A ship's ladder has flat treads and parallel stiles. Fig. 6 indicated that the preferred steepness for this kind of unit is 65-75°. A ship's ladder for access to a level must either have stiles that stick up above the deck, so that a person on top can find and grasp the ladder, or solidly mounted handholds (handrails are even better) that make a safe descent possible. Note that a typical ship's ladder has a rise on the order of 1 foot.

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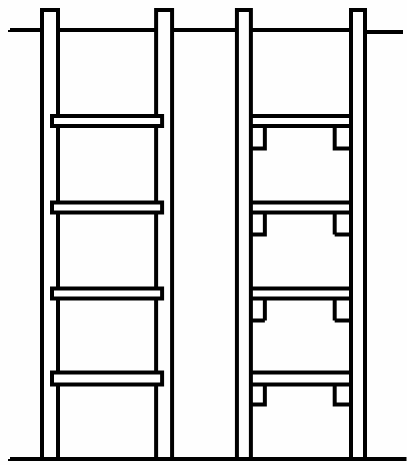

Fig. 33

You can build a ship's ladder in any of three ways. Fig. 33 illustrates two of them, the mortised construction and the cleated construction. Each of these ladders is made from 2x4, with 2x6 preferred for the stiles of the cleated one. The third construction is what I call "built-up," and I'll describe it in Section 10.2.

10.1. Mortised Ship's Ladder

Determine the angle at which the unit will stand. If the steepness is 65°, all your mortises will make an angle of 25° with the edge of the stile. A carpenter's bevel will help you produce this angle again and again. Start by beveling the foot end of each stile at the correct angle and fixturing the stile. Measure up 1 foot from the deck and mark the stile; using your bevel, draw a horizontal line through the mark. The top face of the first tread will hit this line. Repeat at a height of 10-1/2 inches. These two lines define your first mortise. The tops of the other treads will fall at 2 feet, 3 feet and so on; mark out their mortises. Do the same on the other stile, making sure you are producing the mirror image of the first one.

Use a router with the proper jigs or fences to cut mortises 3/4 inch deep. In the meantime, someone can be cutting the treads. They are preferably about 14-18 inches long. Stick a tread in a mortise (see Fig. 34) and drive three 10d nails through the stile into the end of the tread. Repeat until you have a comb; then attach the second stile in the same way. Paint the ladder and it's ready for use.

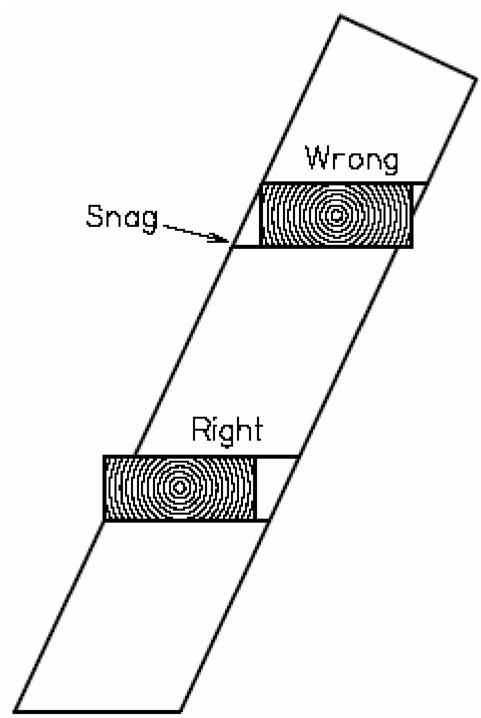

Fig. 34

10.2. Built-Up Ship's Ladder

No router? Take quite a lot of 1x4 and some 1-1/4 inch drywall screws. Cut two solid stiles, beveled at the foot, and attach shorter sections of 1x4 to the inside faces. The first section runs from the foot up to where the first mortise would have been; the second starts at the top of the mortise and runs up, and so forth. The treads are 2x4. The construction is as strong as the mortised type, but heavier.

