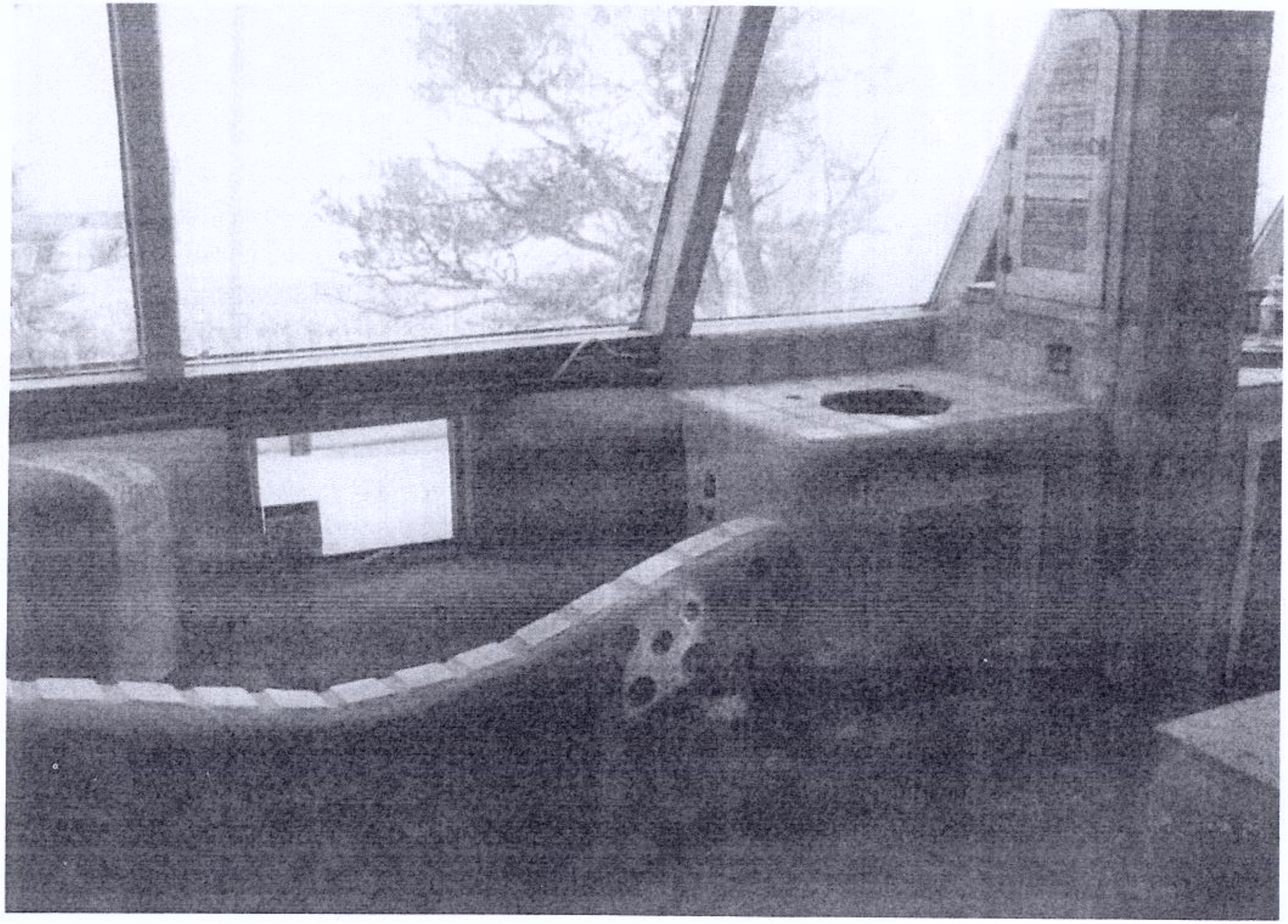
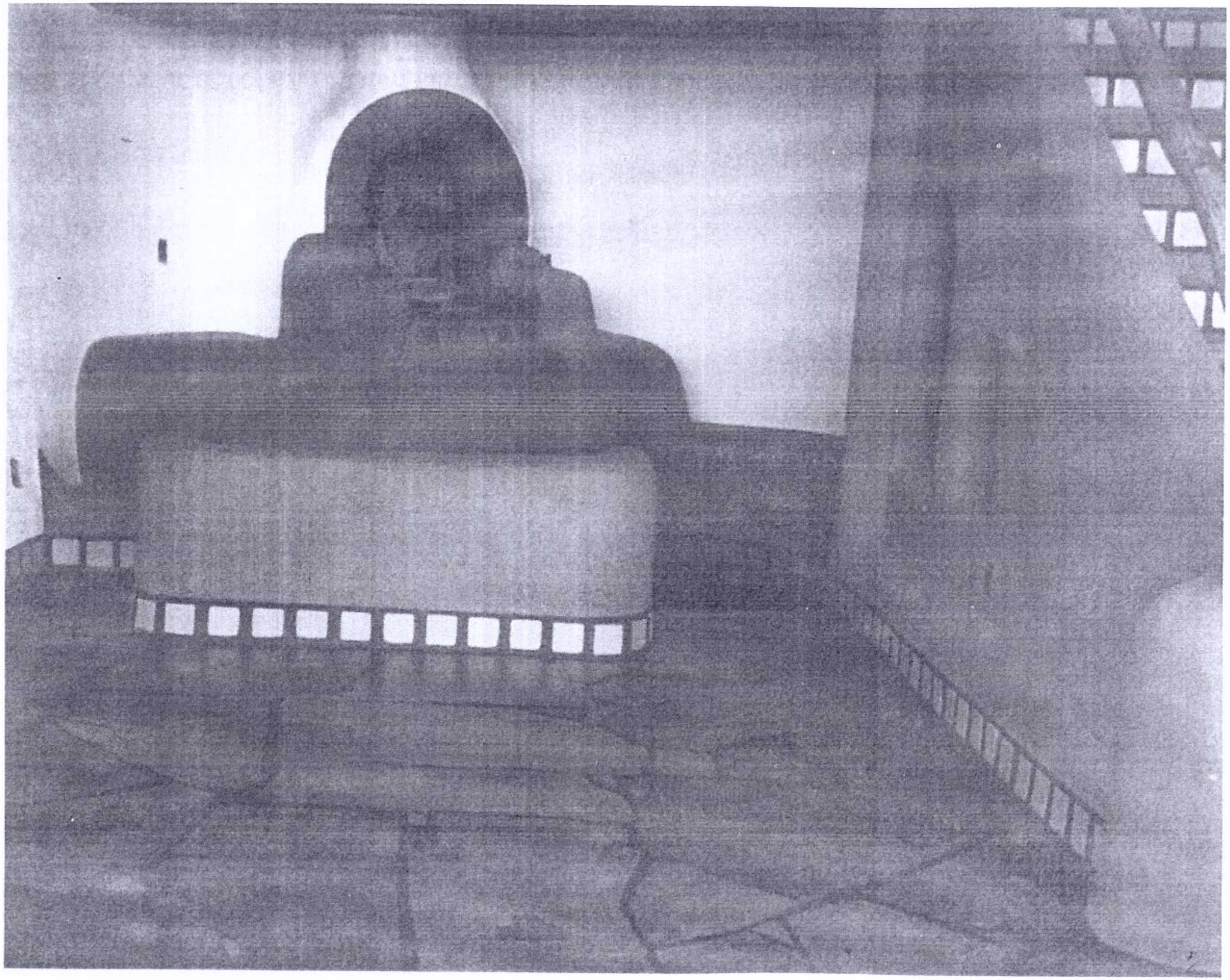
PART TWO
COMPONENTS OF THE EARTHSHIP





6. ADOBE FIREPLACES

C O M P O N E N T S

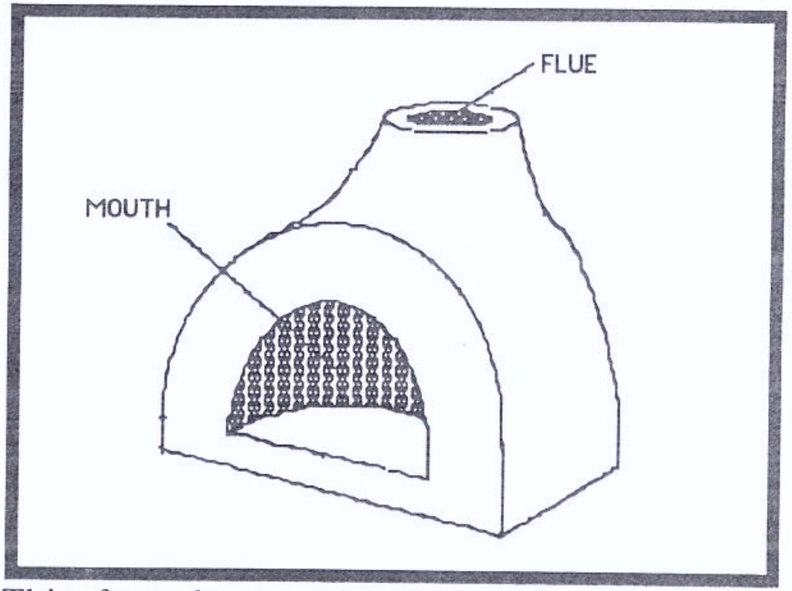
MOST HOUSES ARE KEPT TOO WARM (AT THE EXPENSE OF THE OWNER AND THE ENVIRONMENT) BY THEIR VARIOUS HEATING SYSTEMS. IT IS MUCH MORE HEALTHY TO KEEP AN INTERIOR ENVIRONMENT JUST A BIT ON THE COOL SIDE. ONE REASON FOR THIS IS THAT WHEN THE *DIFFERENCE* IN TEMPERATURE BETWEEN INDOORS AND OUTDOORS IS NOT SO RADICAL, THE HUMAN BODY HAS LESS ADJUSTING TO DO WHEN GOING FROM INSIDE TO OUTSIDE. THIS REDUCES STRESS ON THE HUMAN BODY THUS MAKING IT STRONGER TO RESIST ILLNESS OR DISEASE. THE EXISTING ACCEPTED COMFORT ZONE IS BETWEEN 70 AND 80 DEGREES FARENHEIT. IT SHOULD BE BETWEEN 60 AND 70 DEGREES F. THIS WOULD BE HEALTHIER FOR THE HUMAN BODY AND EASIER TO ACHIEVE WITH A THERMAL MASS HOME AS THE TEMPERATURE OF THE EARTH ITSELF (BELOW THE SURFACE) IS CLOSE TO 60 DEGREES. EARTHSHIPS CAN BE DESIGNED, DETAILED AND OPERATED SUCH THAT THEY CAN HOLD A STABLE TEMPERATURE WITHIN THE 60-70 DEGREE COMFORT ZONE. SERIOUS HEATING *SYSTEMS* ARE NOT NEEDED. IN MOST CASES, A SIMPLE AND BEAUTIFUL FIREPLACE IS ENOUGH IN THE WINTER TO TEMPER THE ENVIRONMENT INSIDE AN EARTHSHIP TO A LEVEL OF COMFORT ACCEPTABLE TO MOST HUMANS. THIS CHAPTER WILL EXPLAIN THE PRINCIPLES AND METHODS OF BUILDING AN ADOBE FIREPLACE.

Since a fireplace is simply needed for mild tempering of the environment in an Earthship, it need not be a serious, super efficient fireplace. It will not be used enough for heat to warrant the expense of a high tech, super fireplace. Fireplaces in Earthships are used mainly for atmosphere and light duty heat tempering. A simple adobe fireplace that draws well, and doesn't smoke is all most Earthships need. Adobe fireplaces can cost as much as you want to spend, as they have become an art form which is always license to charge a fortune. The truth is that there is about $150 maximum in materials in an adobe fireplace, and the equivalent of about four full days of labor for one person. (This doesn't include plastering, which is part of the wall finishing process.)

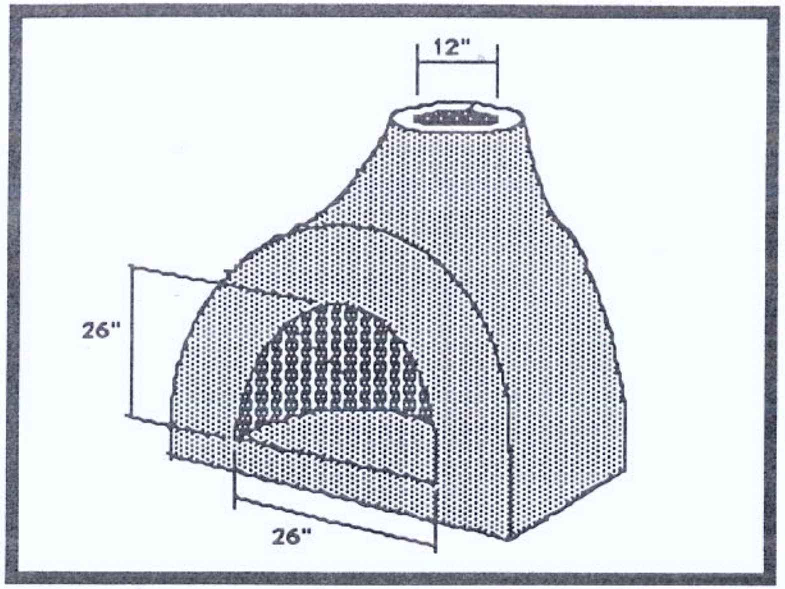
Adobe fireplaces need not be limited to the Southwest. They are obviously easier to build there, due to the fact that adobes can easily be bought in the Southwest. It takes about 100 adobe bricks to build an adobe fireplace. One hundred adobes is a full pallet. This would cost about $60.00 plus freight. It would be as easy to ship one hundred adobes anywhere in the country as it would to ship regular bricks. However, shipping of materials is never as good as using something made locally. Adobes can be made anywhere there is enough sun to dry them. Making 100 adobes would not be very difficult. There are many books already written about making adobes. If you want to make your own adobes, check the appendix of this chapter for "how to" books on adobe making. See this appendix also for where to purchase adobes. You want 4"x8"x12" adobes.

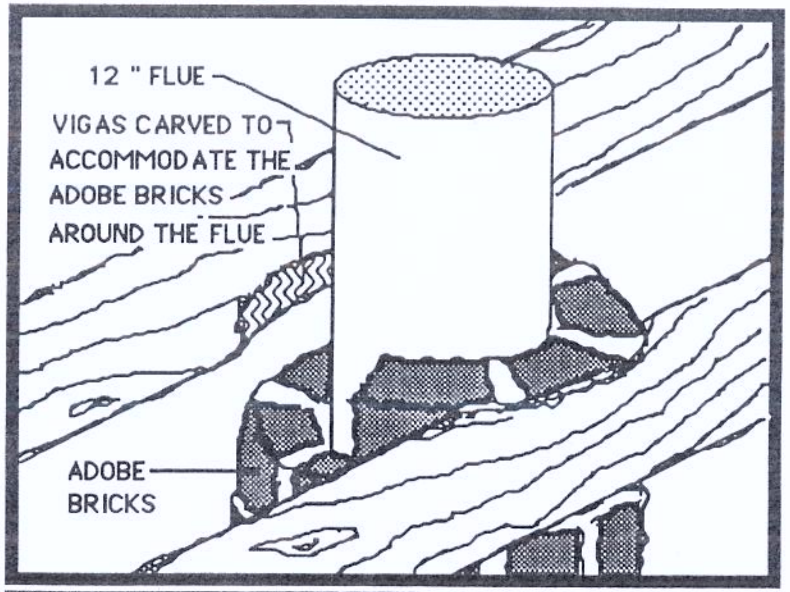
SIZING THE FIREPLACE

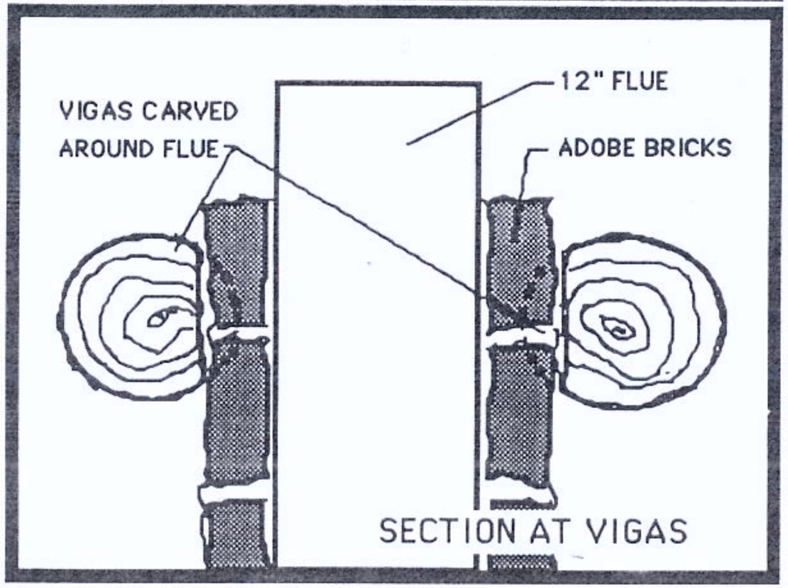
There is a required relationship between the stack or flue size of a fireplace and the mouth size. The area of the flue must not be smaller than 1/8 the area of the mouth.



This formula must be followed to keep the fireplace from smoking. A good size for an average adobe fireplace is a 12" diameter flue and a 26" by 26" mouth.



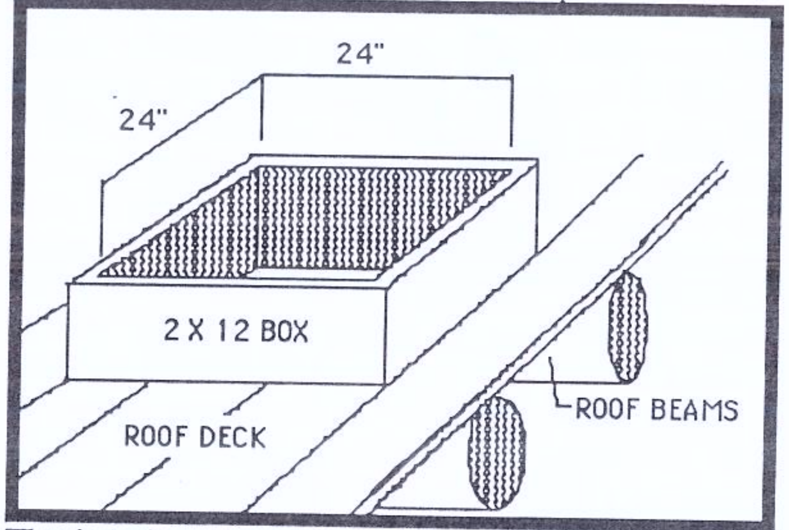




LOCATING THE FIREPLACE

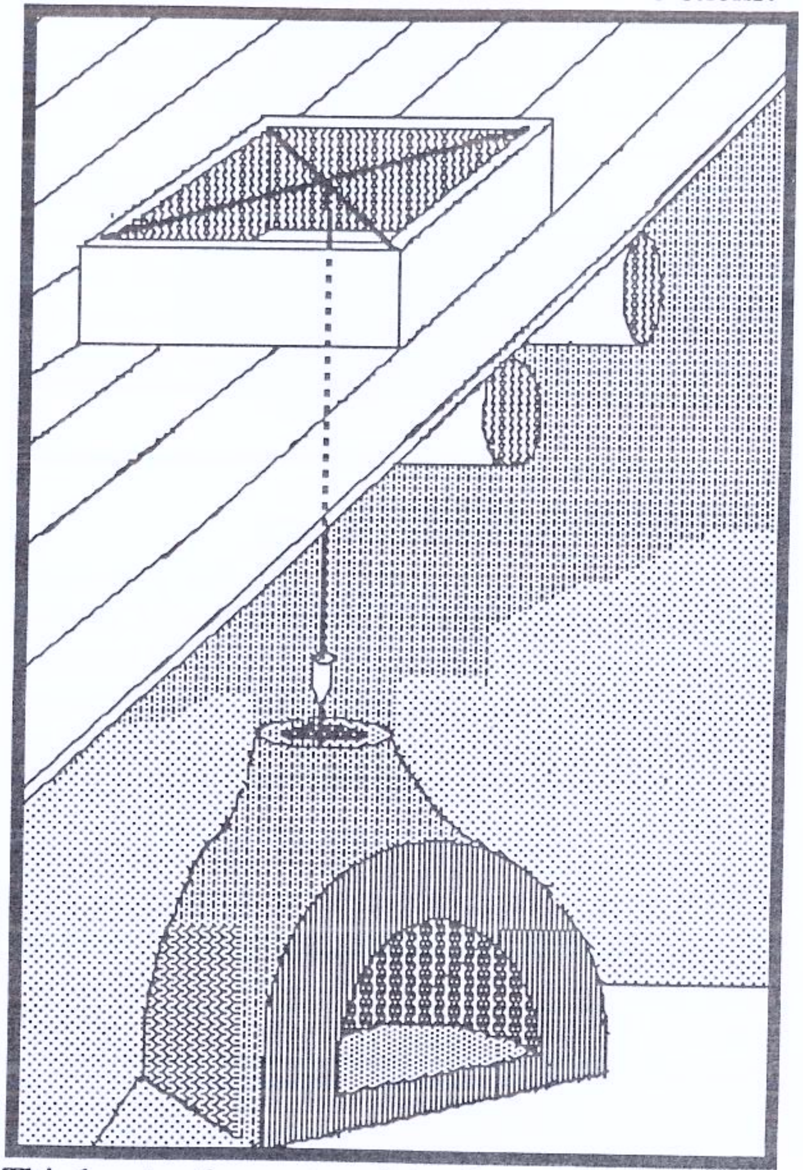
The fireplace must be located so the flue will pass between two roof beams with six inches of adobe brick between the metal flue and the wood beams. The flue can be 12" diameter galvanized furnace pipe. It need not last forever as it is simply a form and/or liner for the adobe brick flue.

A wood box out of 2x12 stock is usually made to accommodate the fireplace flue. This is very similar to the skylight boxes detailed on page 114 of Earthship Volume I. This box is installed as the roof decking goes on. This allows the roof insulation and roofing to be totally detailed out and weather-proofed before the fireplace is built.