10.3. Cleated Ship's Ladder

Use 2x6 for the stiles. Bevel and mark in the same way as for mortising, but cut short pieces of 2x4 to make the cleats. Nail the cleats on, lay in the treads, and nail or screw each tread to its cleats. See Fig. 35 for an illustration.

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This ladder is far heavier than the others without offering any extra strength. It has a hidden virtue, though: Make the angle a lot shallower, down in the 40-45° range, cut the treads from 2x6, and call it a pretty good utility stair unit.

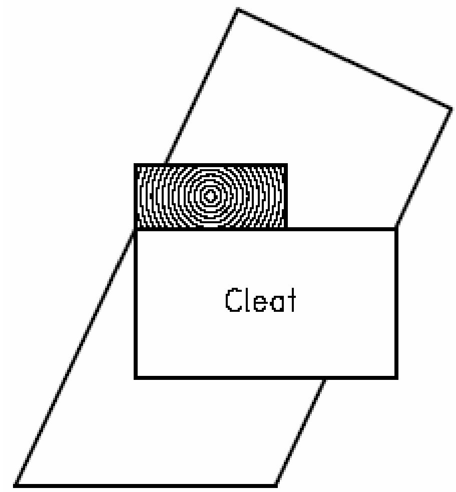

Fig. 35

11. Turning Stairways

There are only two hard things about turning or multi-flight stairways: (1) calculating the rise and the location of landings and (2) supporting short flights that begin somewhere up in the middle of the air.

11.1. Selection

Use a turning or multi-flight stairway onstage for the same reason you'd use it in a home: to give access to a high level without eating up every square foot of stage. In addition, it's often the case that a landing will improve the stage picture and blocking.

11.2. Design

As far as the vertical dimensions are concerned, the design calculations are just the same as in Section 2. Divide the total height difference by whole numbers until you get a rise that's in the comfort range of 6-9 inches. Now you know the total number of steps, including the top landing, and it's just a question of distributing them among flights.

It's rare that a stairway, on a small stage anyway, turns more than once, so I'll work the solution out for a first flight up to a first landing plus a second flight up to a second landing. Let's say the head is 5 feet above the deck. (That isn't very high, but the theater where I build these things has a low grid. We'll hide the top landing behind a wall.) A rise of 6 inches gives 10 steps, which I think is too many; a rise of 7-1/2 inches gives 8 steps, which I like, so I'm going to build a seven-step stairway including one landing. To save a few square inches, I'll specify a run of 9-1/2 inches.

Where does the landing go? Stairways I've studied often have a landing at the second or third level, then turn 90 degrees and continue, and this configuration has several advantages for scene design: It's realistic and comfortable, the landing can double as a *slightly* elevated acting area, and with one or two low steps I can pass through a wall if need be. I'll put the landing three times 7-1/2 inches above the deck. The first flight is a two-step, then we come to the landing, and after making a turn we go up four steps and one more step for the top landing. Simple. Fig. 36 shows a ground plan of the stairway.

11.3. Construction

Obviously any two-step unit works for the lowest steps, and each landing is just a platform legged up to the right height. But then the upper flight has to have an impractically big stringer. There is, of course, a trick. You can see it in Fig. 37. (The two-step has been omitted for clarity.)