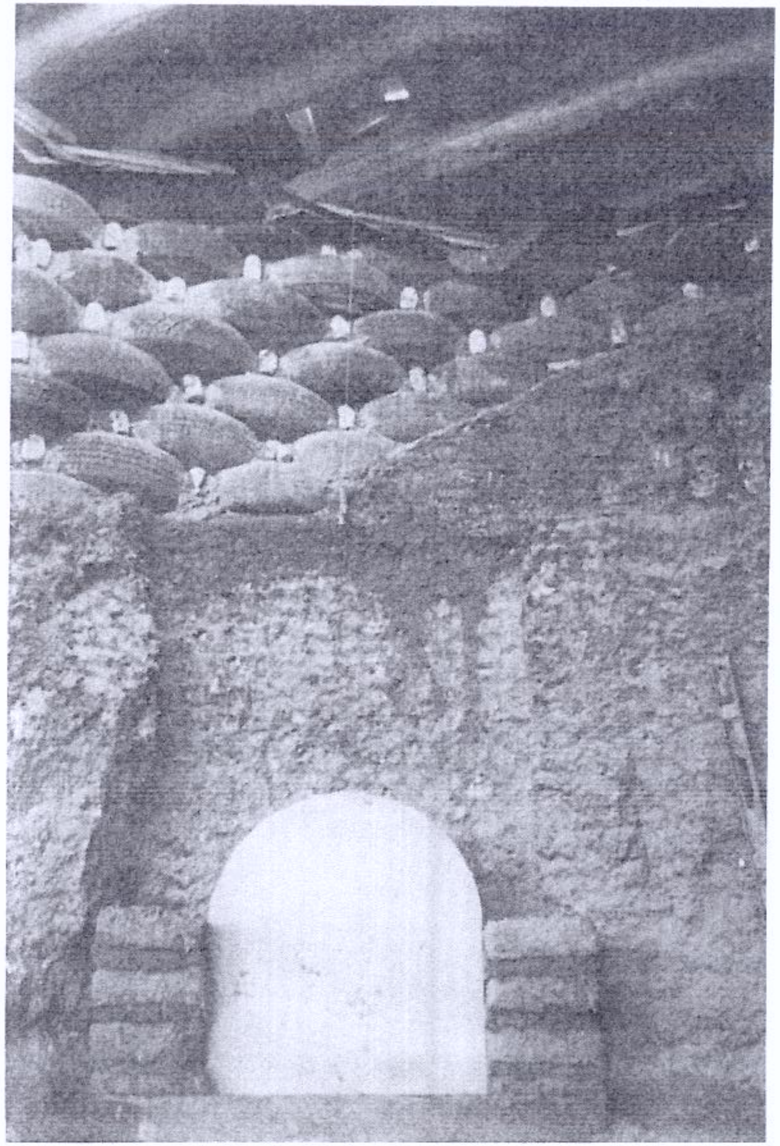


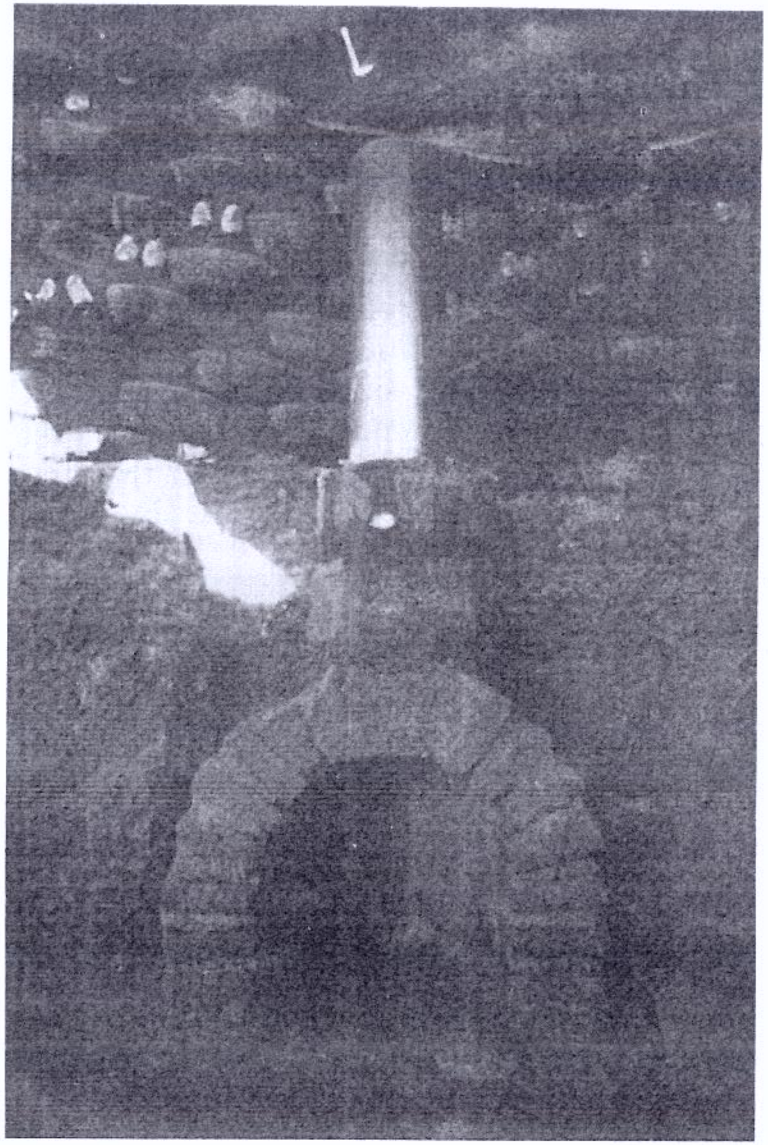
The interior dimension of this box should be 24" x 24". This allows a 12" diameter flue with 6" of adobe all around it to pass through. The beams in this particular space must either be placed far enough apart to accommodate this 24" clearance or they can be carved slightly to allow it.

Once this roof box is installed over the approximate location of the fireplace you are ready to precisely locate the fireplace. Find the center of the skylight box by laying two sticks across the top, corner to corner. Drop a plumb bob down from the intersection of the two sticks.



This locates the center of the flue of the fireplace.



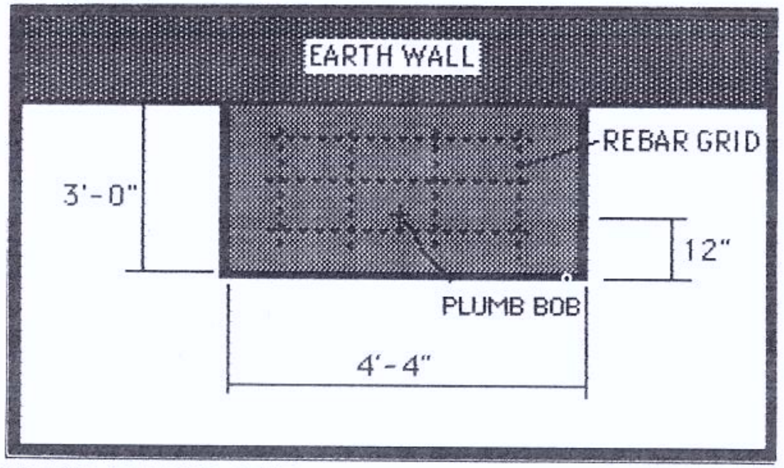


The center of the flue of the fireplace is about 12" from the front face of the fireplace so this also locates the front of the fireplace.

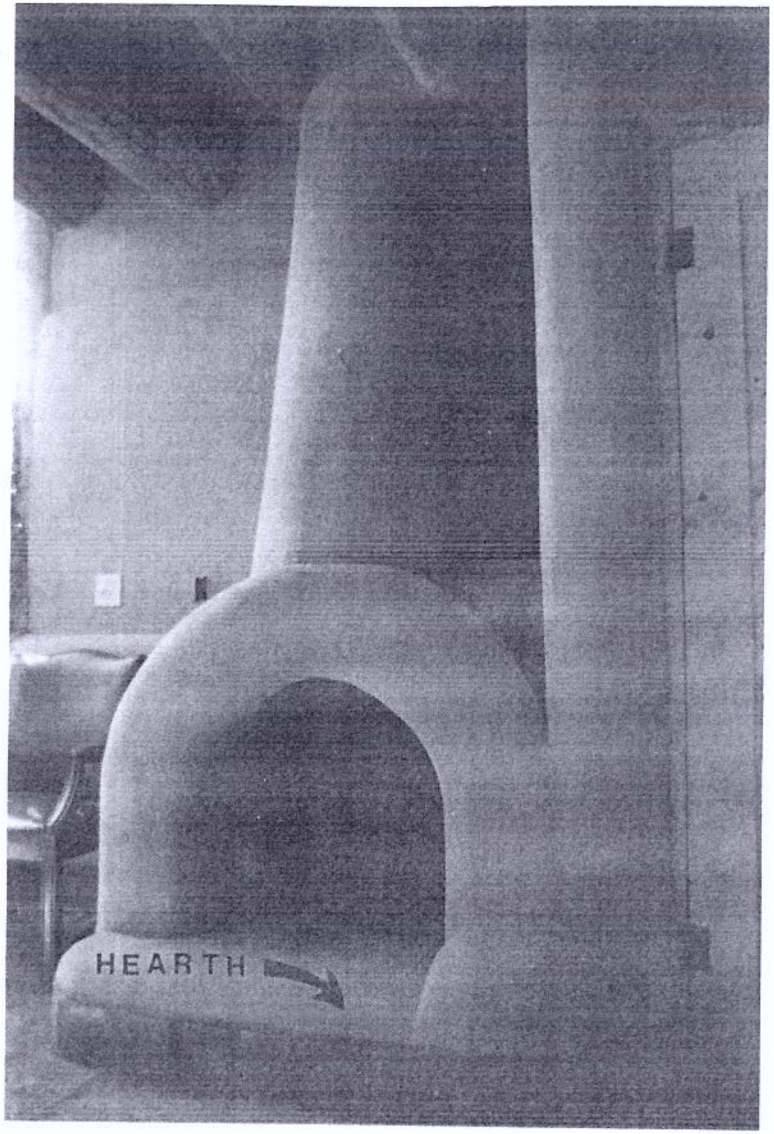
BUILDING THE FIREPLACE

FOUNDATION

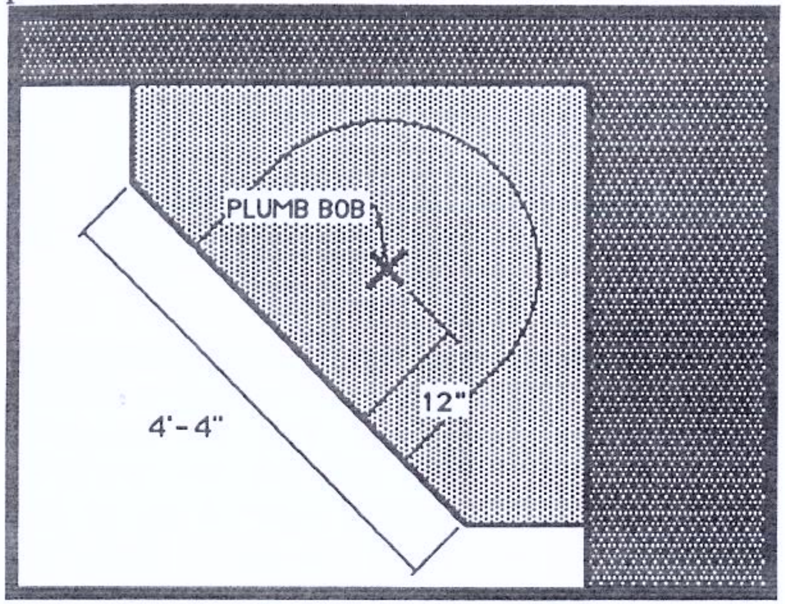
The fireplace should set on an 8" thick concrete foundation. This foundation is usually about 4'-6"x 4'-6" for an average sized fireplace against a wall. This will accommodate the fireplace and the hearth. The hearth is a code required extension in front of the fireplace usually about 16" thick.



WALL FIREPLACE



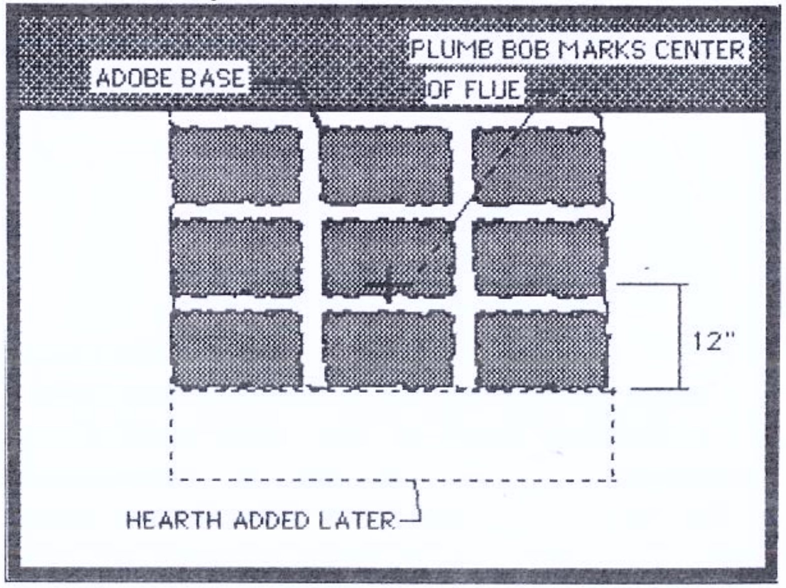
Corner fireplaces would also require a 4'-6" wide foundation, however, they are shaped a little differently, going all the way back into the corner. In both cases, center the foundation with the plumb bob from the center of the roof box.



CORNER FIREPLACE FOUNDATION

It is a good idea to lay out your fireplace on the dirt before you pour your foundation. This will insure the proper foundation size. The mix for the foundation should be a 3-4-5 mix. That is: 3 parts portland cement, four parts sand and five parts gravel added to water. The mix should be barely loose enough to pour. The foundation should have a 12" grid (see diagram previous page) of half inch rebar placed in the middle of the pour (4" from the bottom). The top of this foundation should be at the level of your subfloor. Therefore, it can usually be formed by simply digging the appropriate sized 8" deep shape out of the earthen subfloor.

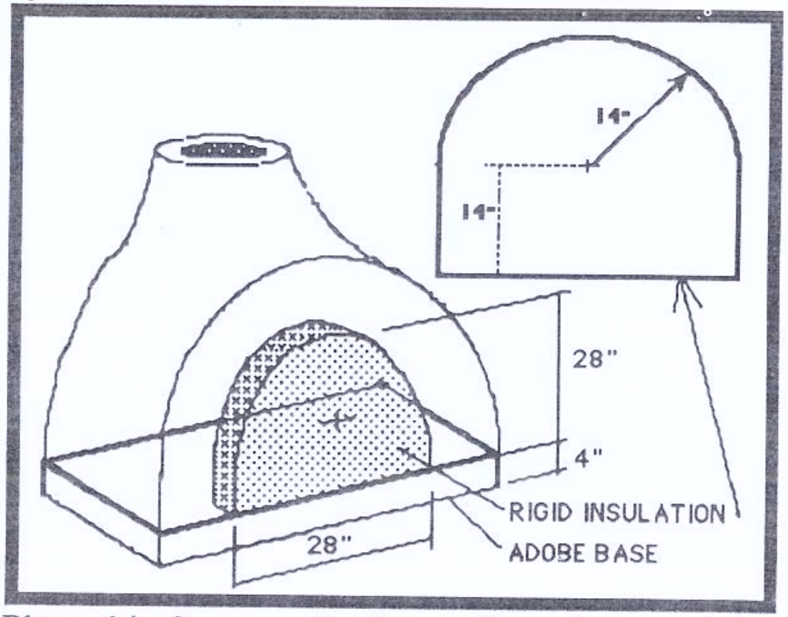
Once the foundation is poured, you can immediately lay the adobe base for the fireplace. This is done by laying adobes (which are 4" thick) up to the height that you want the fireplace above the finished floor. This height is usually about eight inches and involves at least two layers of adobes. Stagger the joints of the adobes so that <u>no</u> second layer joint is directly over a first layer joint. All that is necessary now is the base for the fireplace. The hearth comes later. The base begins 12" out from the plumbob which marks the center of your flue.



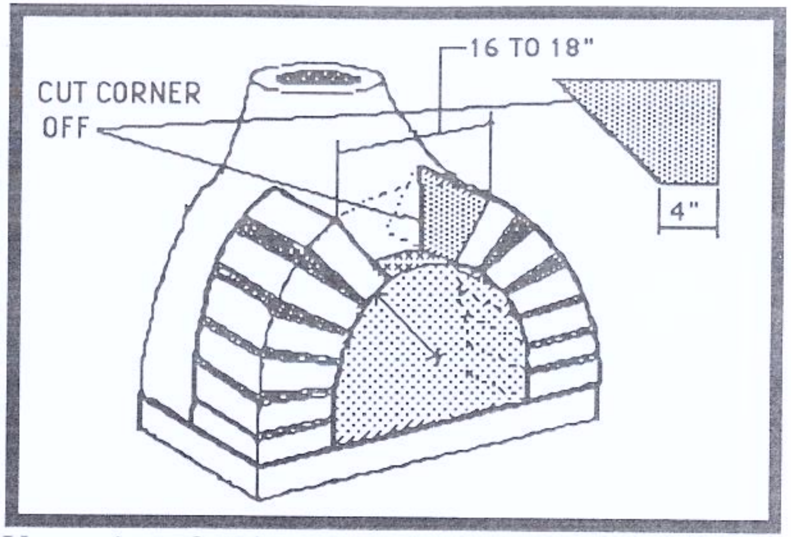
Adobes can be cut with a hand axe. Score the adobe deeply all the way around where you want to cut it and then hack it right on the score mark. You will break a few trying to learn this.

THE MOUTH

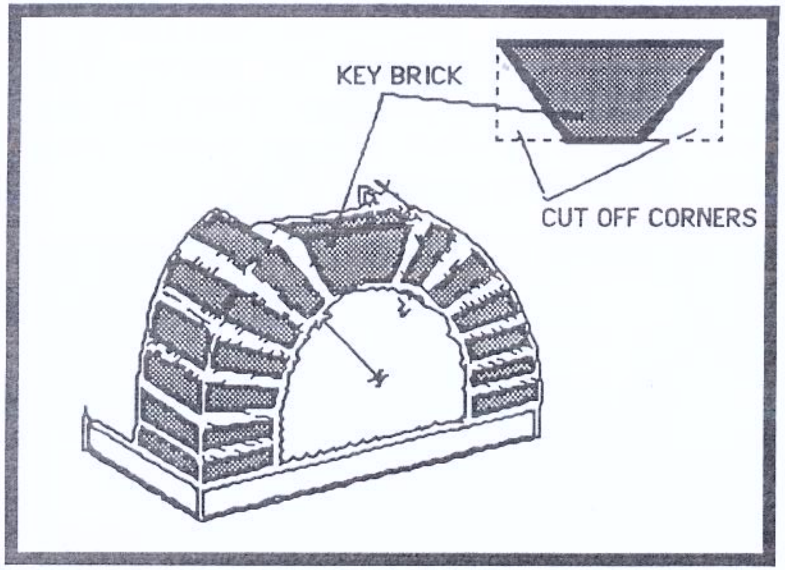
The next step is to make a form for the mouth of the fireplace. This is made from any rigid foam insulation. It should be 4" thick to support the adobes. Typical size is 28" high and 28" wide. The mud plaster will eventually bring both these dimensions down to the recommended 26" high by 26" wide.



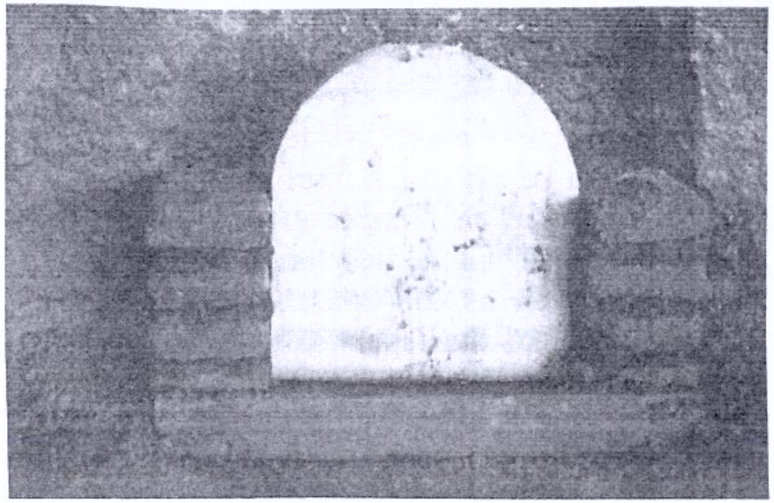
Place this form on the front edge of your adobe base. Now you can begin laying the 4"x8"x12" adobes around the form to make the box.

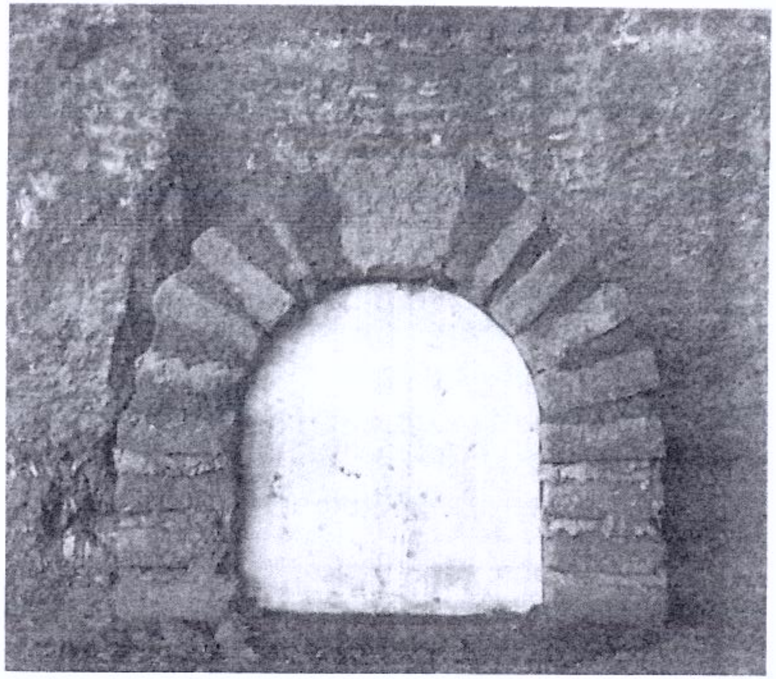


Use a 1 to 3 mix of portland cement to sand to bond the bricks together. This mix should be quite stiff (not runny). The first few bricks on either side will be stacked right on top of each other and laid with the 8" dimension facing out. When you get into the arch notice that all bricks are aimed at the center of the rigid foam form. Mark this center point clearly so it will be easy to aim at. Lay the bricks all the way up until there is a space at the very top of 16" to 18" between the top corners of the top bricks. This is the space for the "key brick". Notice that the bottom corner of the two top bricks is cut off. It is cut off as shown in the inset diagram above. Now you are ready to place the key brick. The key brick is laid standing up on its 4" edge. The corners are cut off to conform to the space left for it.



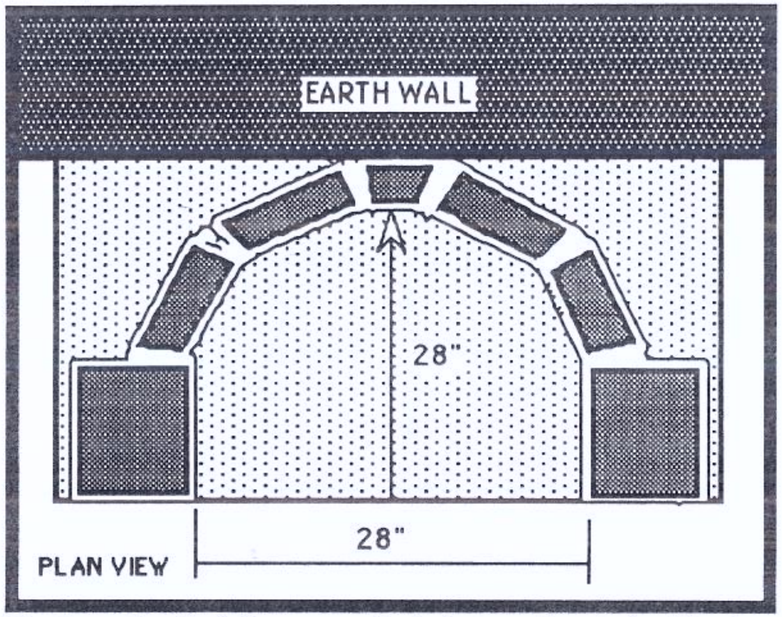
The above process of building the face of the fireplace can be done in two work sessions. Go halfway up the first session and let the cement set up a day. Then go all the way to the key brick.



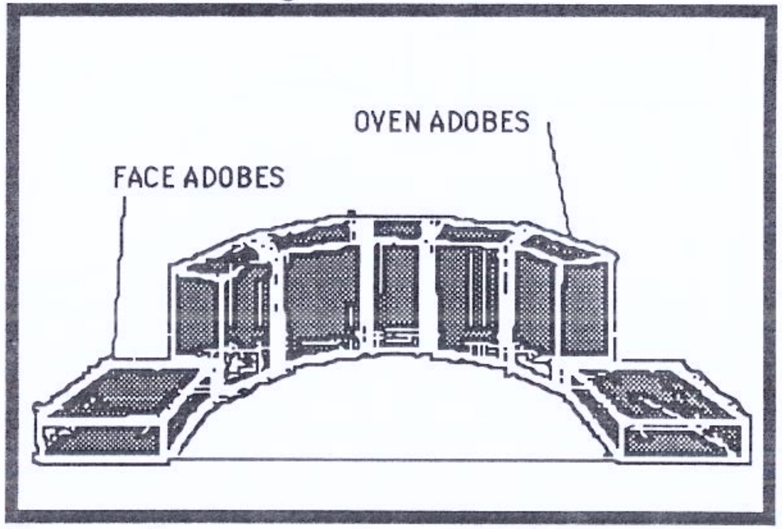


THE OVEN

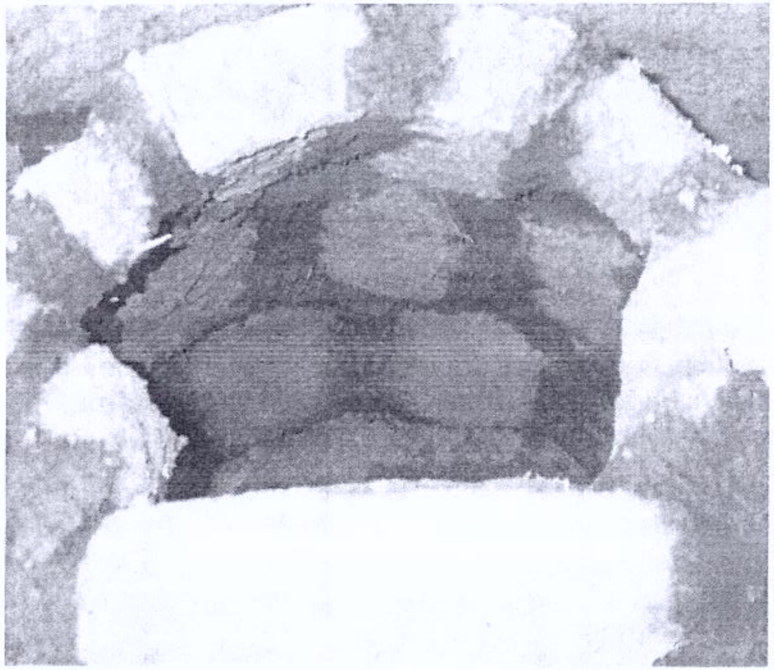
The oven can be built while the face is being built. It also takes two or three sessions to build. It starts by standing the bricks on end (in mortar) around a chalk line drawn on the foundation 28" deep and 28" wide.



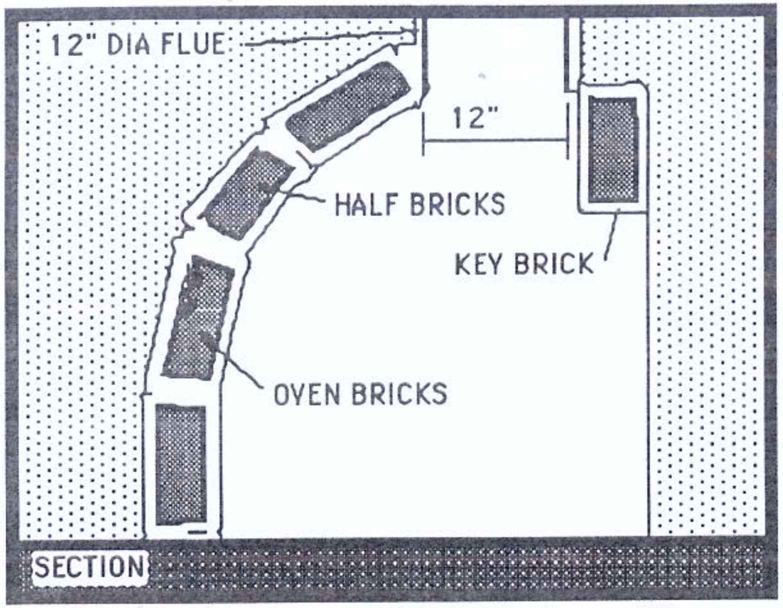
Notice the bricks are slightly wedged (with the hand axe) to fit together better.



Now another course of oven adobes standing up on edge is laid on top of the first course. This happens as the face is going up. **Don't let any joints in the second course occur over joints in the first course.**



The second course must also lean slightly toward the center to begin the funnel effect to the 12" diameter flue. The next few courses are done with half bricks. This allows a sharper arc at the top of the oven as the space gets smaller and constricts toward the flue. Keep leaning toward the 12" diam. flue opening and don't let any joints occur over joints below. This makes a stronger overall unit.



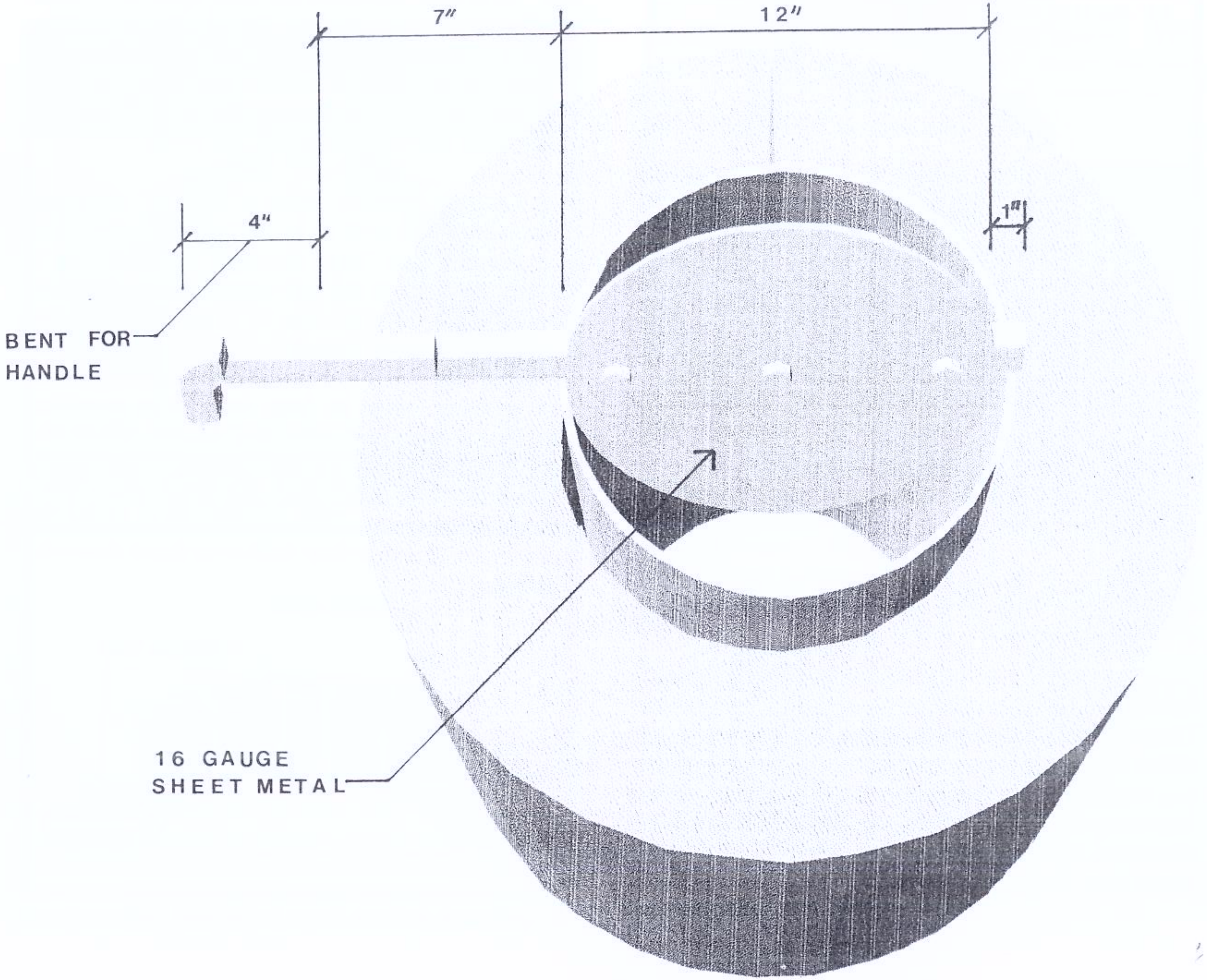
When you get to the flue opening with your adobe work, you will be ready to place the 12" diameter galvanized flue liner. Simply set it in position (as shown in the diagram above). Slightly insert it into the opening and pack cement around it. It is a 2'-0" or 3'-0" length of galvanized furnace pipe. This first section of your flue liner is where the damper usually goes.

DAMPER

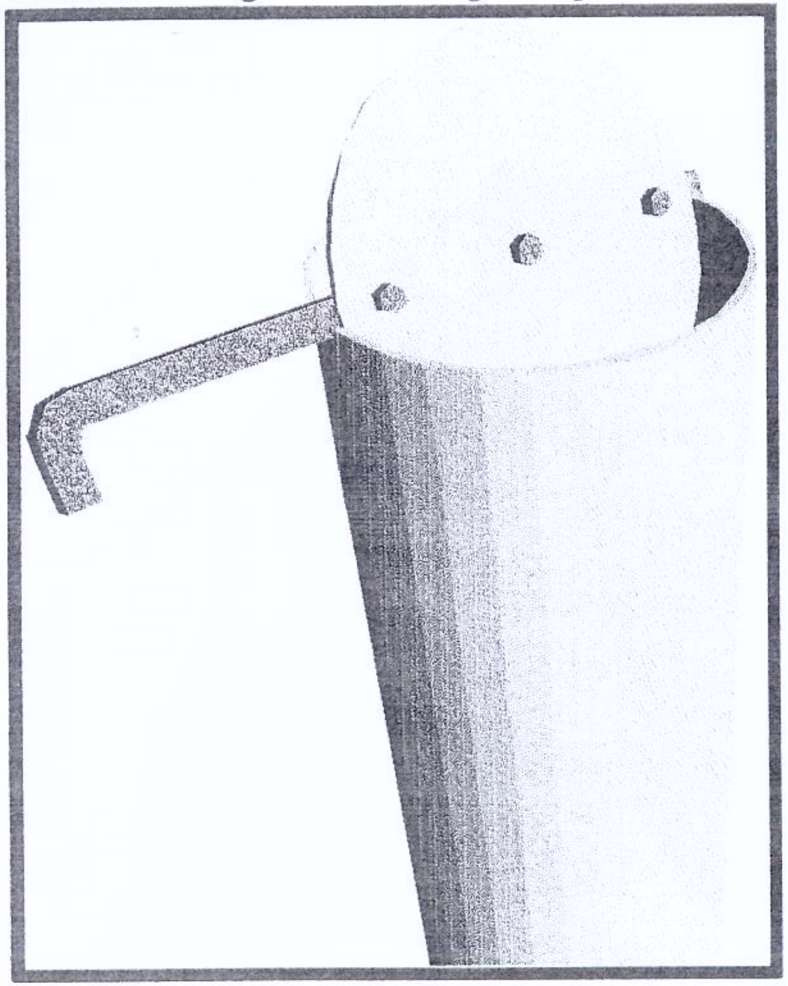
The purpose of a damper in this kind of fireplace is to block the flue when the fireplace is not in use so that back drafts from wind will not blow into your room and spread ashes all around. It is also used to block cold winter air from dropping down into the room when the fireplace is not in use. As a rule, dampers are kept open only when the fireplace is in use and closed the rest of the time. Occasionally, they are opened in the summer to aid in ventilation. The fireplace must be clean of all ashes during this time to prevent ashes from blowing back into the room.

The damper is made from a disk of 16 gauge sheet metal screwed to a 1/2" square steel rod. The disk is just large enough in diameter to scrape the sides of the galvanized metal flue liner when closed. This friction fit is all that is needed to keep the damper closed.

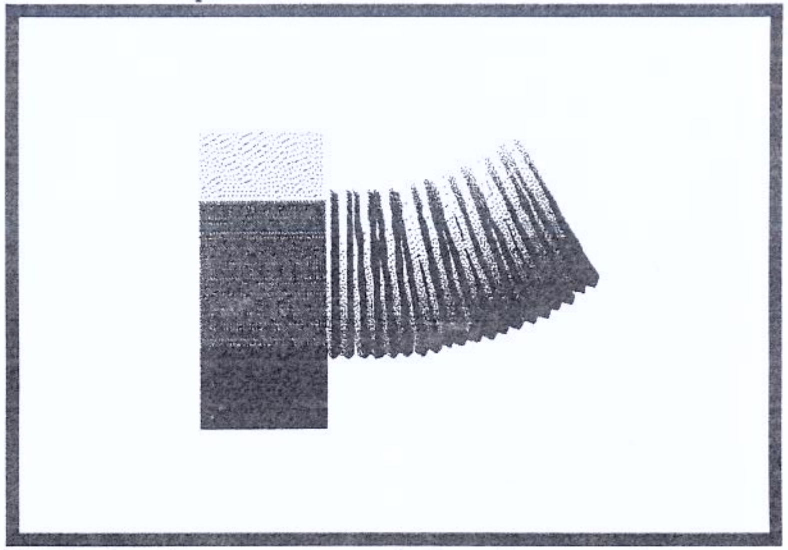
The steel rod must be long enough to penetrate one side of the flue liner and extend about one inch. It must also extend through the adobe chimney on the other side and bend down for a handle in the room . This usually takes about 20" overall plus another four inches to bend down for a handle.


7"
12"
4"
1"
BENT FOR HANDLE
16 GAUGE SHEET METAL

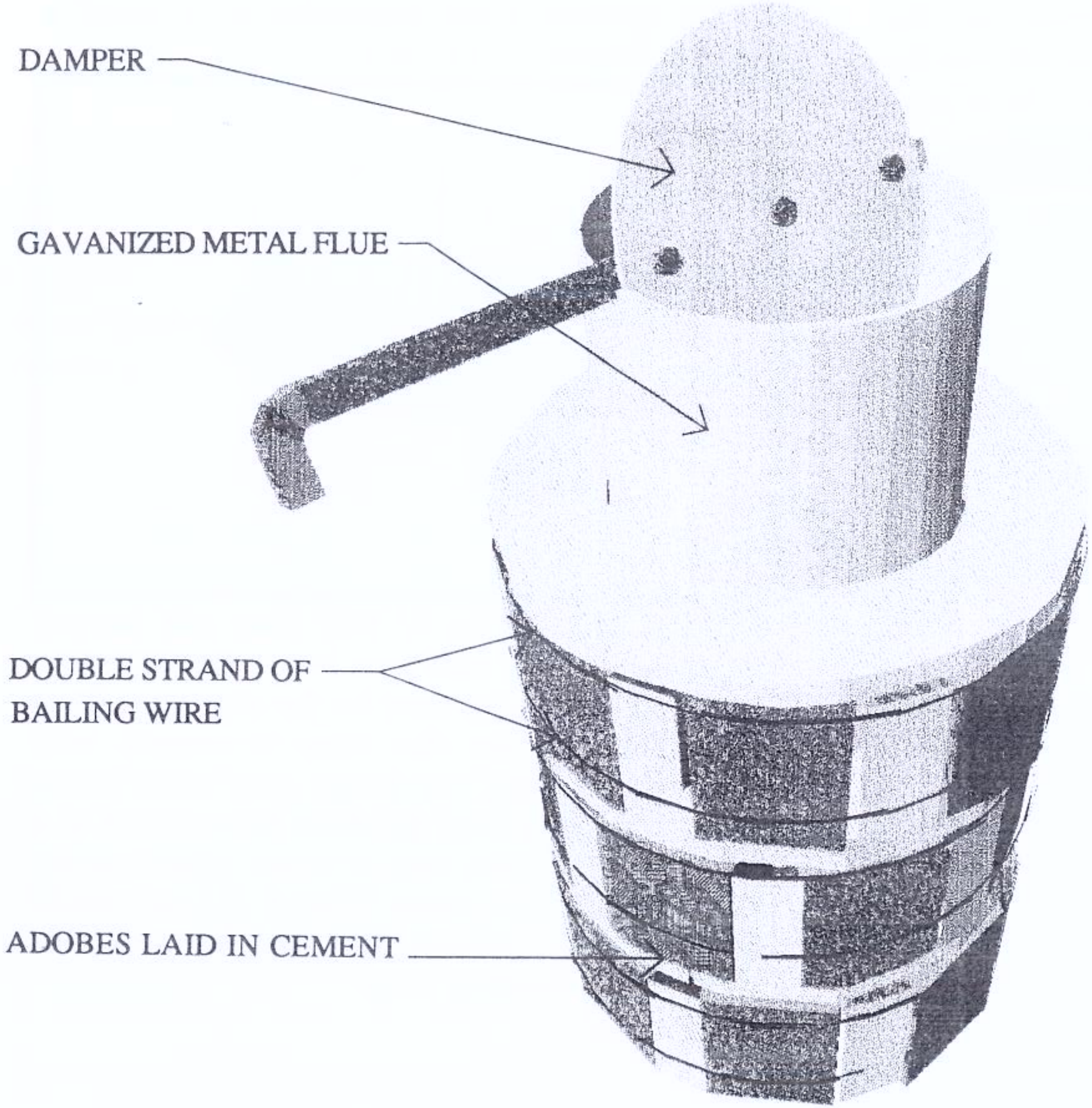
The damper can be ordered from a sheet metal shop. The steel rod is drilled to receive at least three small bolts for holding the disk to the rod. Upon installation, the disk is unscrewed and the rod is inserted through two holes punched into the galvanized flue liner. The holes must be aligned at the same height and 180 degrees apart.



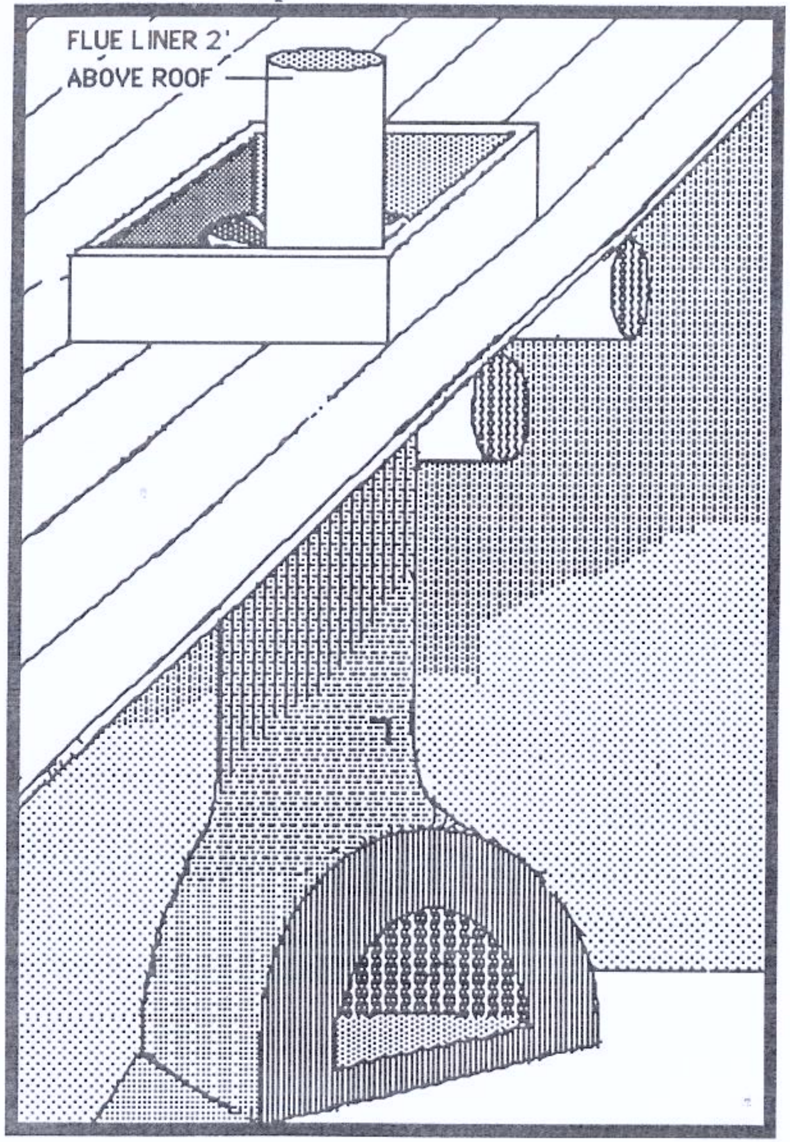
Insert the rod and then bolt the 16 ga. steel disk back on. Now the bolts must be bent on the ends to prevent the disk from coming loose. It would be very difficult if not impossible to re-install it after the fireplace is finished.



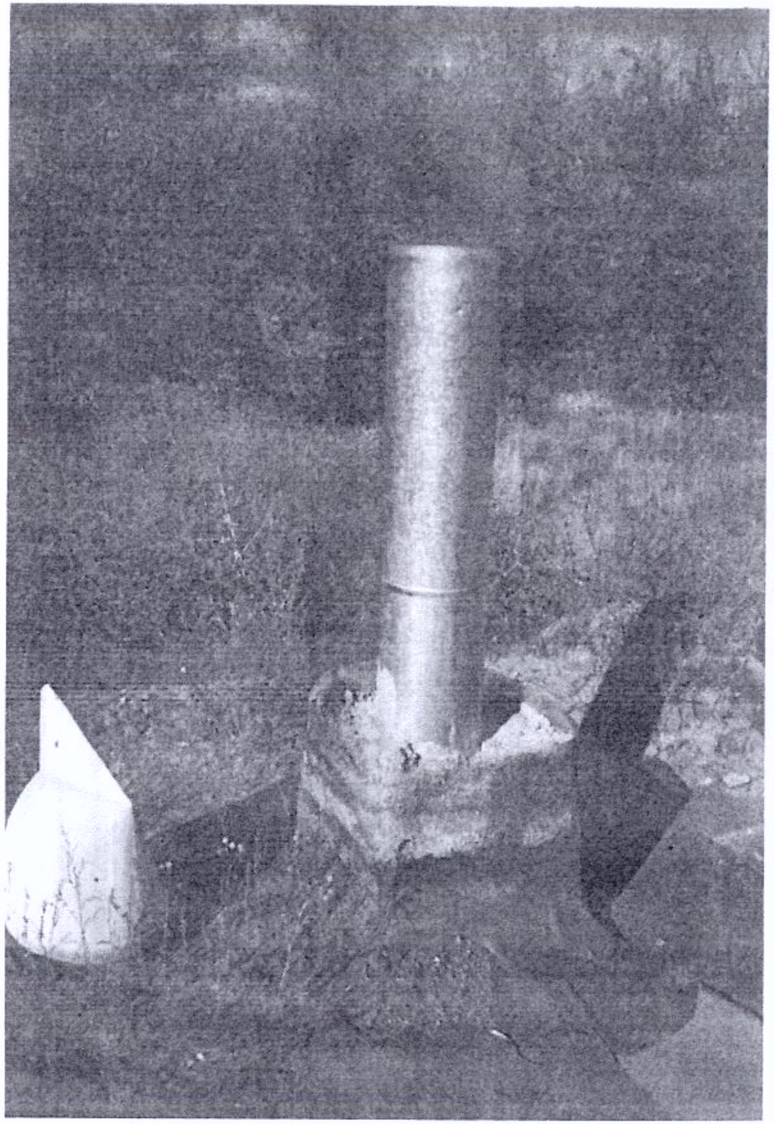
With the first section of flue liner and damper installed, you are ready to begin the chimney. Half adobe bricks are used for the chimney. They are laid around the flue liner in cement with staggered coursing (no joints over other joints below). You can only go about two courses at a time. Then you must stop to let the cement set up before you do two more. Every course should have two double strands of bailing wire wrapped around it as a banding strap.


DAMPER
GAVANIZED METAL FLUE
DOUBLE STRAND OF
BAILING WIRE
ADOBES LAID IN CEMENT

The chimney is now taken up to the roof box described on page 108. At the bottom of the roof box the adobe stops.

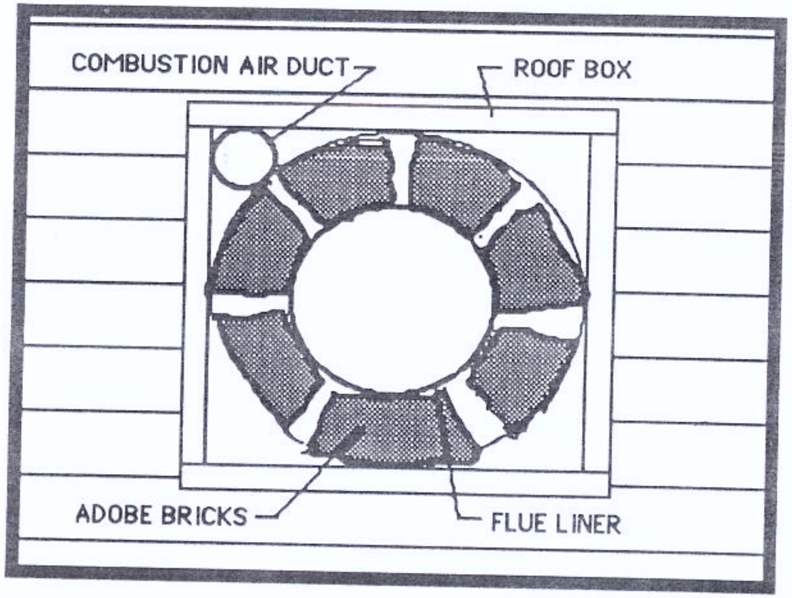


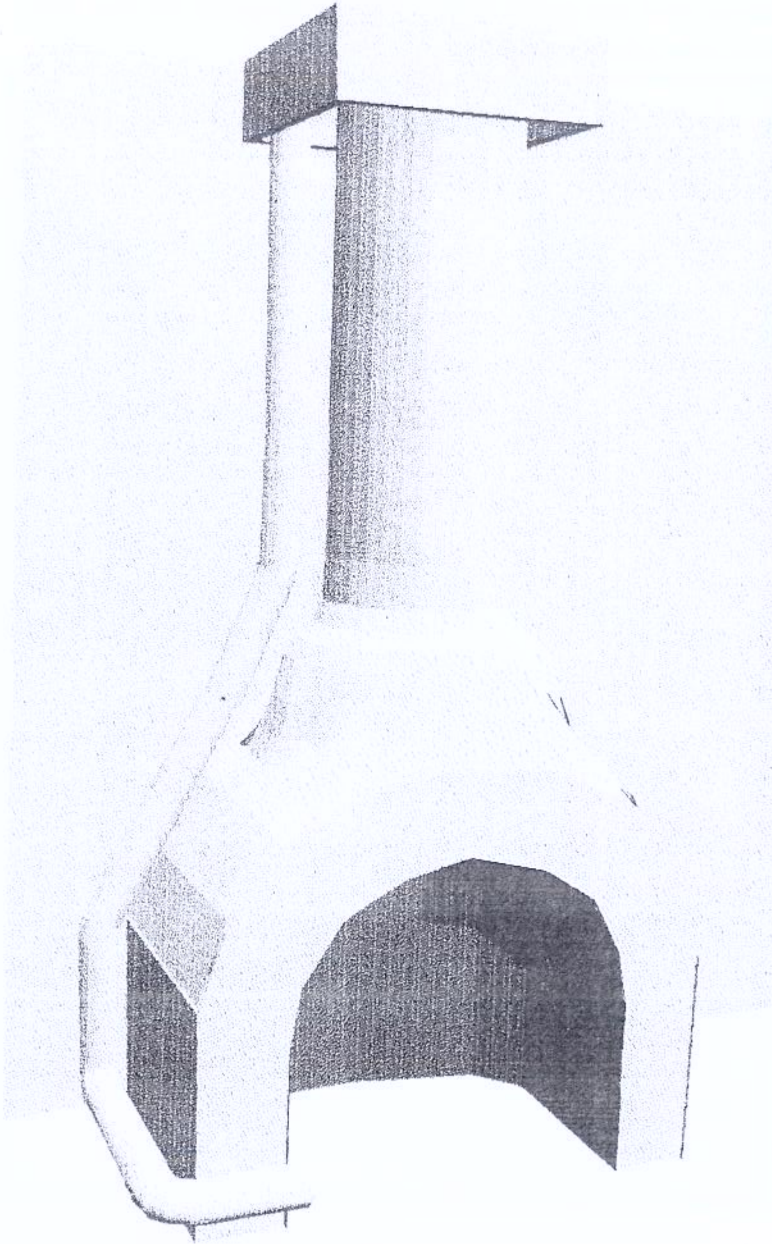
The flue liner is extended up at least two feet above the roof. It must be two feet above anything within ten feet from it.