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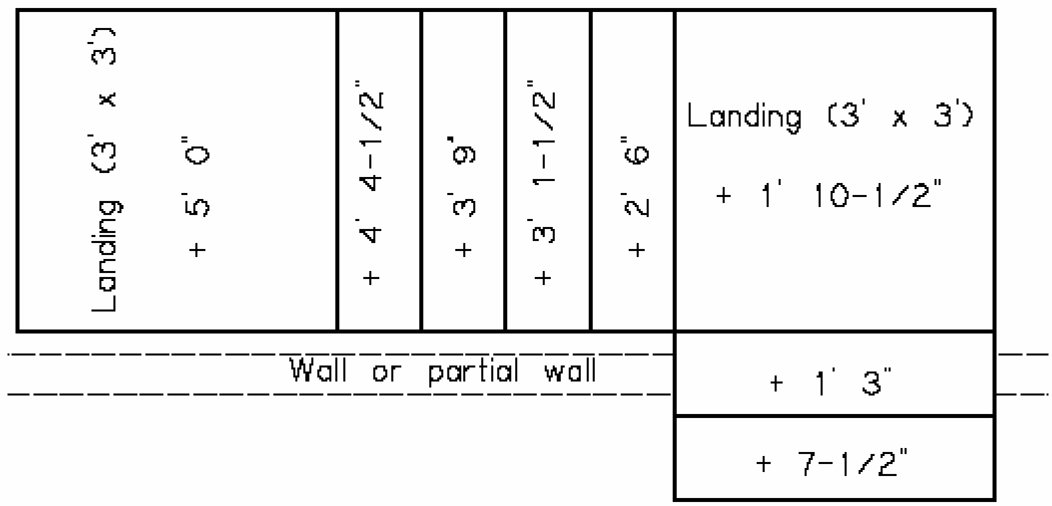

Fig. 36

You must cleat and batten the whole system together and brace it aggressively. Once again, the stairway lacks the sideways support it would get from the walls in a real house.

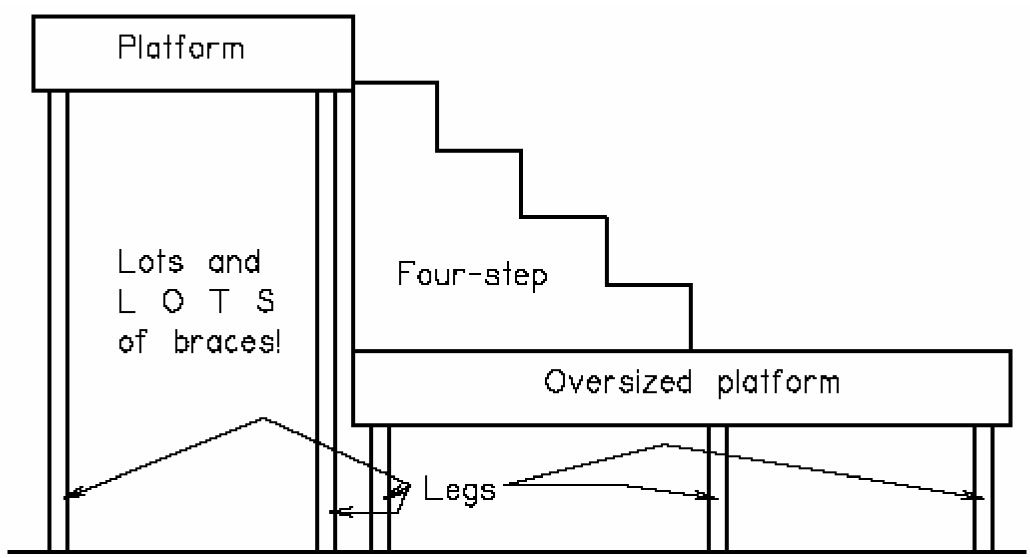

Fig. 37

12. Winding Stairways

Most shows will not repay the effort it takes to build a winding stairway. Plan carefully, aim for precision in your work, start early—none of these is worth as much as trying to talk the designer into a different choice.

12.1. Selection

The winding stairway has one great virtue: It looks incomparably wonderful in a sword-and-cape thriller.

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12.2. Construction

You make this stairway by the unit-tread method of Section 4. The units are not rectangular, but everything else is familiar. The pattern of stresses is different, in that the units want to lean to the outside when a performer runs up or down; the tradeoff is that reinforcement from unit to unit is stronger than it is in a straight flight.

The designer probably tells you angles; for example, each tread turns so many degrees, or it takes so many treads to turn 90°. Fig. 38 shows the ground plan of a typical winding stairway; here 90° divided by 6 gives a tread angle of 15°. It's quite difficult to lay out the cuts by angles, and there is an easier way that is just as good.