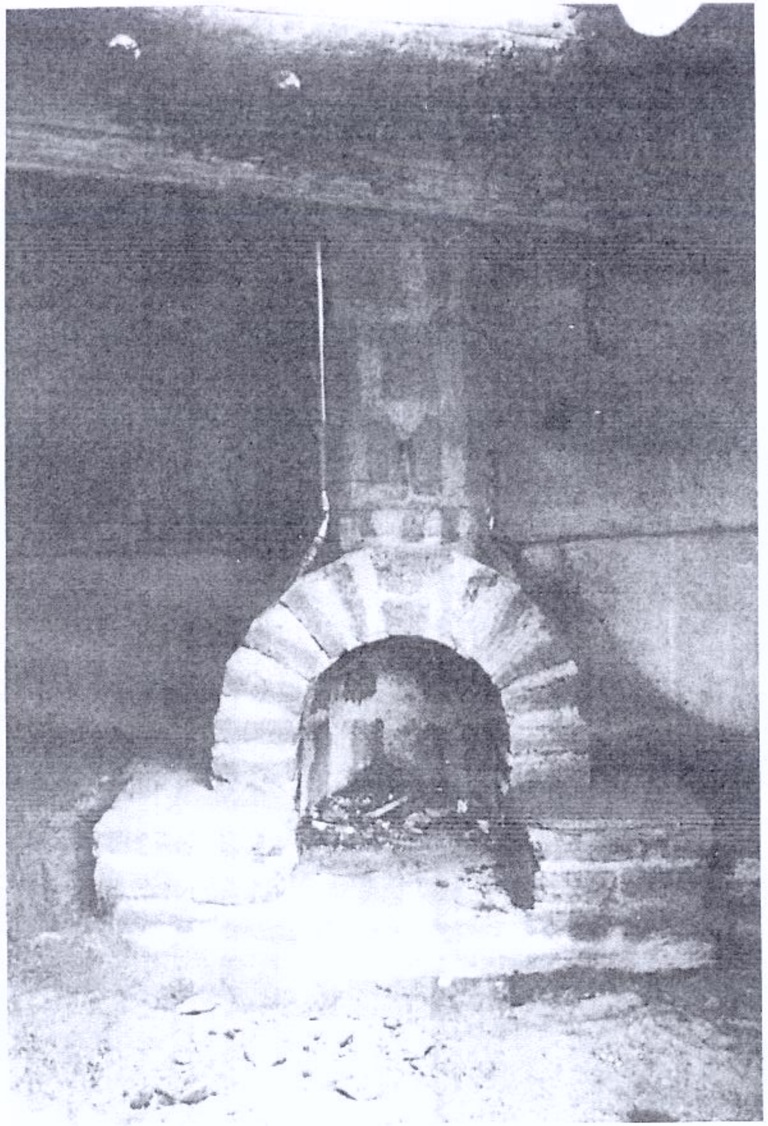


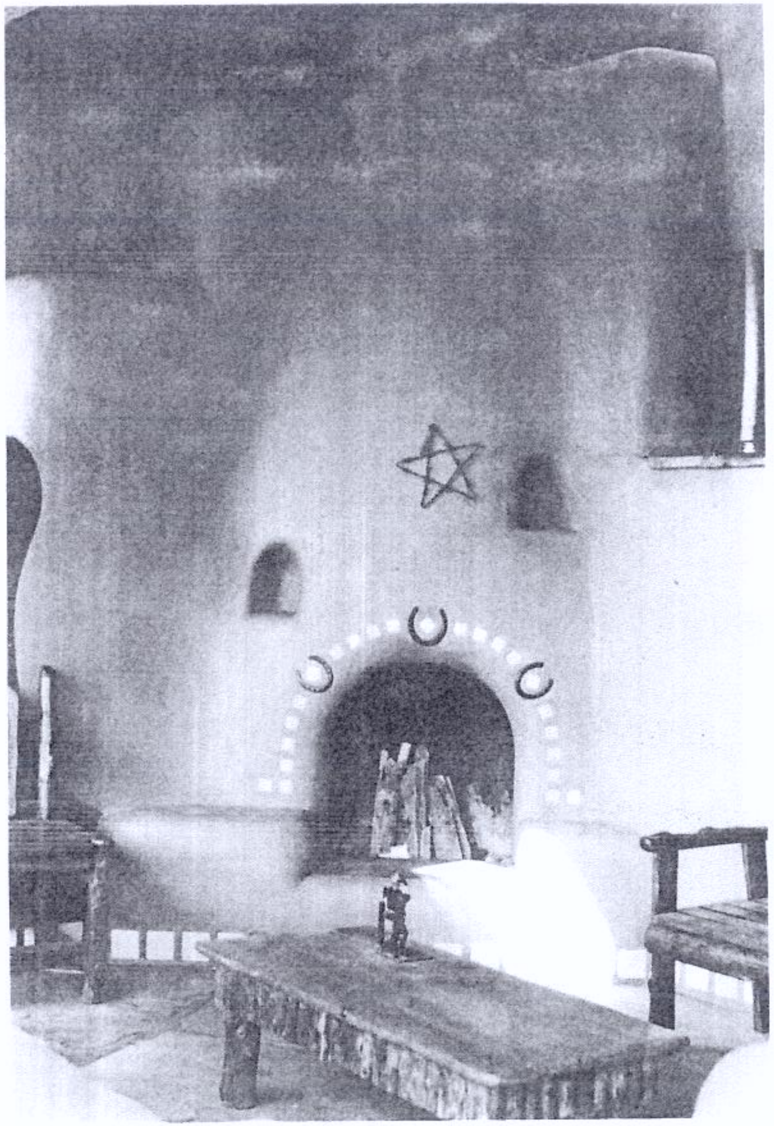
COMBUSTION AIR DUCT

Earthships have the potential of being shut up very tight with few, if any, drafts. For this reason a 4" diameter fresh combustion air duct must be installed at the base of the mouth of the fireplace. It is best made from a flexible metal duct material (see Appendix, Chapter 6). It is laid in place and built into part of the hearth, tucked into a corner then taken out through a corner of the wood roof box.

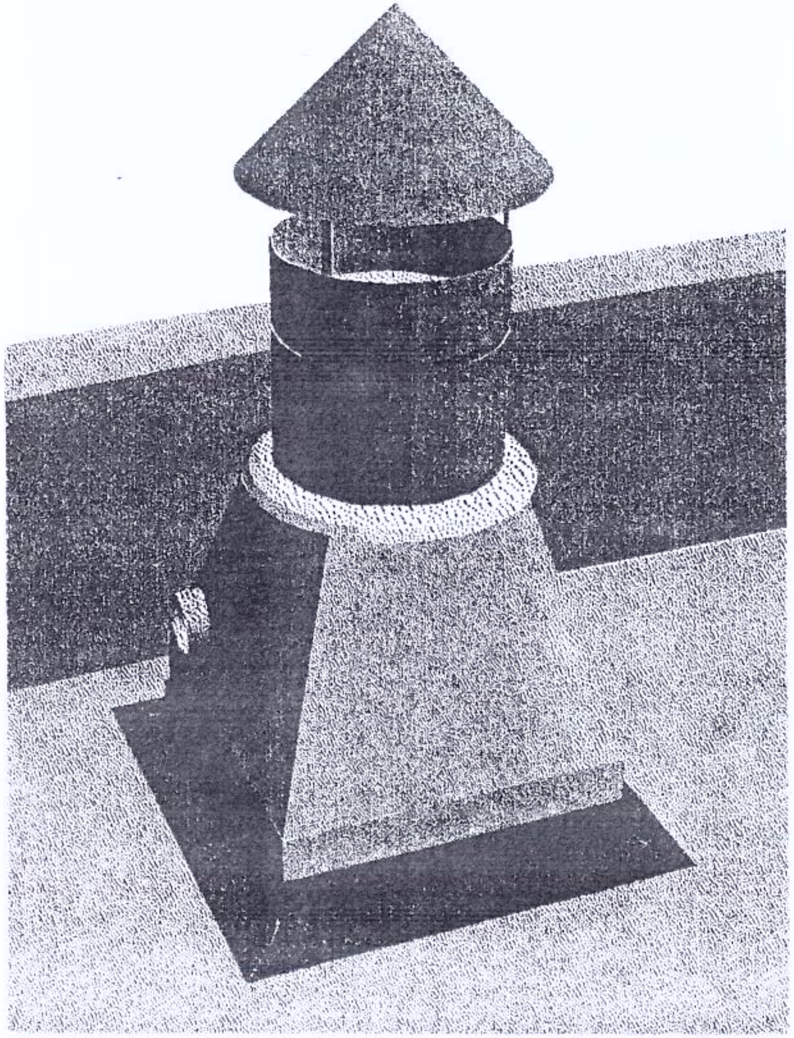




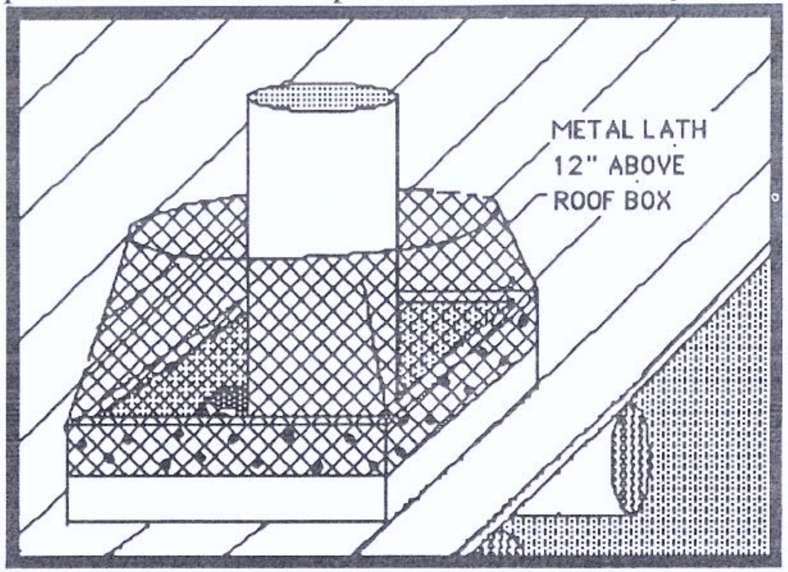




Outside and above the roof, the cumbustion air duct is turned out and down and poured into a pumicecrete (light weight concrete) chimney cowling.

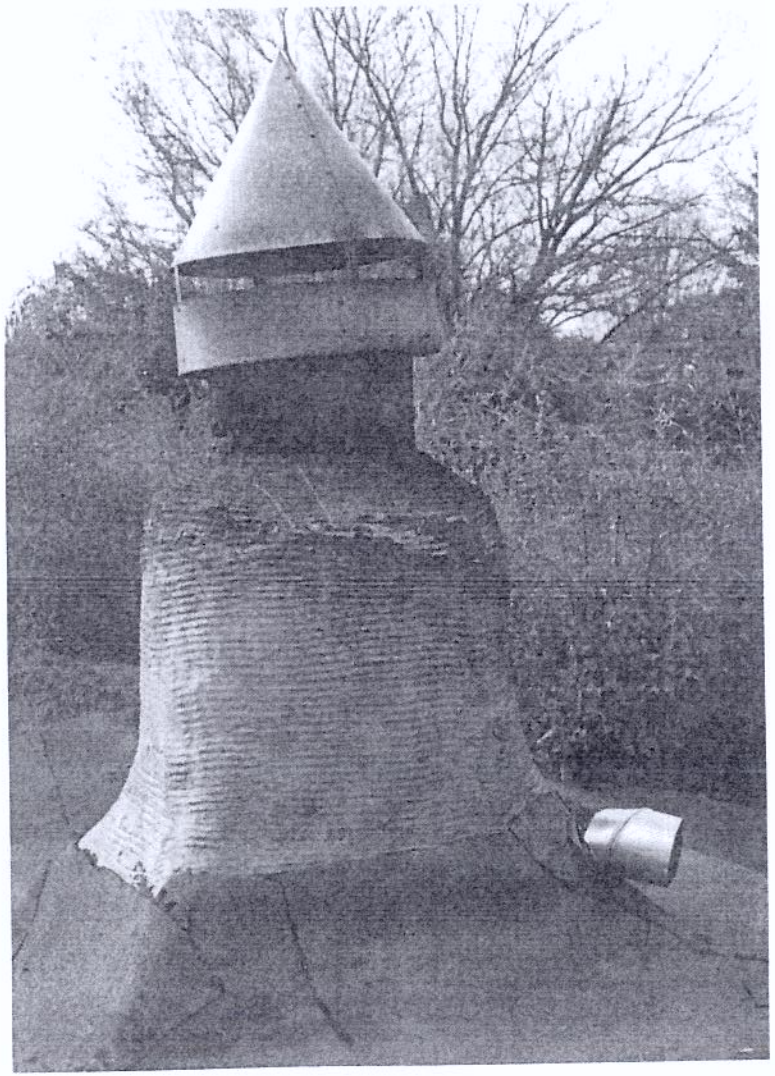


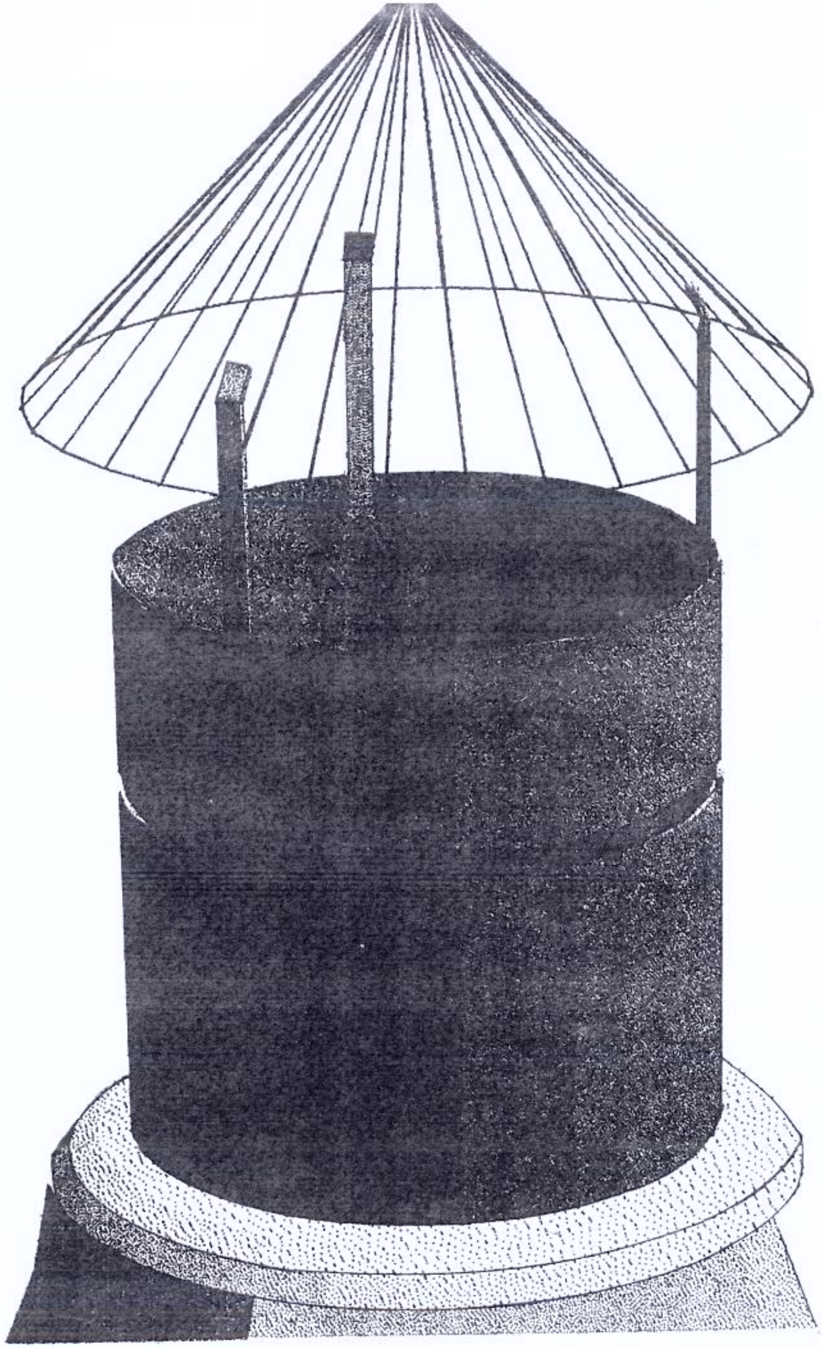
A form made from metal lath is built around the metal flue liner for a height of at least 12 " above the roof box. This is to form the poured pumicecrete exterior portion of the chimney.



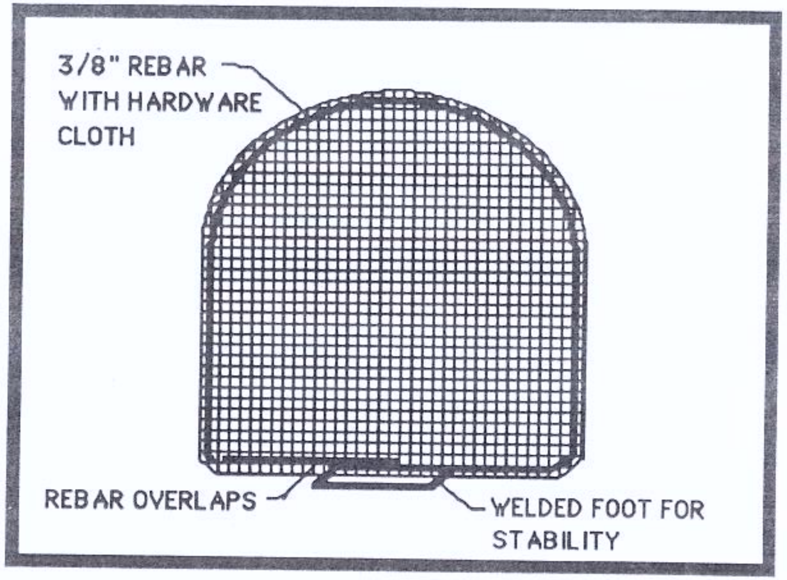
Adobe will deteriorate when used on the exterior. For this reason the pumicecrete (made from three parts cement to ten parts pumice) is used. If pumice is hard to find, regular sand/cement (3 to 1) can be used, however, pumice is lighter and is a better material for this application. Silicone caulking is now applied around the joint between the pumicecrete and the flue liner and then conventional scratch plaster and stucco are used to finish the short chimney extension.

A wind/rain hood is used to help prevent back drafts and rainfall down the chimney. They can be ordered from your local sheet metal shop. Twelve inch rain hoods are sometimes hard to find. If this is the case you can have your local sheet metal shop make one as per the accompanying diagram.

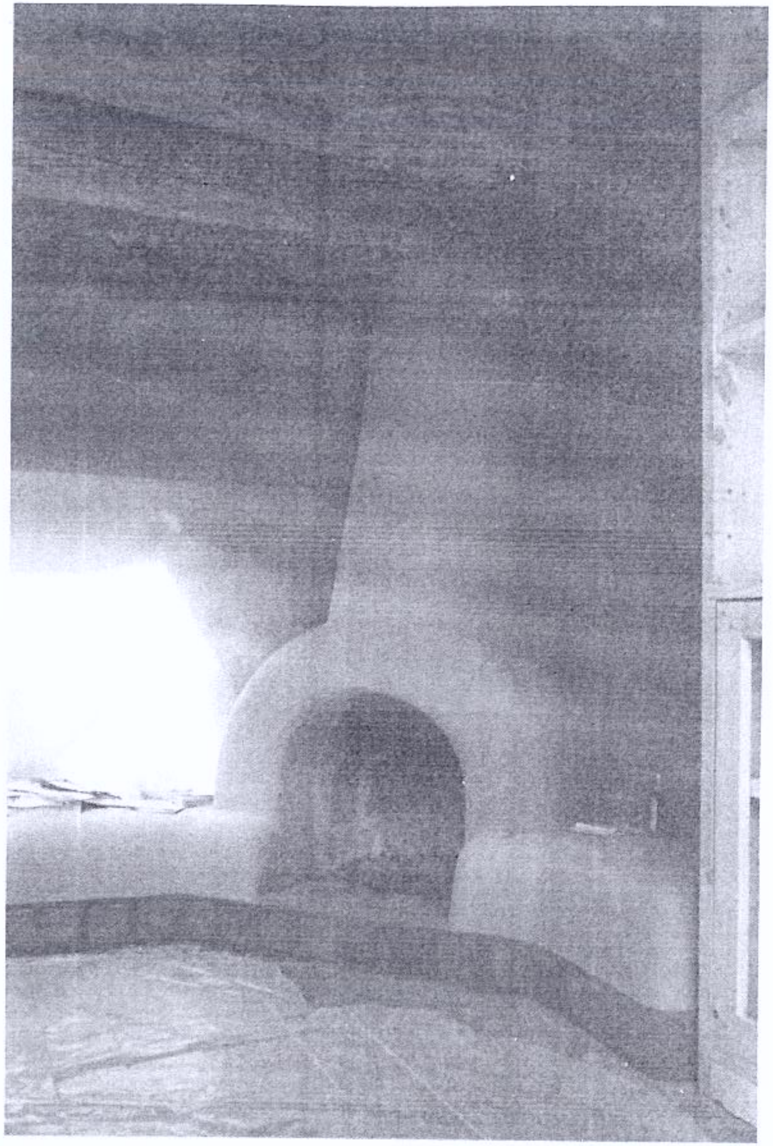


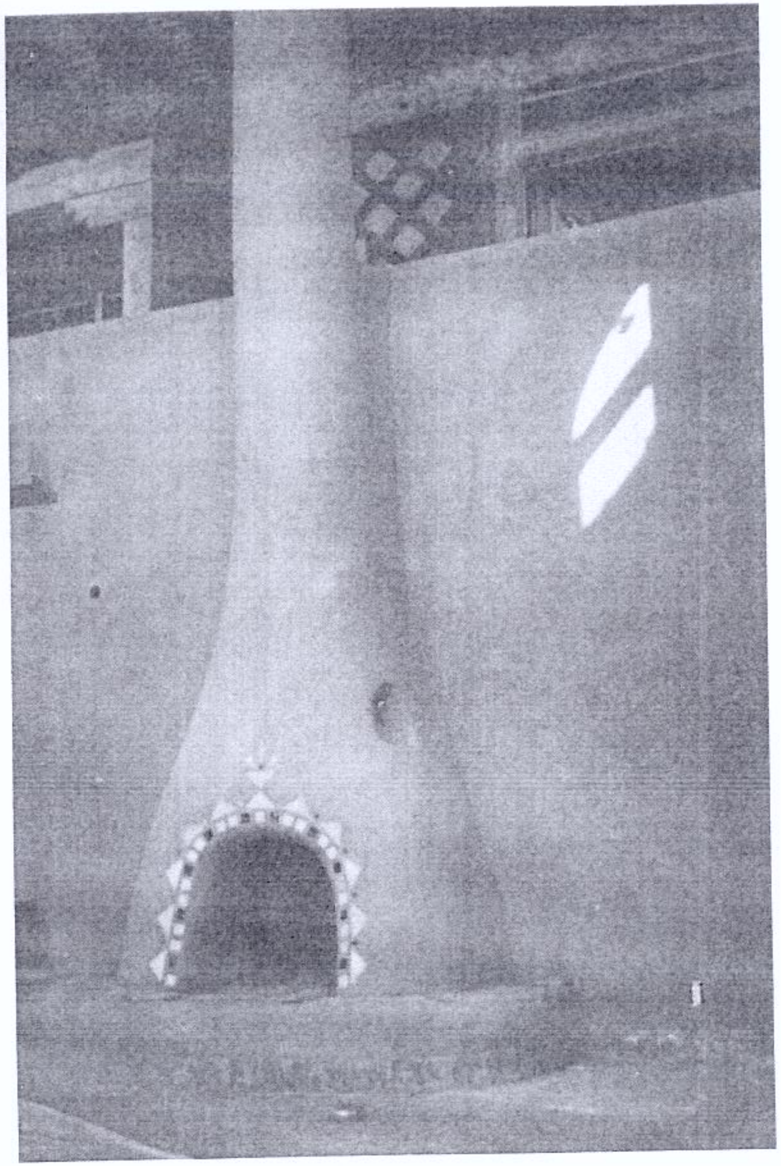


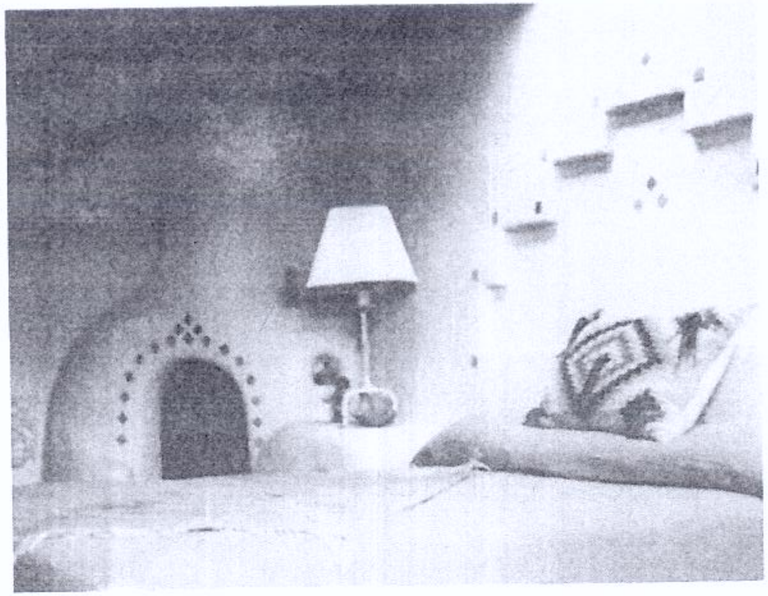
You now have a functional fireplace. It can be finished as per the mud plaster instructions in Chapter 9, Volume I. Where wood or carpet floors are used, a 16" minimum hearth is recommended. A custom screen can be made by shaping 3/8" rebar to the mouth of the fireplace and wiring 1/4" hardware cloth to the rebar frame.