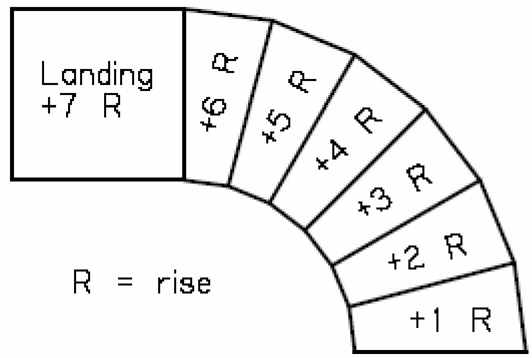

Fig. 38

Lay out a 15° tread with graph paper or a CAD program and take off the dimensions of the sides. Round off each measurement to a convenient level. Draw the modified tread and compare the outlines, as in Fig. 39. Literally nobody will be able to tell that you cheated and did all your measurements with a ruler instead of a protractor. You should cut the tread with straight edges, not curved; the succession of lines will make audience members think they are seeing circles anyway.

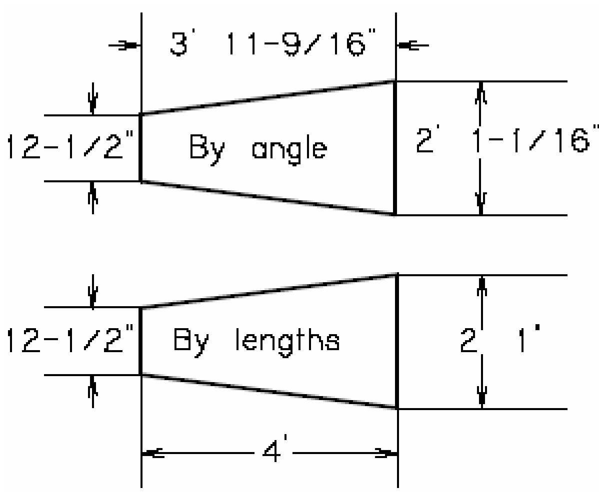

Fig. 39

12.3. Handrails

Handrails are . . . a beast. The rail doesn't follow any plane curve; to prove I'm right, take a scale model of a winding stairway and try to lay it flat, upside down, on a tabletop. Artisan metalworkers make rails of iron, using rosebud torch tips and tire benders, and even *they* say it's hard to do.

The long and short of it is that I can't yet make a really proper handrail from lumber, though I am still experimenting. Here are my latest two ideas:

Bevel the tops of the balusters and install them. Working in a team of three or four, lay a sheet of 5.2 mm lauan plywood on the lowest balusters, butting against the newel. A different material may work just as well. Attach it loosely to the first baluster, allowing it to flex as it wants to. Continue screwing the lauan to the balusters. The material should lie flat on top of each baluster. Now draw a smooth curve on the lauan joining the points of attachment. Use a jigsaw to make a cut 2 inches to the right of the curve and a second cut 2 inches to the left. This should give the first course of a built-up rail. Making the second course may involve removing the first one and tracing it onto other material. While lauan by itself is not strong, a pack of four to six thicknesses should be adequate if the balusters are spaced tightly.

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Or: Start with a length of PVC pipe. Butt it against the lower newel and lay it across the first baluster. Mark where the baluster hits the pipe. Cut a hole in the pipe. Put it back in place with the first baluster sticking into the hole, and mark where the second baluster hits the pipe. Continue. Build the “real” handrail around the pipe. I have serious doubts about this because the PVC has little or no strength, especially after you’ve pierced it, but the material is cheap, so this may be worth a try.

If called on to build another winding stairway, I’ll ask for money to get a blacksmith to fabricate the rail.

13. Ramps

You use a ramp to access a level or to create a raked acting area. While Equity may allow double-digit slopes, you really must think of the people you are building for. I found that a 10° ramp caused a lot of pain to an actor with a bad knee. Coming down is always worse than going up, and ramps don’t usually have handrails to mitigate a fall. On balance, I think the Carter guideline (Fig. 6) of 7.5° is a good maximum for ramps that have to carry traffic.

You usually build a ramp in place and dismantle it when the show strikes, but there’s no reason you can’t store it as a unit.

Draw the ramp in a scaled side elevation, using graph paper or CAD software, and determine the “slant length.” This gives the overall length of the stringers. Cut the stringers from one-by or two-by and bevel their toe ends. A 7.5° angle means a *long* bevel, but you have to cut it anyway. Side-to-side, the stringers should be no more than 2 feet apart.

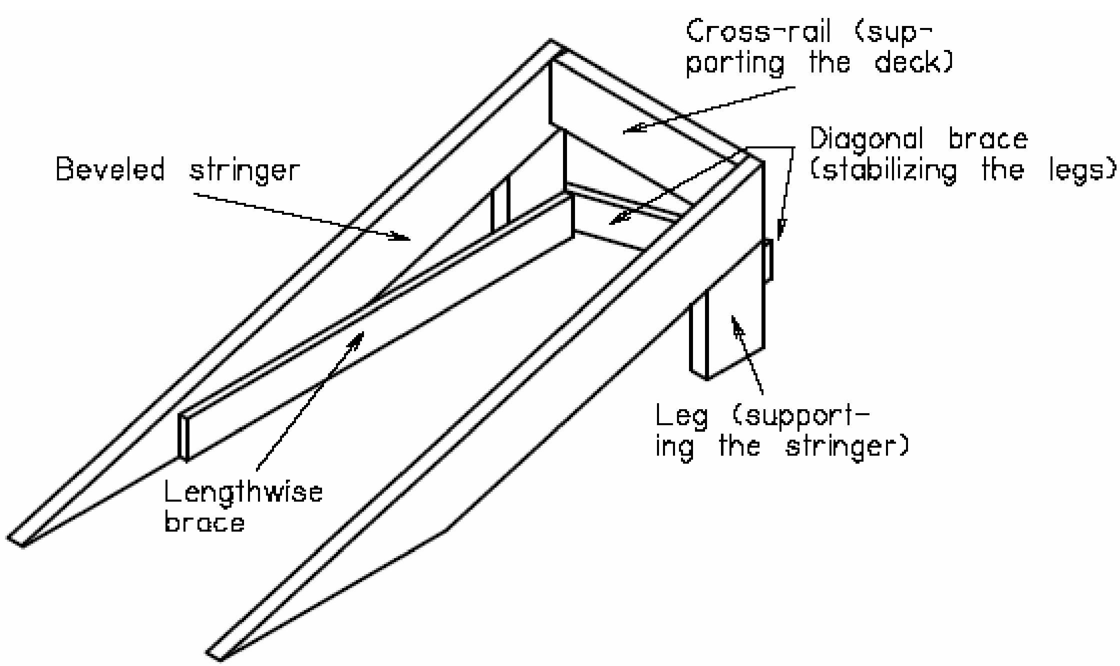

Fig. 40

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Fixture the stringers; lay the deck material (usually 3/4 inch plywood) on top so you can check the height at the head. You must install at least a leg at the top of each stringer, plus more legs if the stringer has an un-beveled length of 4 feet or more. Section 7 describes how to measure a leg. Each leg must go under the stringer, not beside it. Use a plate of one-by or a scrap of plywood to attach the leg.

It's important to brace the ramp legs in the left-right direction. Cross-rails are needed to support the deck between stringers but won't quite provide the lateral bracing. You should also use lengthwise braces at floor level, tying the legs to the low end of the stringers. Fig. 40 illustrates the structure of the frame.

If you are permitted to drive screws into the stage, then anchoring both the stringers and the legs in this way makes the *playhouse* function as a lengthwise brace.

Install the deck, using 2-inch drywall screws to attach it. It is vital to drive the screws down flush to the plywood; they will injure somebody if they stick up.

Where the edge of the deck is exposed at the toe, you should install quarter-round molding to improve the picture.

If—in the face of all this good advice—you build a steep ramp, provide some traction aids. Working on a 35° "lilypad" in *A Midsummer Night's Dream* was just impossible until we affixed anti-slip bathtub strips to the deck. Cleats on the surface would have created a frightful trip hazard.

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