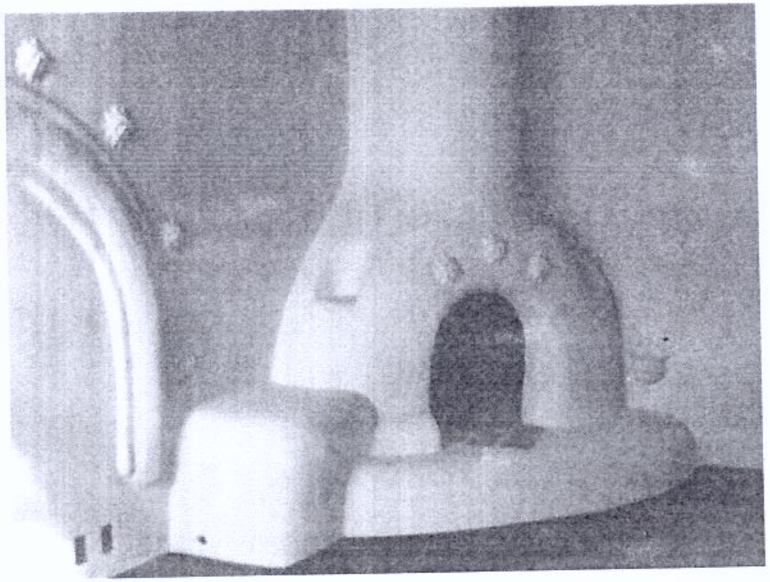


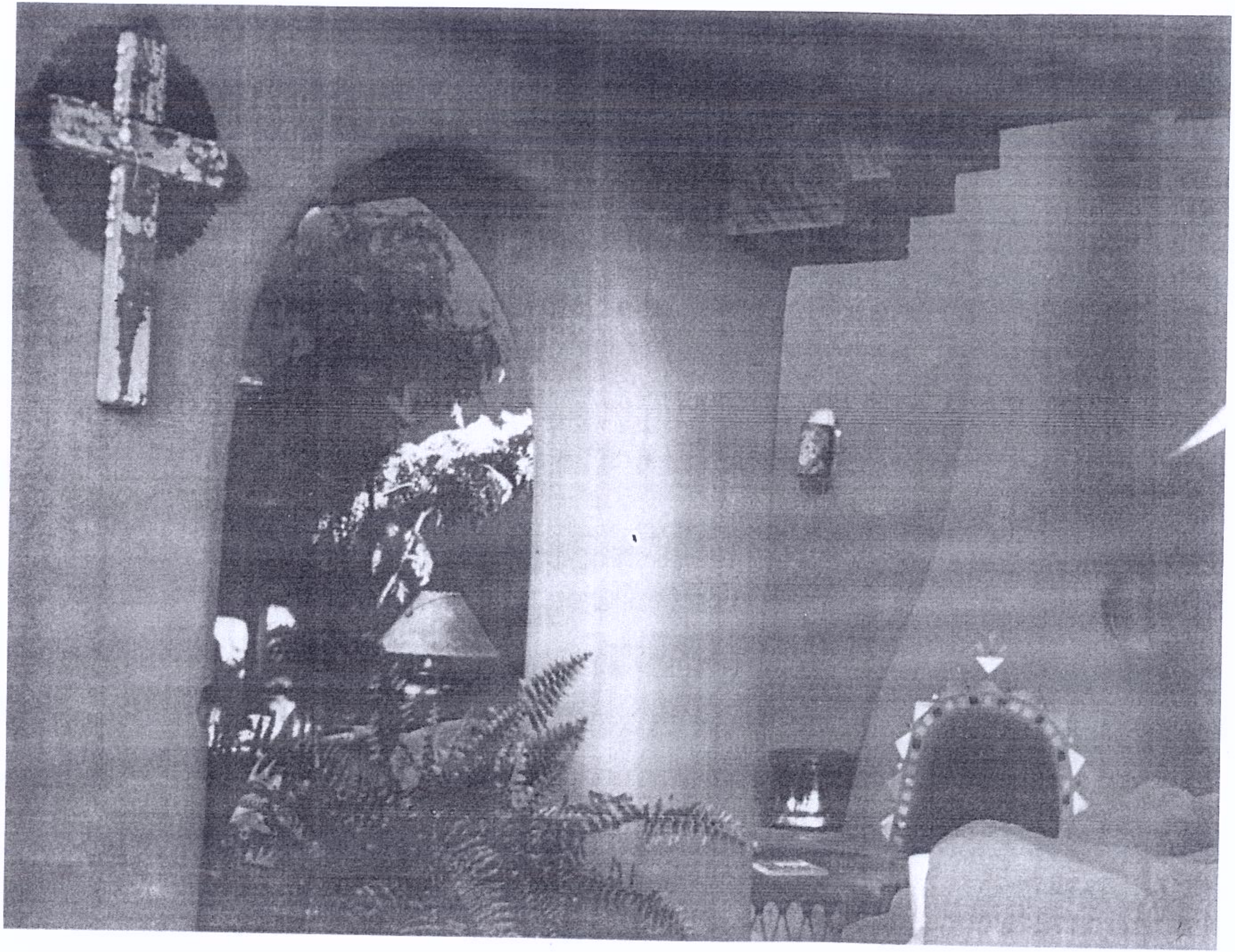
Following are some typical Earthship fireplaces.











APPENDIX

Flexiliner

4" flexible flue liner comes in a variety of extendable lengths.
Order from SSA
Box 1041, Taos, NM 87571
(505) 758-9870

Adobes

Order from Adobe Factory
PO Box 165
Alcalde, NM 87511
(505) 852-4131

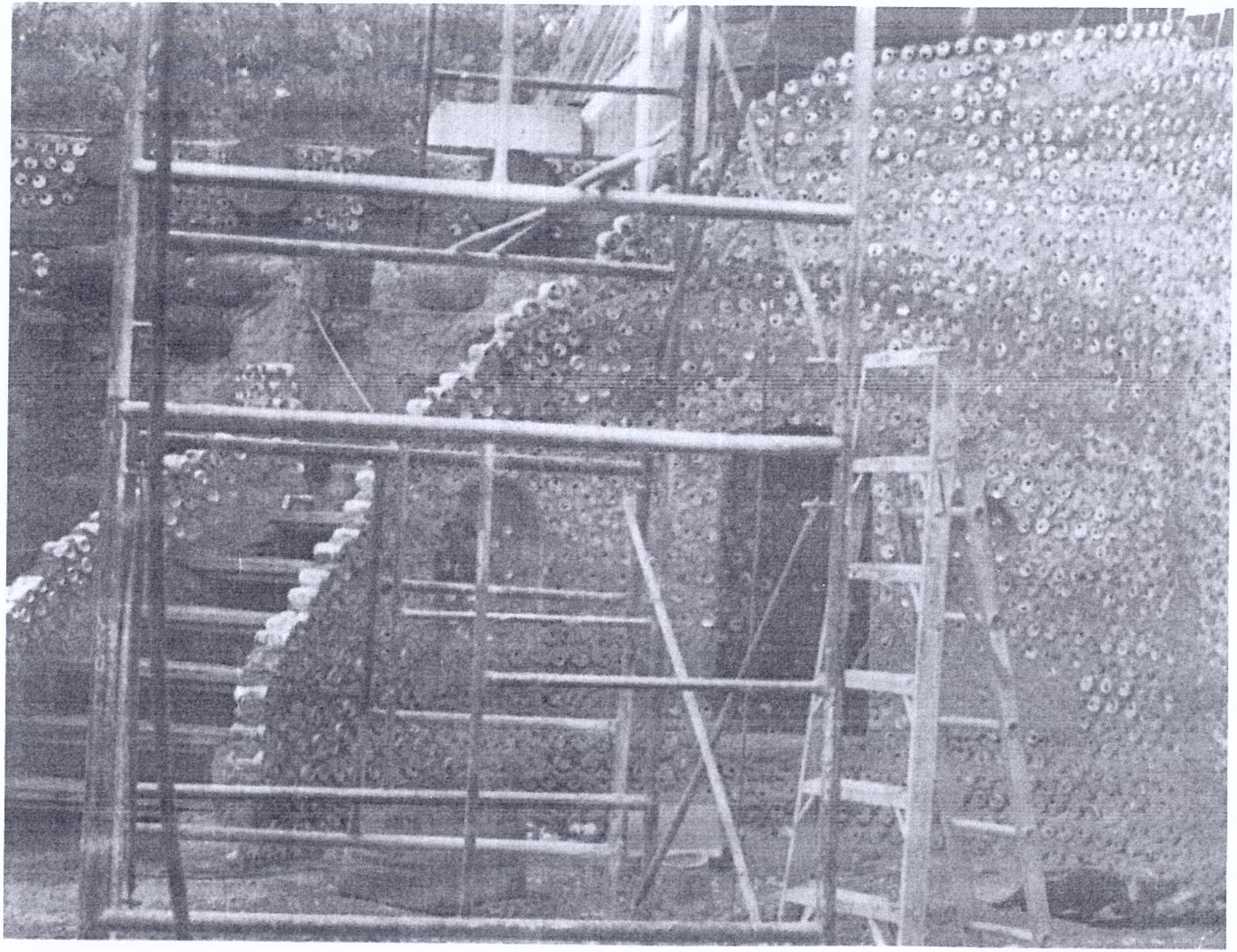
Books on Making Adobes

Adobe Bricks in New Mexico by Edward Smith
Published by New Mexico Bureau of Mines and Mineral Resources

Adobe and Rammed Earth Buildings - Design and Construction by Paul Graham McHenry, Jr.
University of Arizona Press

Adobe: A Comprehensive Bibliography by Rex C. Hopson
The Lightning Tree - Jene Lyon Publishing

These books available at Moby Dickens Bookshop 124-A Bent St. Taos, NM 87571 (505) 758-3050, or check with your local public library.



7. STAIRWAYS

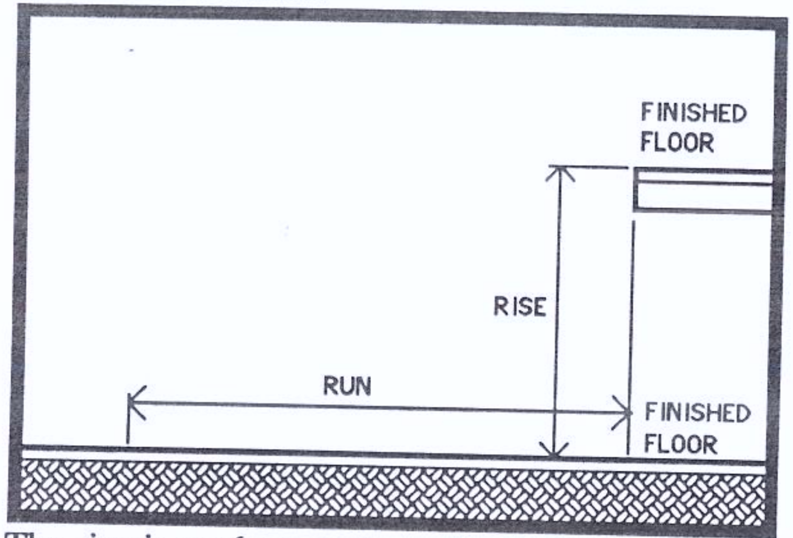
COMPONENTS

A STAIRWAY CAN SIMPLY BE A WAY OF GETTING FROM ONE FLOOR TO THE NEXT OR IT CAN BE A PIECE OF SCULPTURE THAT ADDS BEAUTY AND GRACE TO THE HOME WHILE PROVIDING TRAVEL BETWEEN LEVELS. CONVENTIONAL STAIRWAYS ARE USUALLY COMPLICATED AND EXPENSIVE IF THEY HAVE THIS BEAUTY AND GRACE. IF THEY ARE FAIRLY SIMPLE AND INEXPENSIVE, THEY USUALLY ADD NOTHING TO THE HOME AND SOMETIMES DETRACT FROM IT. THE METHOD OF BUILDING STAIRWAYS PRESENTED IN THIS CHAPTER ALLOWS FOR AN INEXPENSIVE STAIRWAY THAT CAN BE BEAUTIFUL, GRACEFUL *AND* SIMPLE - SIMPLE ENOUGH THAT AN UNSKILLED HOMEOWNER CAN DESIGN AND BUILD ONE HIM/HERSELF.

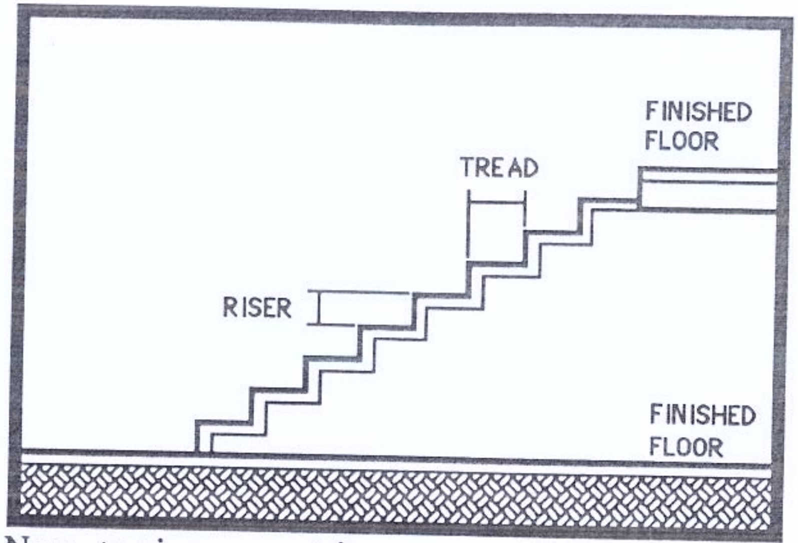
A CONVENTIONAL STAIRWAY IN A FRAME HOUSE IS MADE WITH THE SAME MATERIALS AND SKILLS THAT THE HOUSE ITSELF IS MADE OF, THOUGH THE TECHNIQUES ARE SOMEWHAT MORE DIFFICULT. AN EARTHSHIP STAIRWAY ALSO EMPLOYS THE SAME MATERIALS AND SKILLS USED IN BUILDING THE INITIAL BUILDING, HOWEVER, IN THIS CASE, THE TECHNIQUES ARE NO MORE DIFFICULT THAN THOSE USED IN BUILDING THE HOME. ONE INITIAL PURPOSE OF THE EARTHSHIP DESIGN WAS TO MAKE IT AVAILABLE TO AND WITHIN THE GRASP OF THE AVERAGE PERSON. THE SAME IS TRUE WITH THE COMPONENTS OF THE EARTHSHIP. *IF YOU CAN BUILD AN EARTHSHIP, YOU CAN BUILD AN EARTHSHIP STAIRWAY.*

THE BASICS OF A STAIRWAY

The first step in building a stairway is sizing. This is accomplished by determining the rise and the run of the stairway. The rise is the total distance you want to travel (vertically) between levels, i.e. the floor to floor distance. The run is how far (horizontally) it will take you to travel the vertical distance.



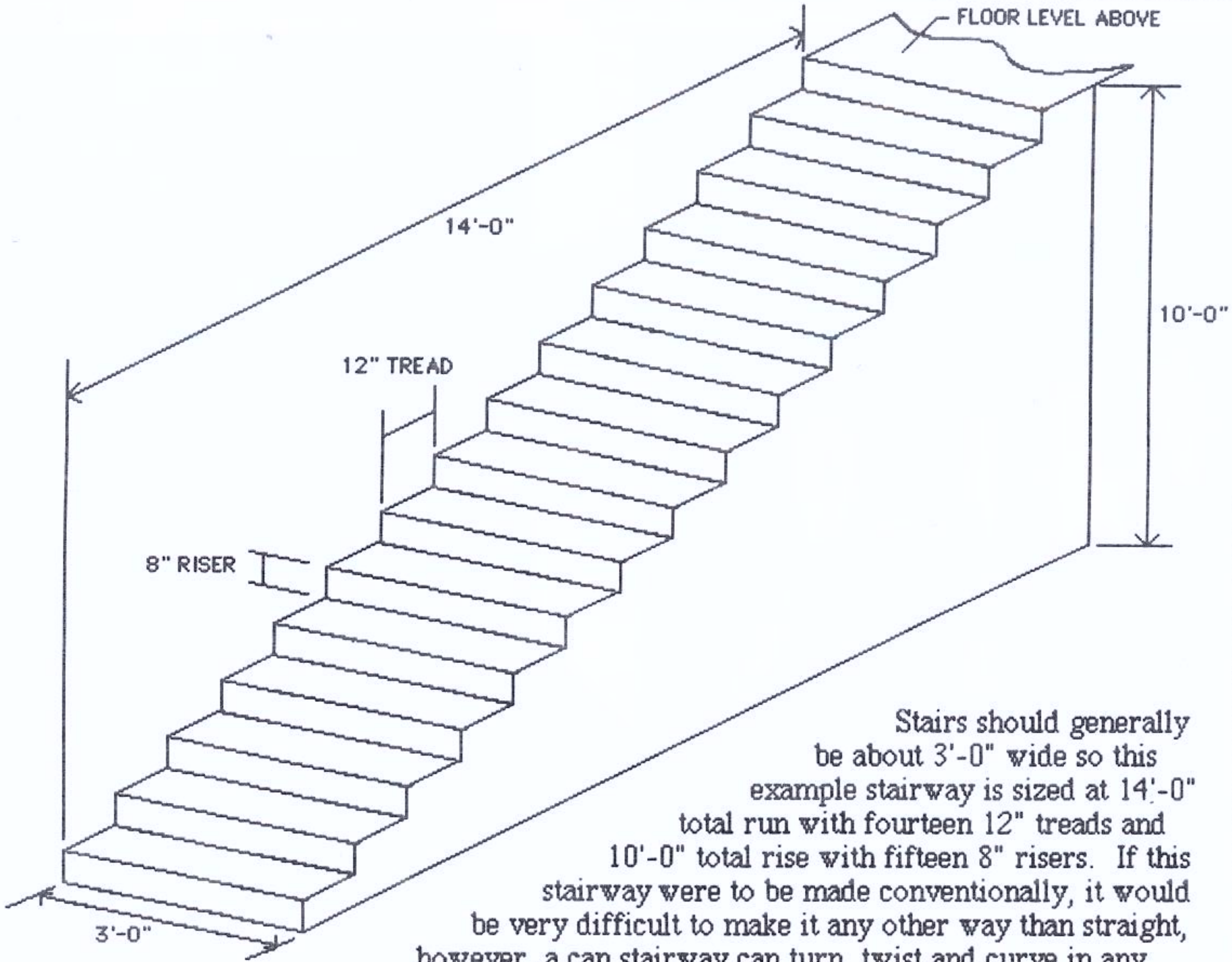
The rise is made up with a series of **risers** all of which should be about 8" tall. The run is made up of a series of **treads** all of which should be about 12" wide. These sizes make a comfortable stair for the average sized human.



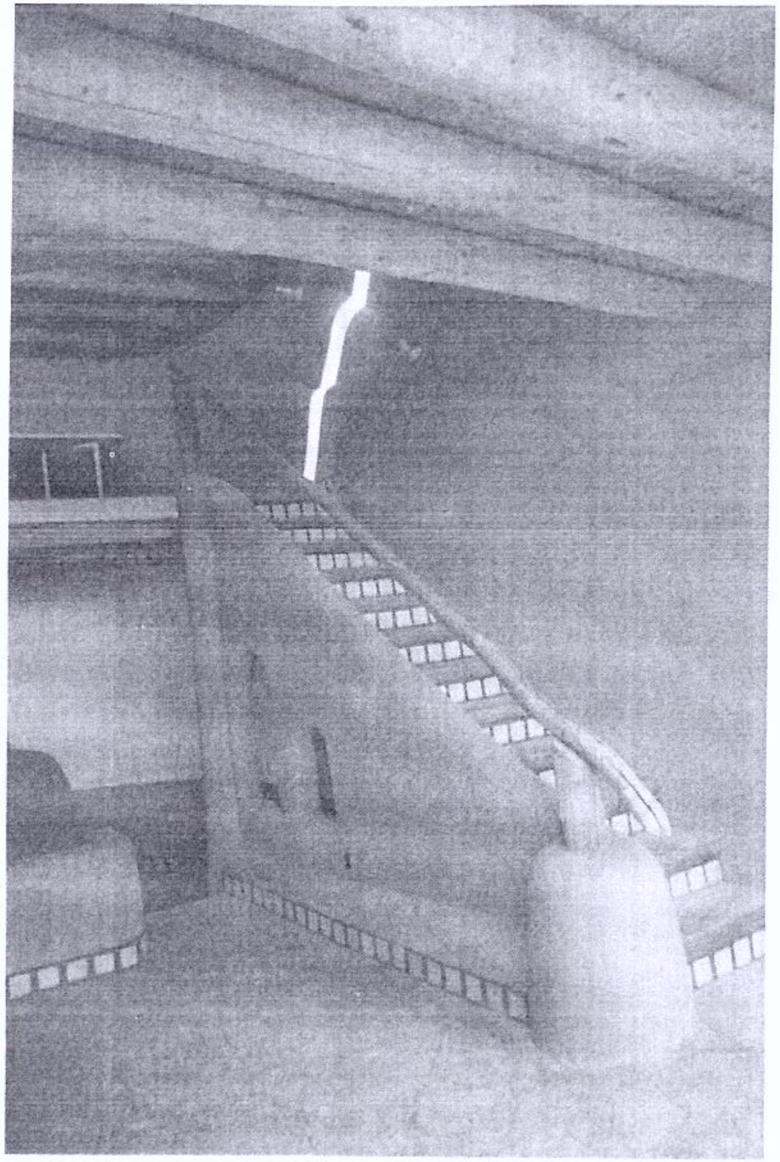
Now, to size your stairway you take your floor to floor height and convert it to inches and divide by eight. This will tell you how many risers you need to go the distance. If it doesn't come out even with 8" then some fraction close to (over or under) 8" will do.

EXAMPLE - Floor to floor distance is 10'-0". This is 120 inches. 120 divided by 8 is 15. Therefore you would have 15 risers.

You always have one less tread than risers because the upper level itself is the last tread. Therefore, the stair in the above example would have 14 treads. Since each tread wants to be about 12", the total run on this stair would be 14'-0".

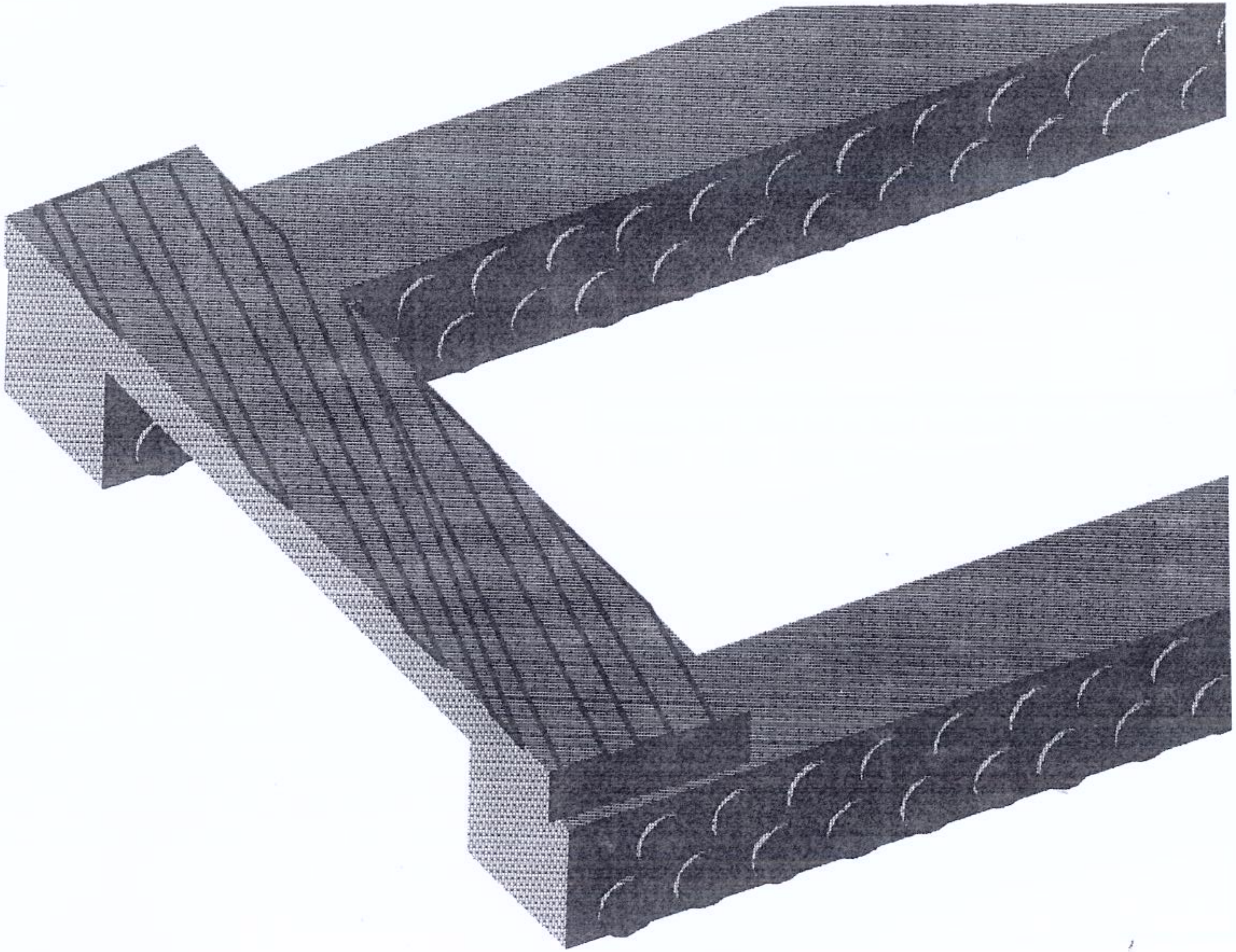


Stairs should generally be about 3'-0" wide so this example stairway is sized at 14'-0" total run with fourteen 12" treads and 10'-0" total rise with fifteen 8" risers. If this stairway were to be made conventionally, it would be very difficult to make it any other way than straight, however, a can stairway can turn, twist and curve in any way you desire once the initial size is established.

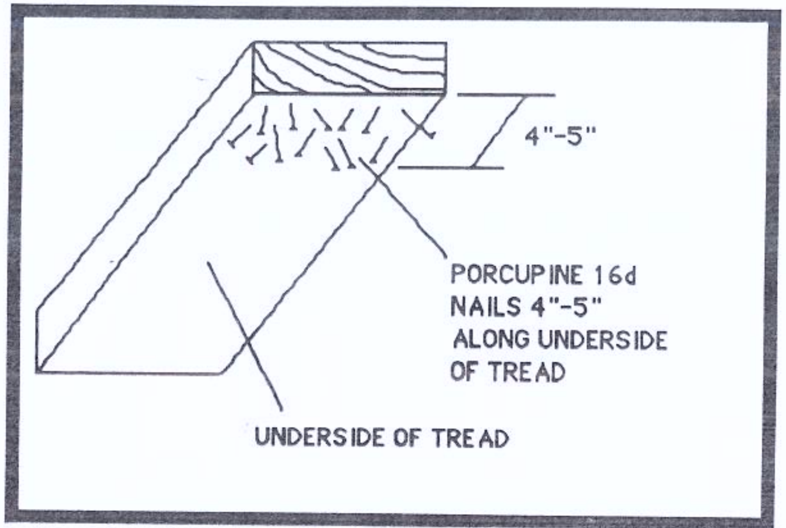


CONSTRUCTION

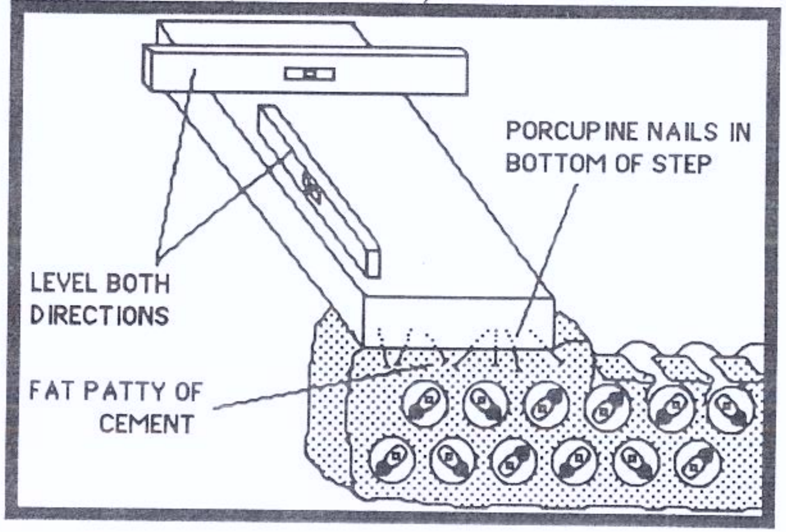
Once you know the size of your stairway you simply draw it on the floor and wall (if it is against a wall) and begin building. The treads are made from wood 2x12's or 3x12's that span between two can walls. The can walls go up to the height of the first tread then it is installed. The treads are laid into the same cement mortar that the cans are laid in.



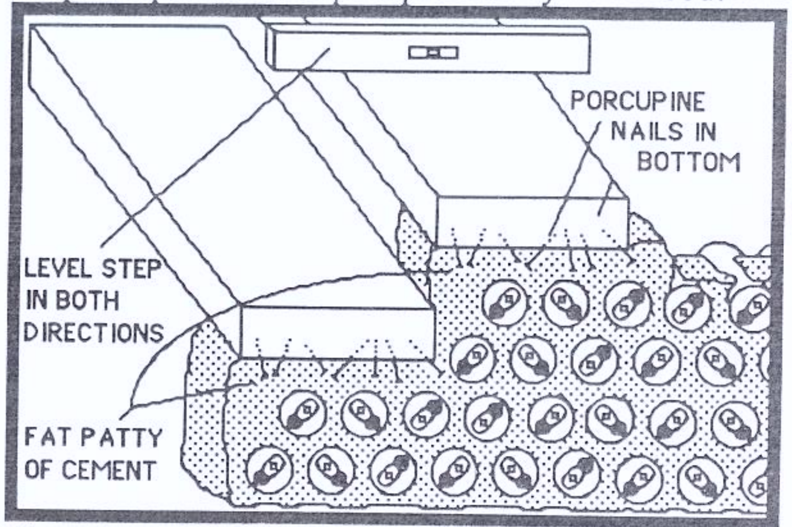
16d nails are nailed halfway into the underside ends of the wood treads to cleat the tread to the cement.



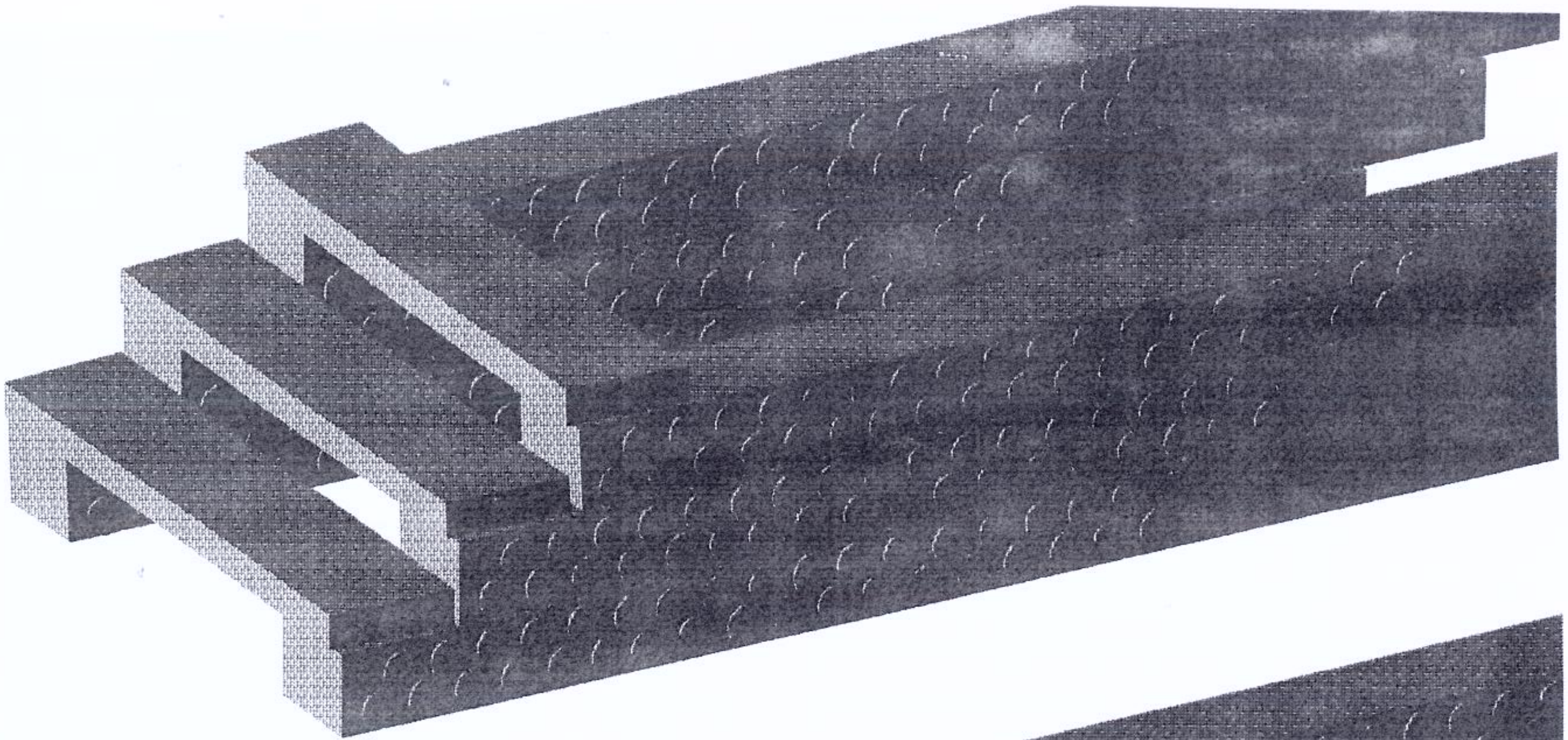
The tread is then pushed into a fat patty of cement on the can wall and leveled both ways with a torpedo level (a short level).

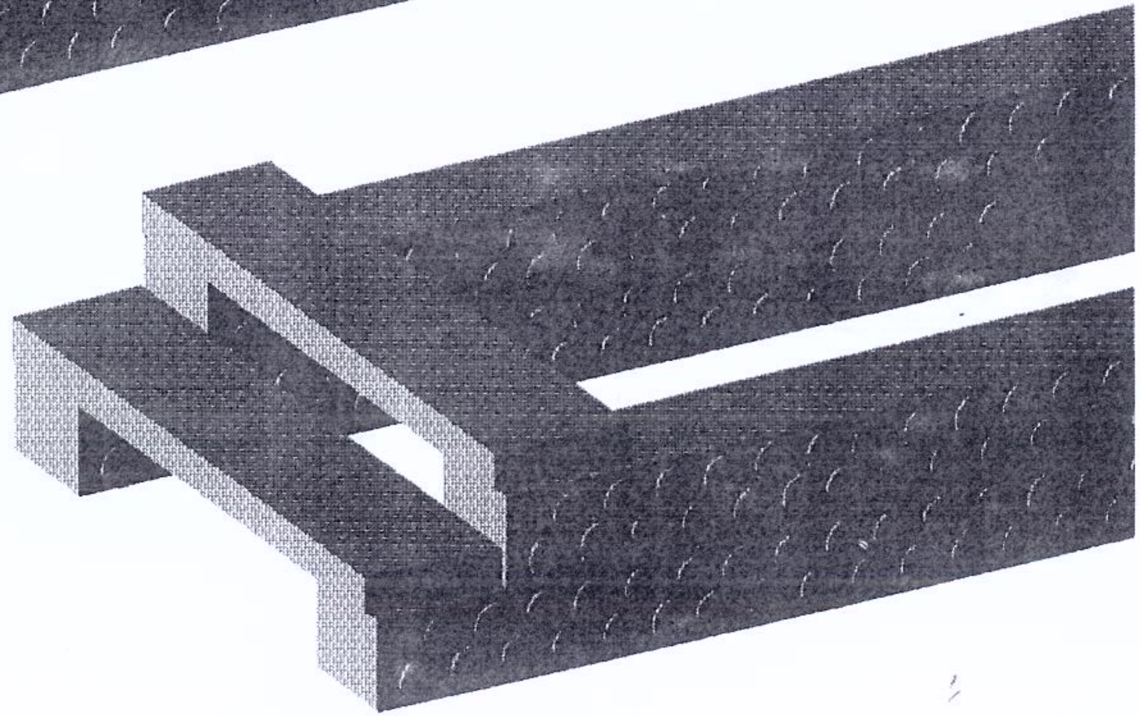


When the cement dries, the tread is firmly fastened to the cement of the can wall. This is essentially the same as nailing the tread to the cement/can wall. This technique is called porcupining - the treads are porcupined then laid into the cement. Next the can walls go up to the height of the second tread then it is installed with the *porcupine technique* previously described.



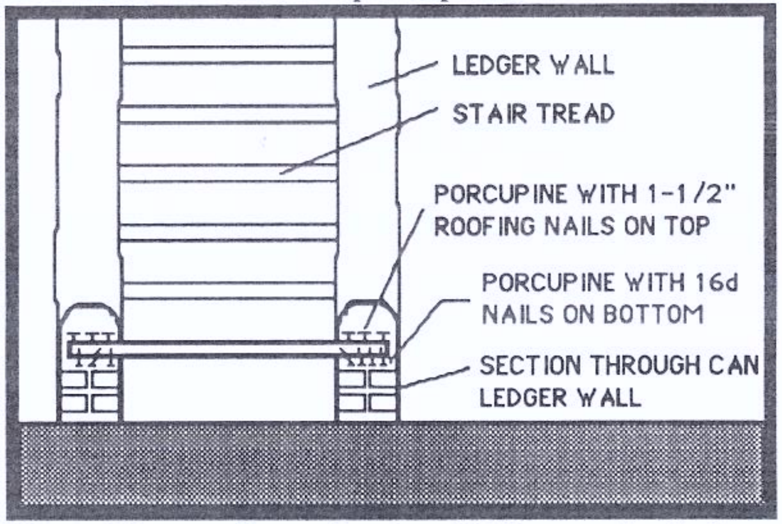
Then the can walls go up to the height of the third tread and it is installed, etc. Can laying is discussed on page 158 of Earthship Vol. I and in Chapter 9 of this volume. The treads (via the porcupine detail) become an integral part of the structure. When laying the porcupined tread on the can wall ledger, be sure to allow a "fat patty" of cement to receive the porcupined nails coming out of the tread.



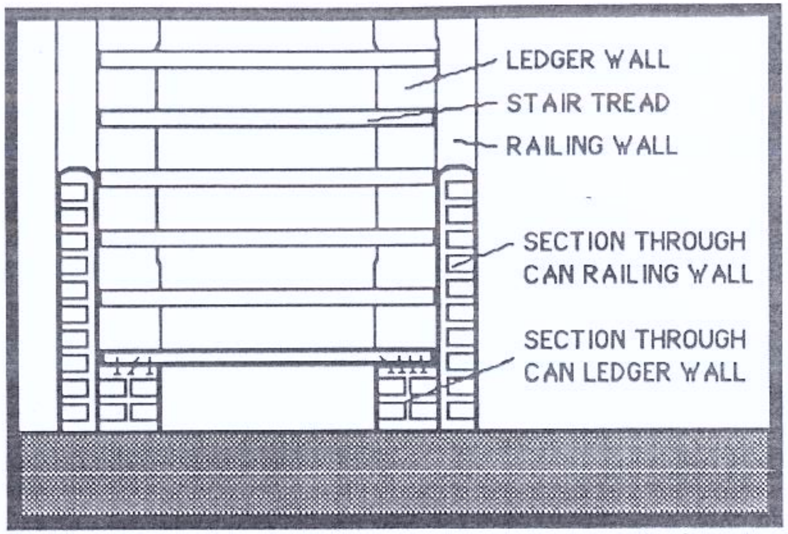


There are two different purposes for the can walls. One is to make a ledger for the treads to set on and the other is to make the railing. This can be achieved in two ways.

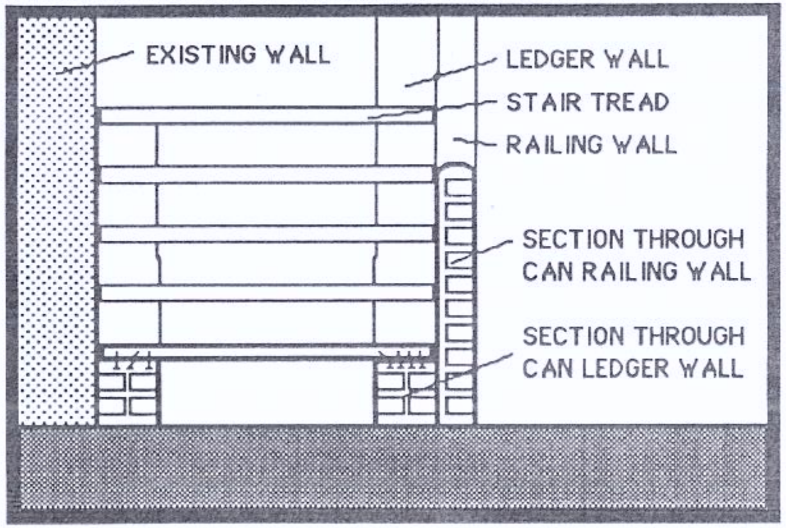
The ledger wall can also be the railing. In this case porcupine the top of the tread with 1-1/2" roofing nails. The ledger wall is then taken over the top of the tread to become the railing. The bottom of the tread is porcupined with 16d nails.

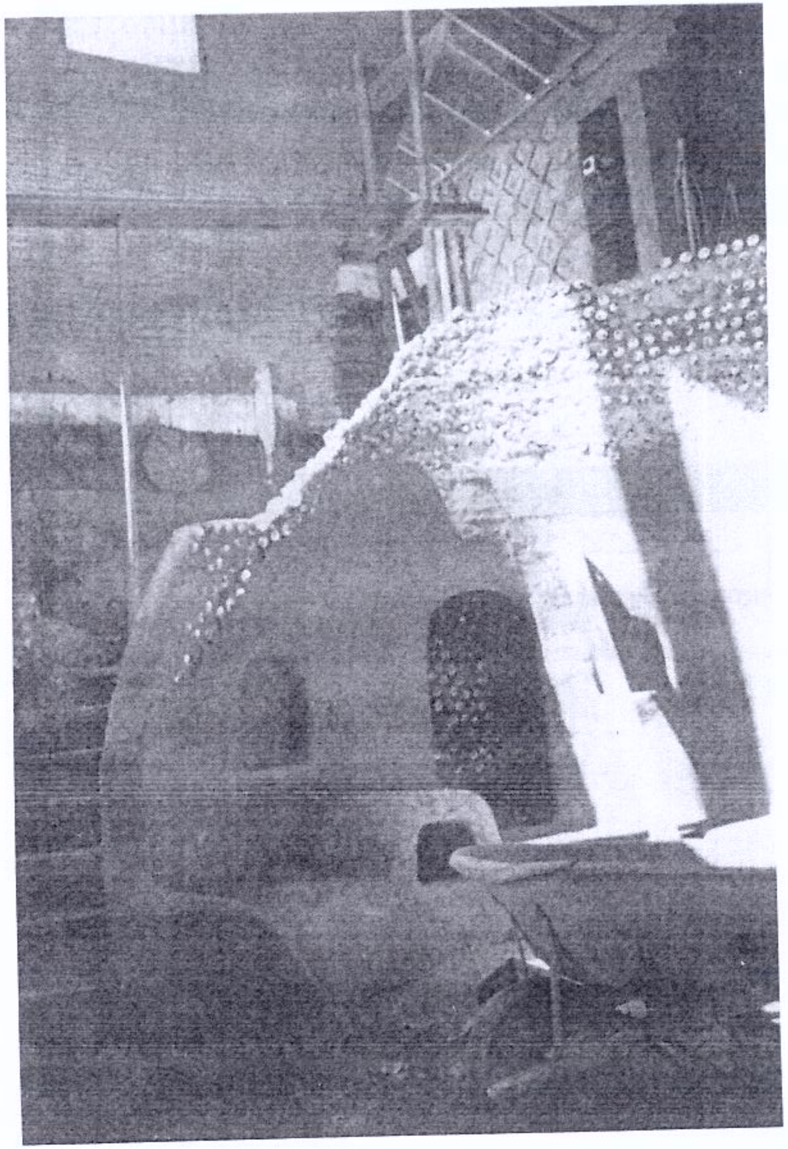


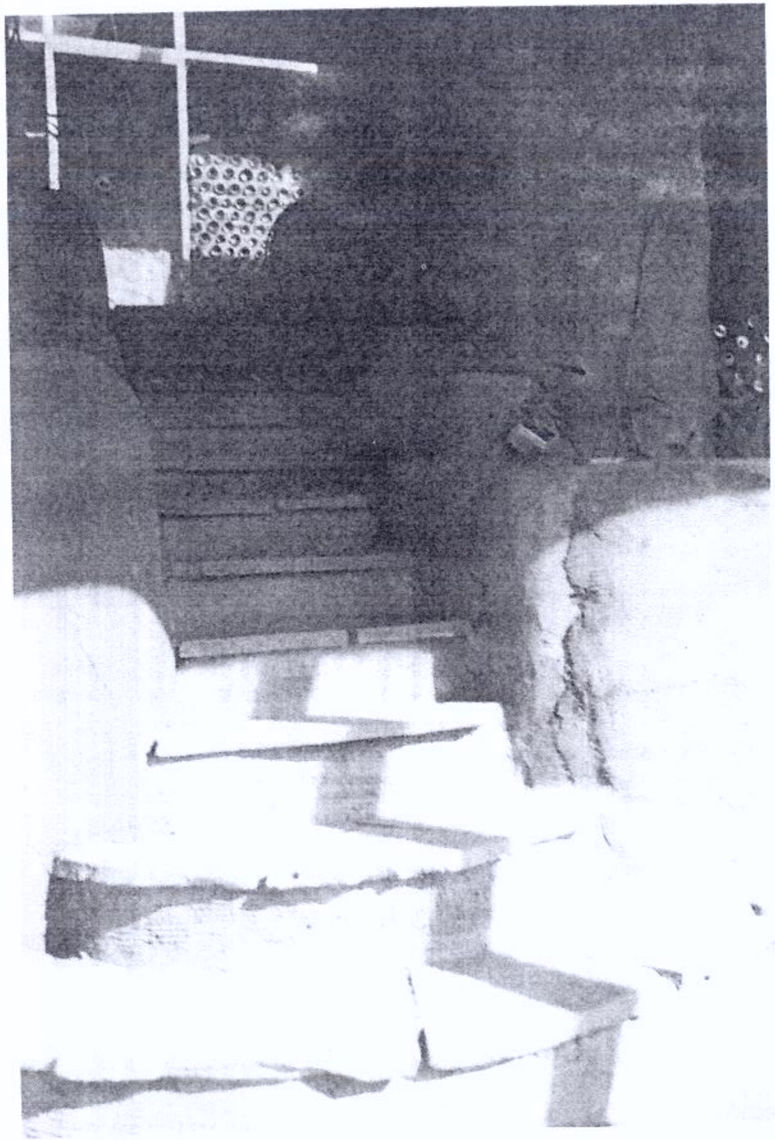
The railing wall can be in addition to the ledger wall. This just makes for a stronger more durable stairway and is advised where ever possible. When this method is used, both the railing and the ledger wall should go up at the same time to the height of the treads as this bonds them together better.



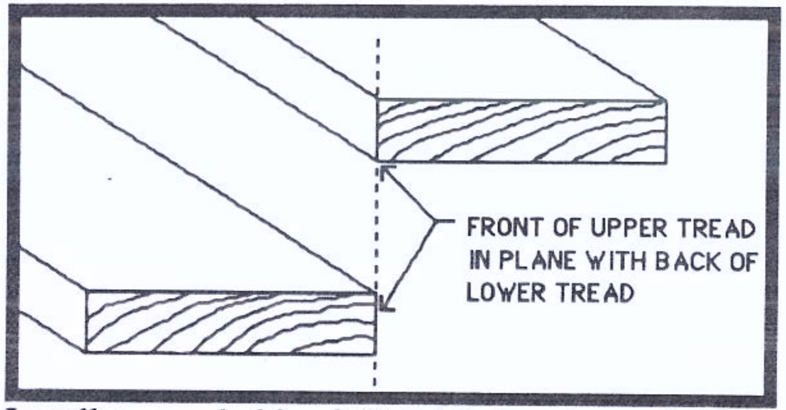
If the stair is against a wall, a ledger wall for the treads is all that is needed on the wall side.



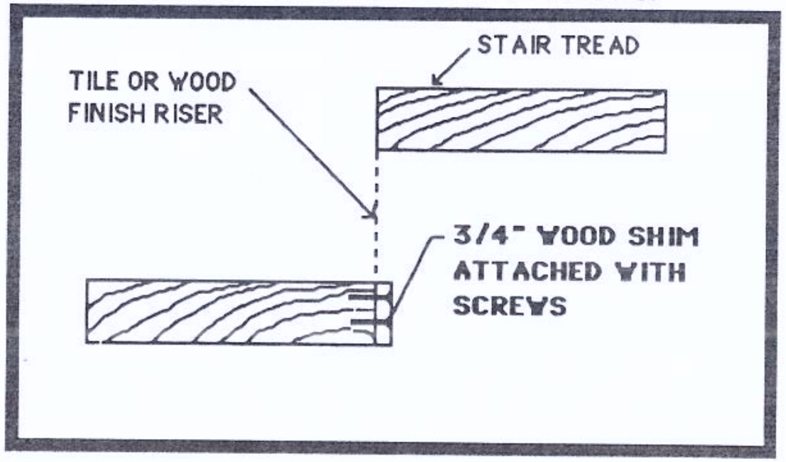




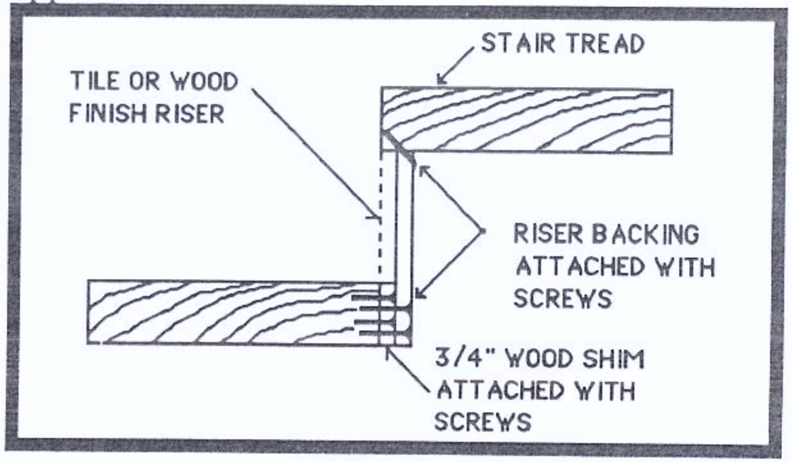
When all the treads have been installed, the stairway is structurally finished. The risers are now added. The treads are laid with the front of the upper tread in plane (lined up) with the back of the lower tread.



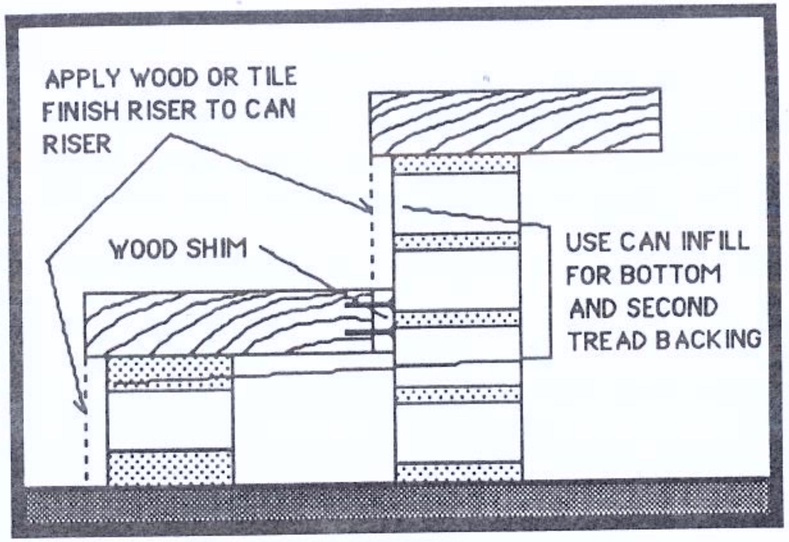
Install a wood shim 3/4" thick (as shown below) to the back of the lower tread with screws.

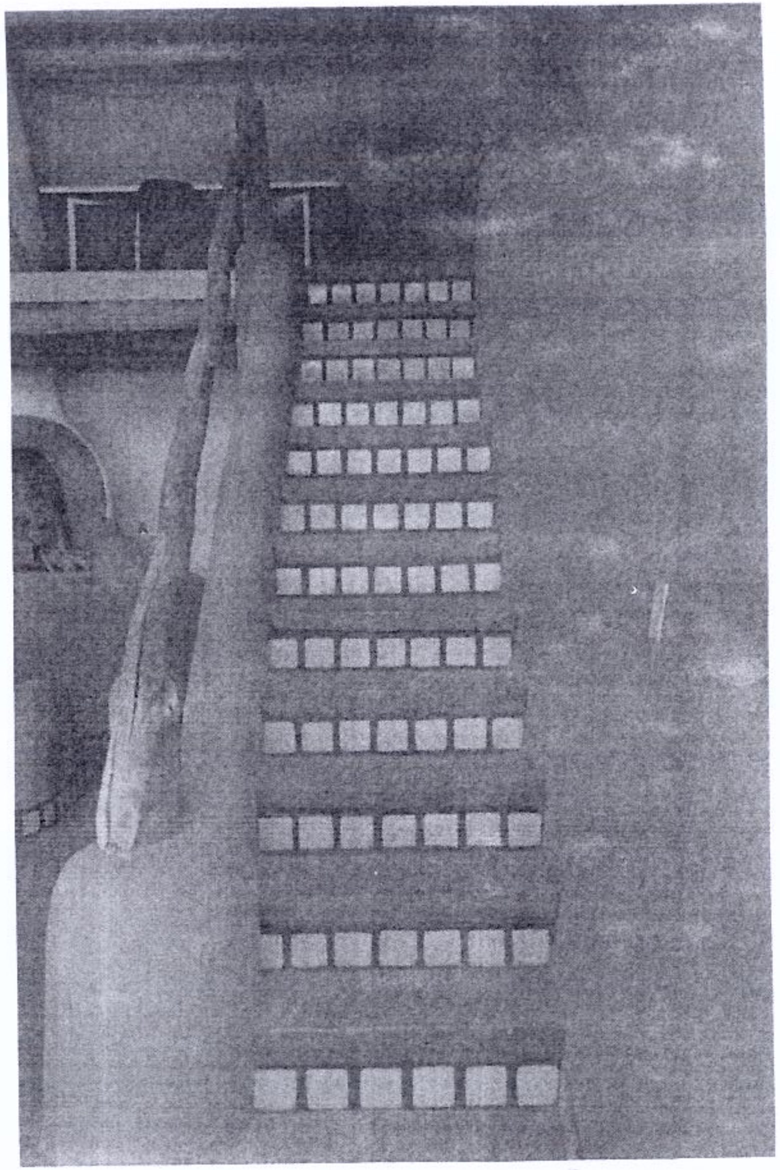


The riser backing can now be installed to this shim again with screws. This piece is 3/4" plywood and is also screwed (at an angle) into the upper tread.



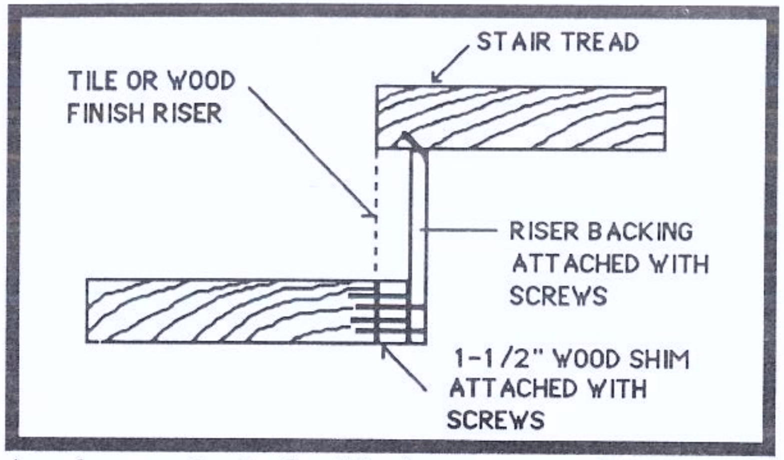
The first and lowest riser is too close to the floor to allow the above method. Bottom risers are usually built with can and mortar fill. This method may also be used for the second tread for the same reason.



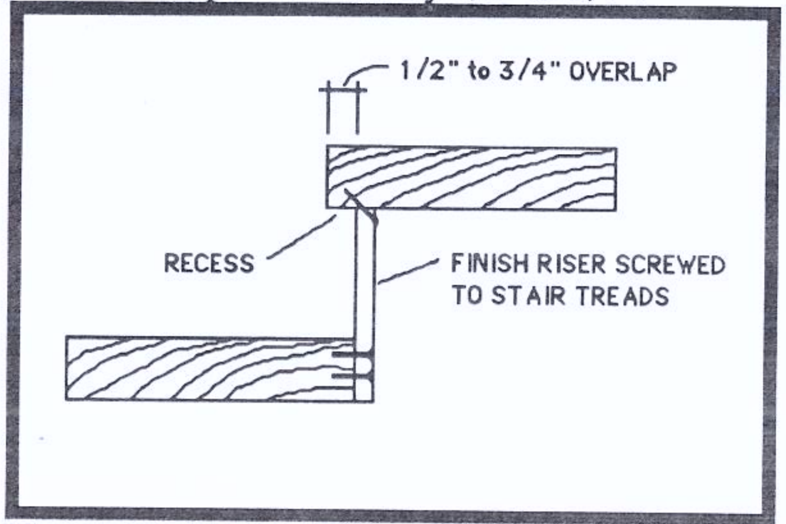


Now a tile finish or a wood finish riser can be installed. If a wood finish riser is used, the bottom riser can be glued (with liquid nails) to the smoothly plastered bottom can riser. The plaster must be allowed to cure for one week before a wood riser is glued to it. The following photo illustrates tile risers.

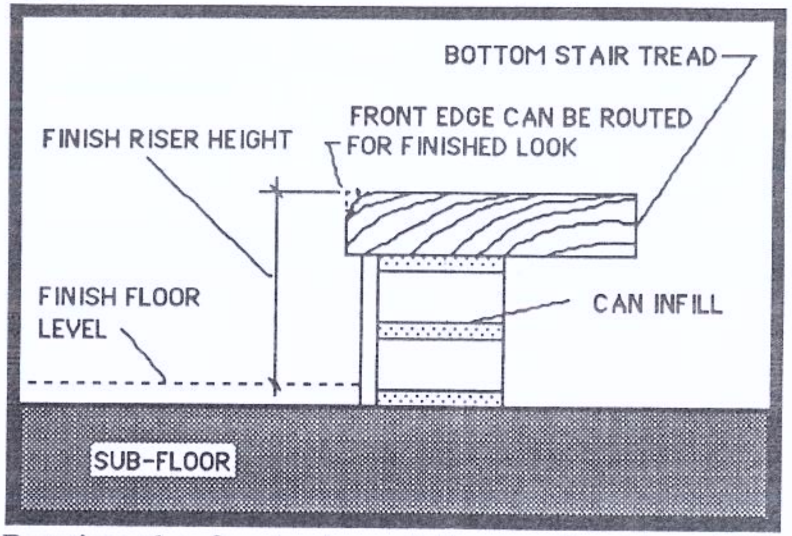
If a recessed riser is desired, the 3/4" shim can be increased to 1 1/2".



Another method of achieving a recess is to let the treads overlap each other by 1/2" to 3/4".

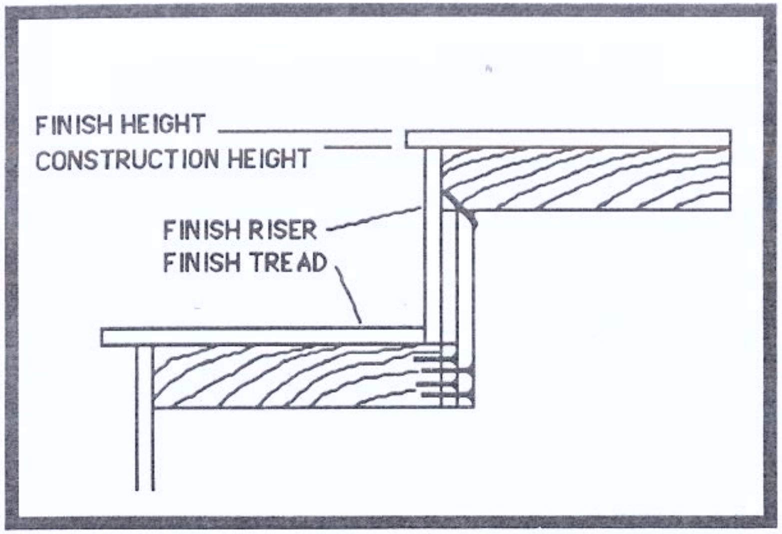


The entire can wall stairway can now be plastered using the techniques described in Chapter 9 of Earthship Vol. I. Due to the nature of can walls, any shape or curve or twist can be built in to the stairway. The shape is drawn on the floor and the can walls follow the drawing. Be sure to allow for the finished floor when laying out the first tread.



Routing the front edge of the tread with a 1/2" round bit gives it a smooth,finished look.

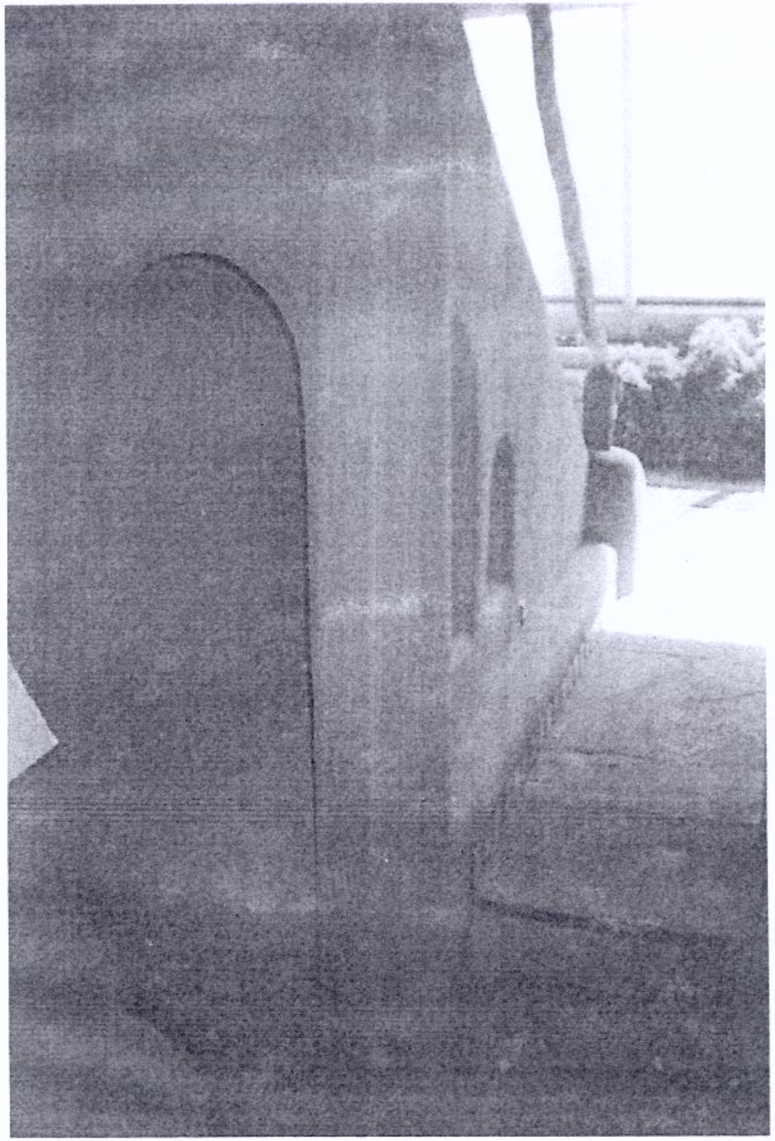
These stairways can be carpeted or finished with tile, flagstone or other floor materials. The heights of the treads would have to be lowered by whatever thickness the finish materials require.



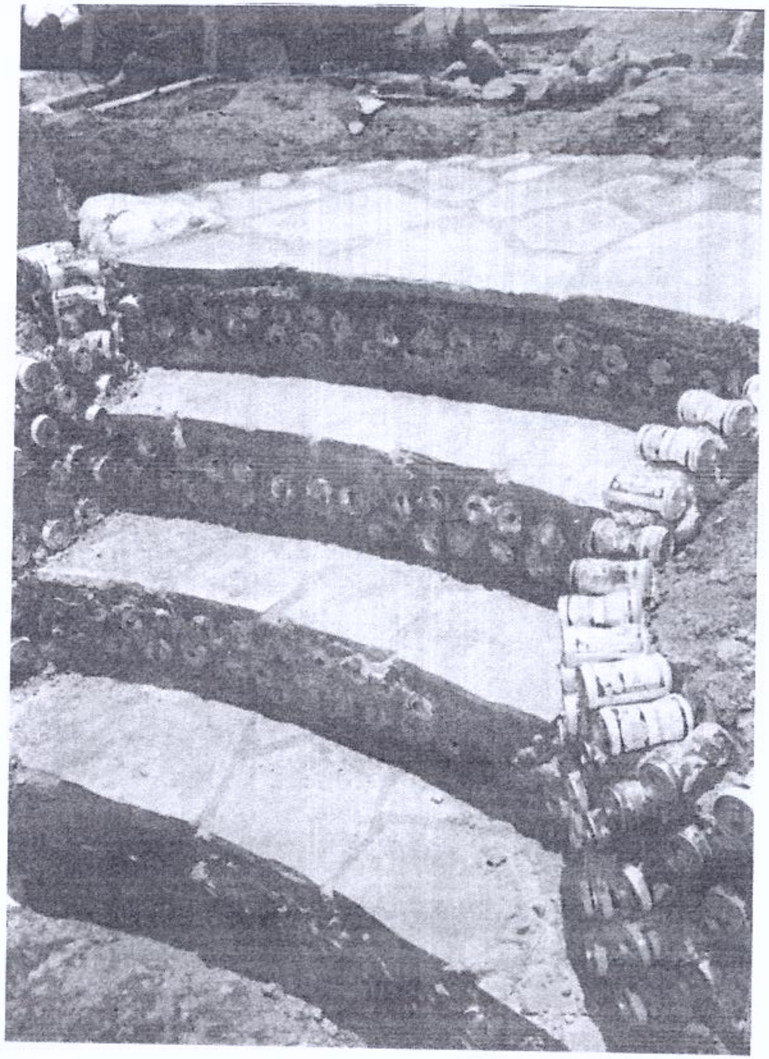
It is easiest and most economical, however, to allow the 3x12 construction tread to simply be the finish tread.

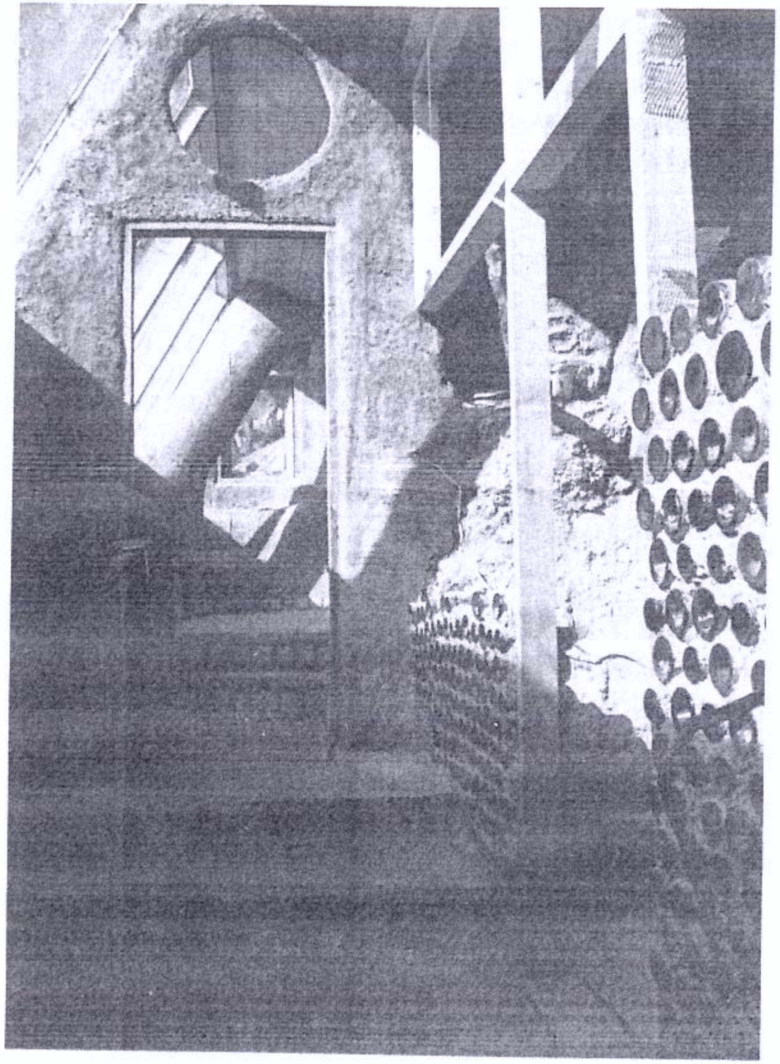
Do not try to lay more than three treads per day and lay these in three different sessions spaced about 1-1/2 hours apart to allow the cement to partially cure on one tread before attempting another. Cement takes seven days to reach maximum strength. Keep this in mind when standing on yesterday's work to lay a few more treads. Treat the stairway delicately for about one week.

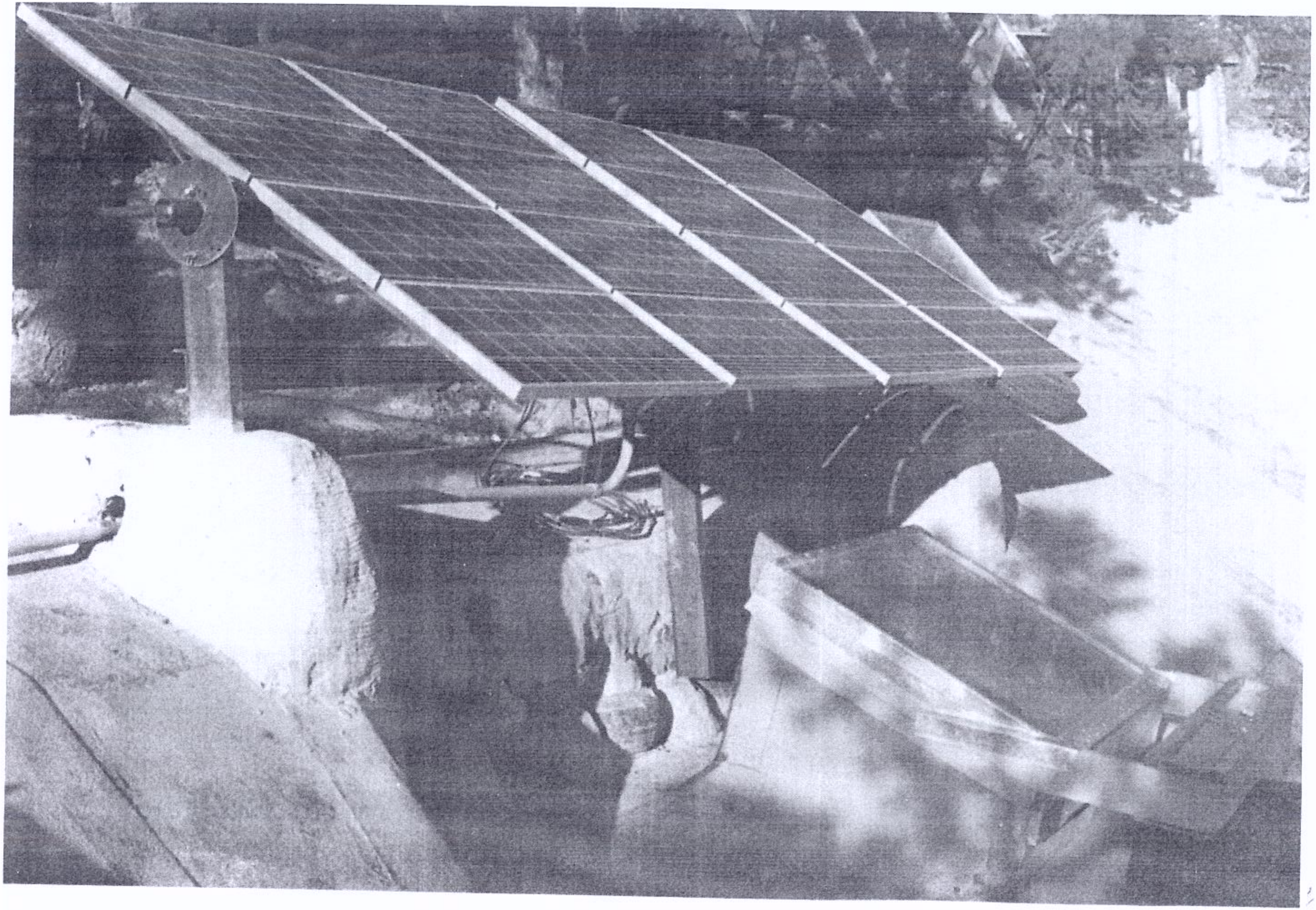
This method of stairway building creates an open space underneath for storage. You may want to design a doorway or arch for access to this space.



Once this technique is mastered, there is no limit to where and how you can apply it.







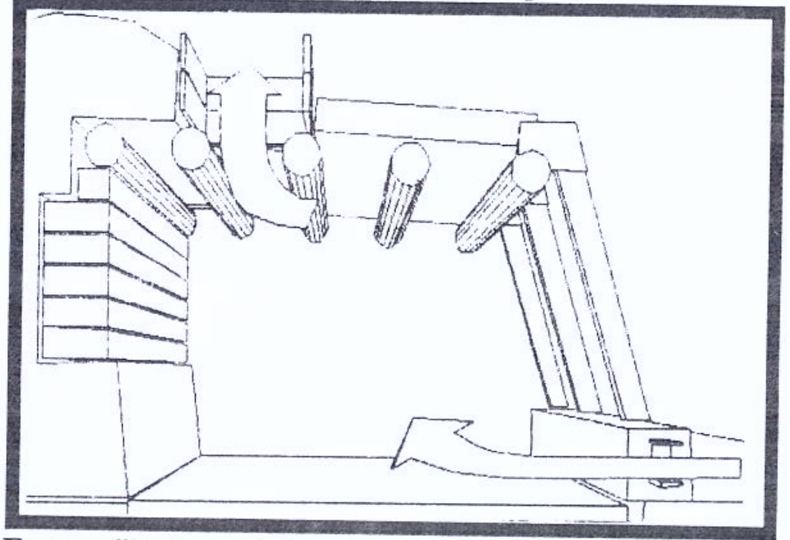
8 GRAVITY SKYLIGHTS

COMPONENTS

THE GRAVITY OPERATED SKYLIGHT IS AN INTEGRAL PART OF THE EARTHSHIP VENTILATION SYSTEM. IT IS THE RESULT OF MANY YEARS OF EVOLUTION OF OPERABLE SKYLIGHTS. THOUGH IT IS VERY SIMPLE IN CONCEPT AND DESIGN, IT HAS MANY IDIOSYNCRASIES THAT ARE CRITICAL TO ITS PERFORMANCE. IF CONSTRUCTED AND INSTALLED PROPERLY, IT WILL LAST A LIFE TIME WITH NO MOTORS OR GEARS TO REPLACE. THIS CHAPTER WILL TAKE YOU THROUGH THIS SKYLIGHT STEP BY STEP IN CONCEPT, CONSTRUCTION, AND MATERIALS.

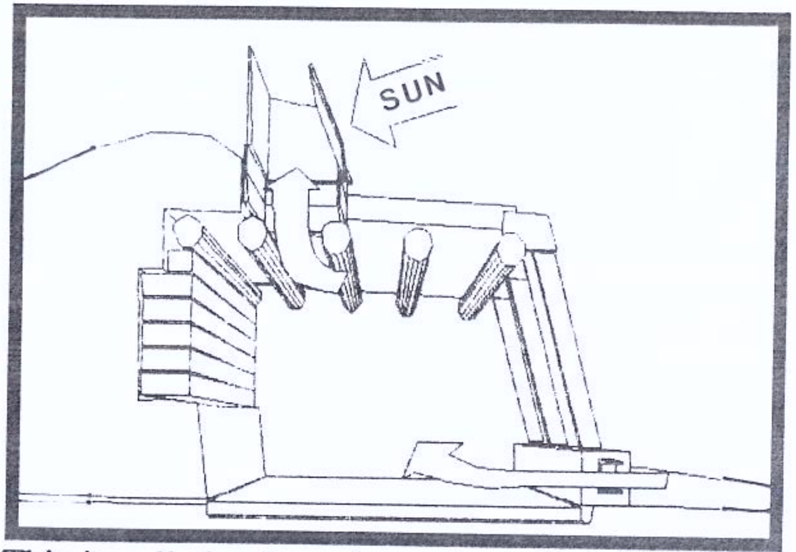
VENTILATION CONCEPTS

The controlled movement of air through an Earthship aligns with a natural tendency of warm air to rise. Skylights therefore should be in the highest possible places to allow this warmer air to escape if necessary. Fresh air must be allowed to enter in the lowest possible places. This creates a natural air flow bringing outside fresh cooler air in and allowing hotter staler air to leave via a chimney effect. The result is a natural air flow and air exchange throughout the space.



Every "U" module should have this air flow available for individual ventilation, air exchange and cooling.

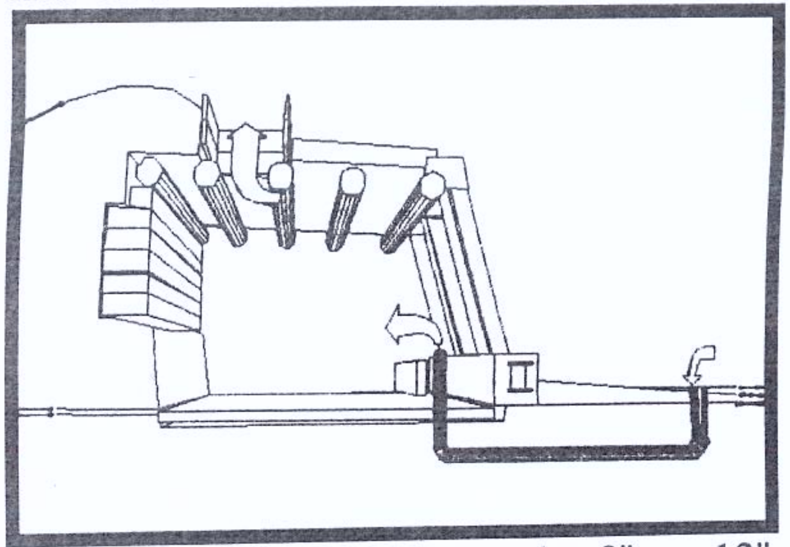
In extremely hot climates this natural movement of air should be enhanced by extending the skylight box up and providing a black metal surface covered with glazing and sloped south to the sun. This creates much hotter air which rises faster and enhances the suction of cooler air in the lower parts of the Earthship where in-coming air is allowed.



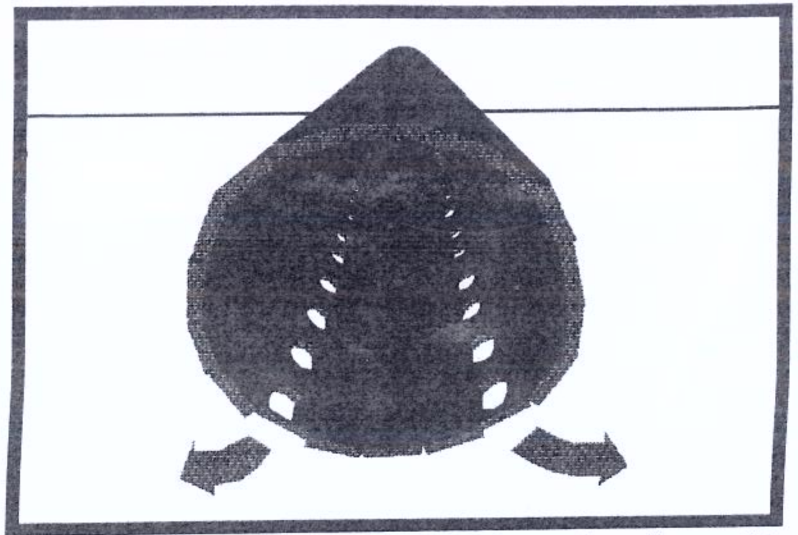
This is called solar enhanced ventilation and is a well used component of buildings in extremely hot climates. Consult an architect, thermal engineer or S.S.A. before building one of these as they require some detailing. At the time of this publication, no existing Earthships have required this apparatus. It is only for extreme desert like conditions.

There is another ventilation variation which can be used in hotter climates where outside air is too hot for comfort. The inlets for incoming air can be taken through the earth before entering the

Earthship. This allows the earth (which stays at about 60 degrees below the surface, see Earthship Vol. I) to cool off the incoming air before it enters the Earthship. The result is a natural air conditioning system which uses no energy and no fans for air movement.

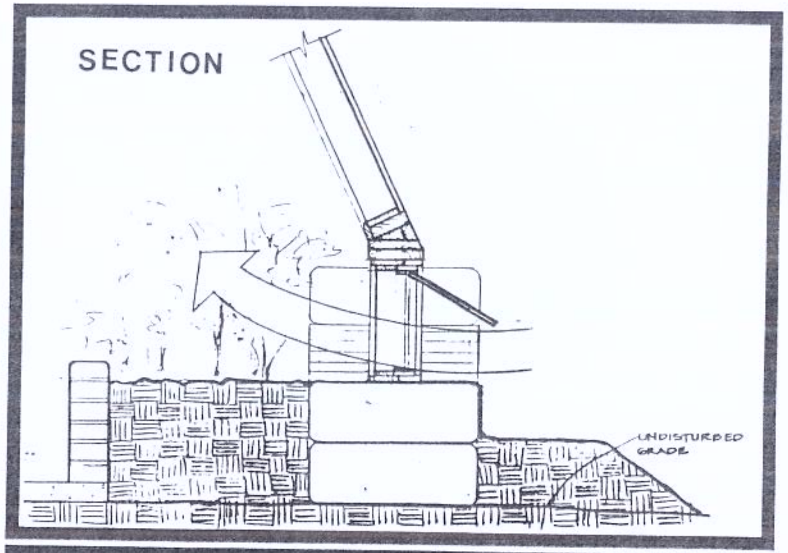


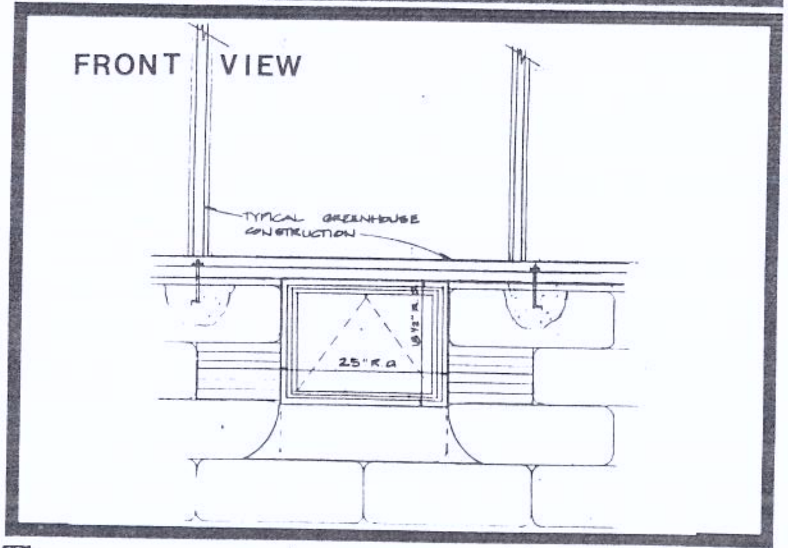
The piping used for this can be 8" or 12" diameter PVC (plastic) pipe with perforations on the bottom side.



The perforations allow the condensation (brought about by warmer air coming in contact with cooler earth) to escape. This process actually dehumidifies the incoming air. The pipes can come in through the planter. You should have 2 pipes per "U" in addition to an operable window.

The recommended operable window has been updated since Earthship Volume I. We now recommend a lower, smaller, hopper window installed below the front face glass.

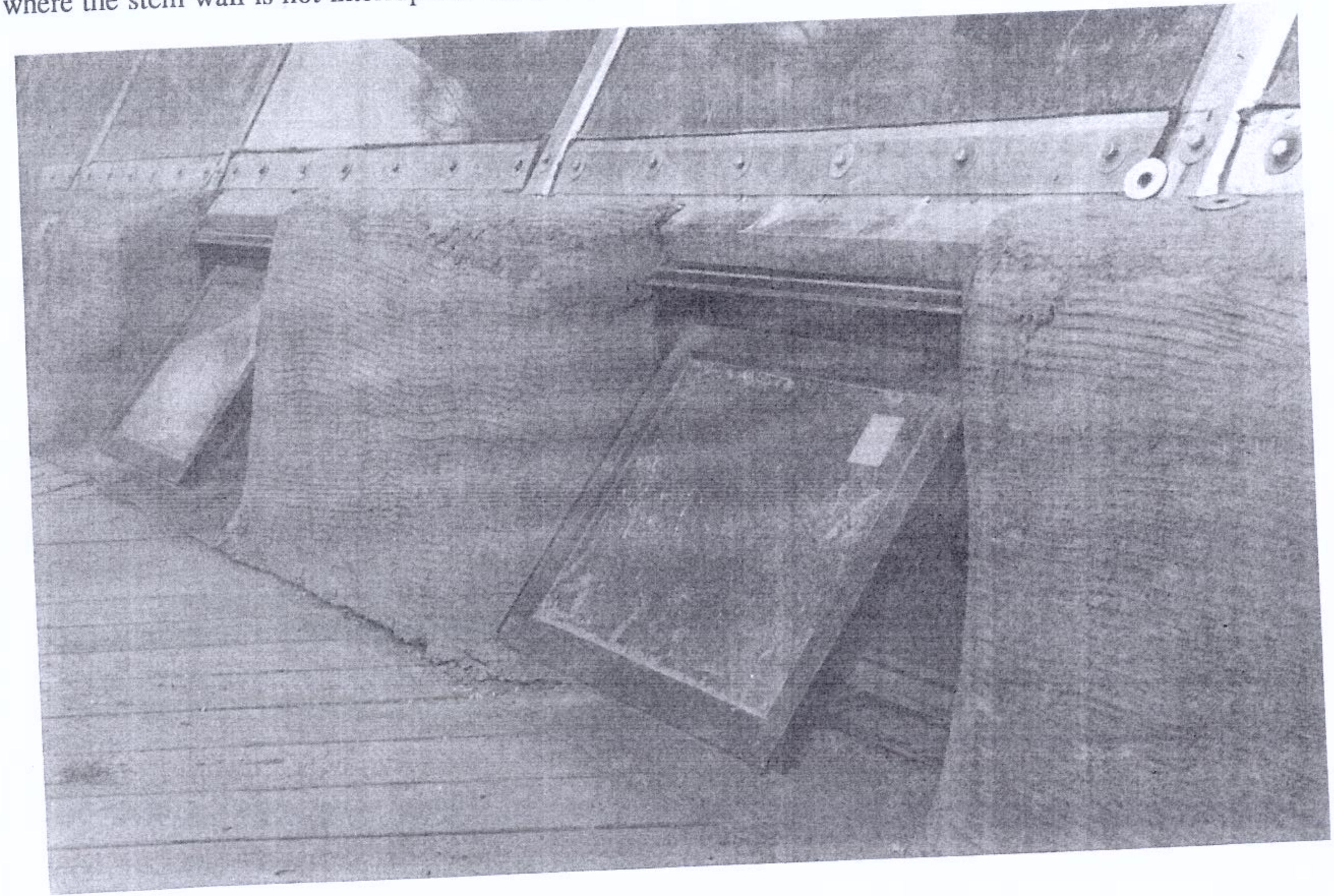


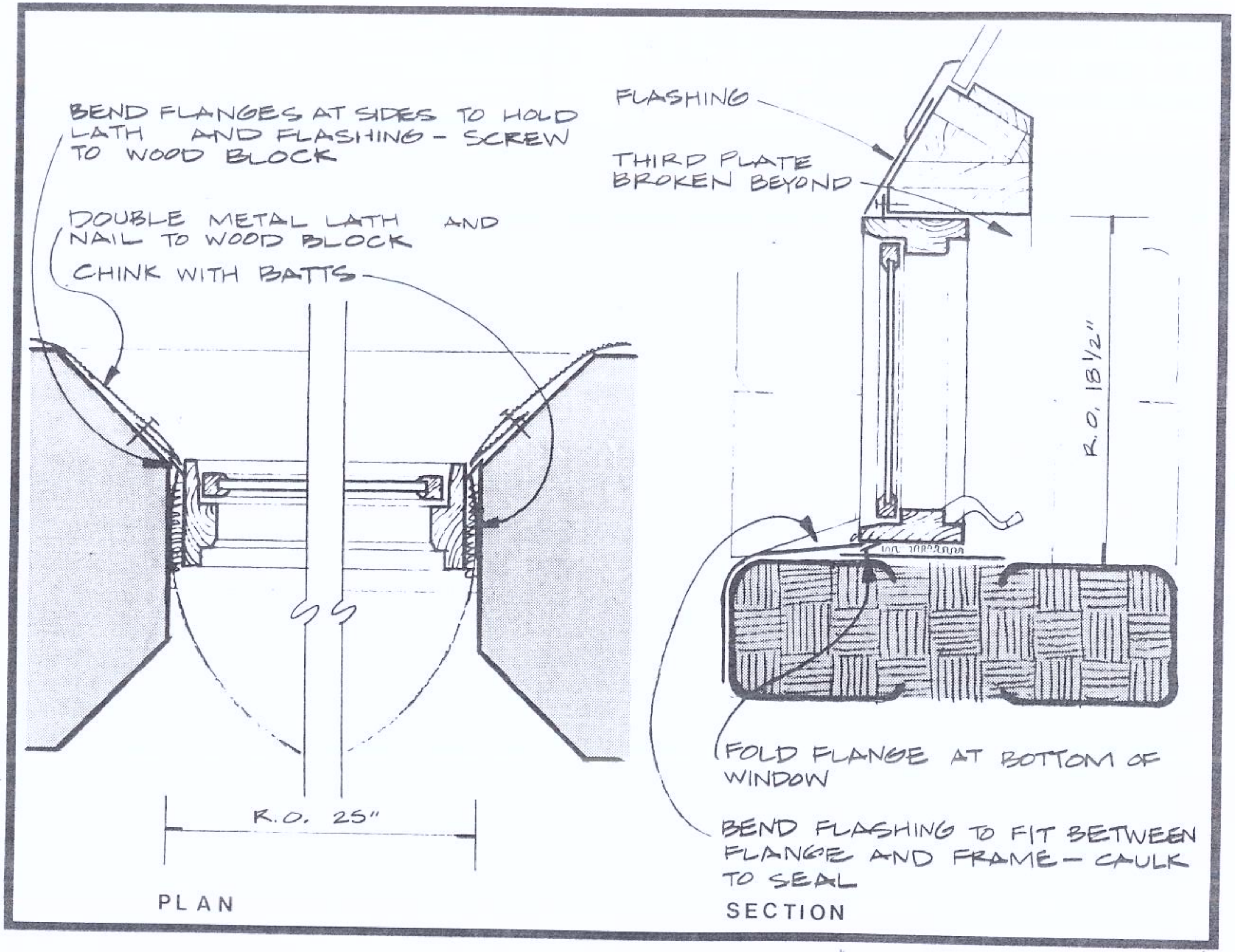


There are many advantages to this window over the one described in Volume I. It doesn't interrupt the front face glazing with shadows or blockage of sun and view like the one described before. It is also considerably cheaper to purchase and install. We use a PEACHTREE* metal clad awning window. The rough opening is 18 1/2" x 25" which works exactly with the coursing of #14 tires in the front face stem wall. These tires are about 25" in diameter and 8 1/2" high. The window unit fits into the coursing of the wall as if it were a tire. It does need a third top plate as the two 8 1/2" tires only make 17" in height. Another 1 1/2" is needed for the rough opening

*1 see Appendix, Chapter 8

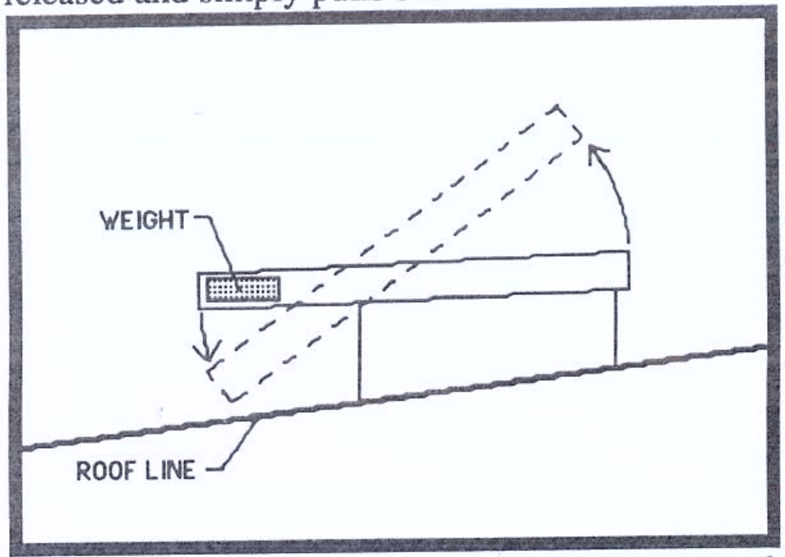
This does break the structural integrity of the stem wall somewhat so we advise cement/can void filling on both sides of the stem wall as opposed to the normal mud/can void filling which is used where the stem wall is not interrupted. Be sure to chink around the window tightly with batt insulation. A "bullnose" lath detail (see page 183 Earthship Vol. I) is required when plastering around the window.



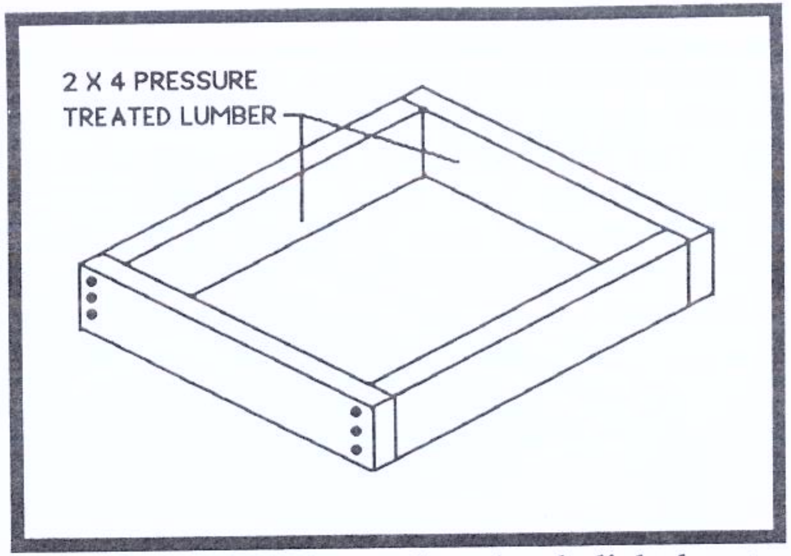

BEND FLANGES AT SIDES TO HOLD LATH AND FLASHING - SCREW TO WOOD BLOCK
DOUBLE METAL LATH AND NAIL TO WOOD BLOCK
CHINK WITH BATTS
R.O. 25"
PLAN
FLASHING
THIRD PLATE BROKEN BEYOND
R.O. 18½"
FOLD FLANGE AT BOTTOM OF WINDOW
BEND FLASHING TO FIT BETWEEN FLANGE AND FRAME - CAULK TO SEAL
SECTION

SKYLIGHT CONSTRUCTION

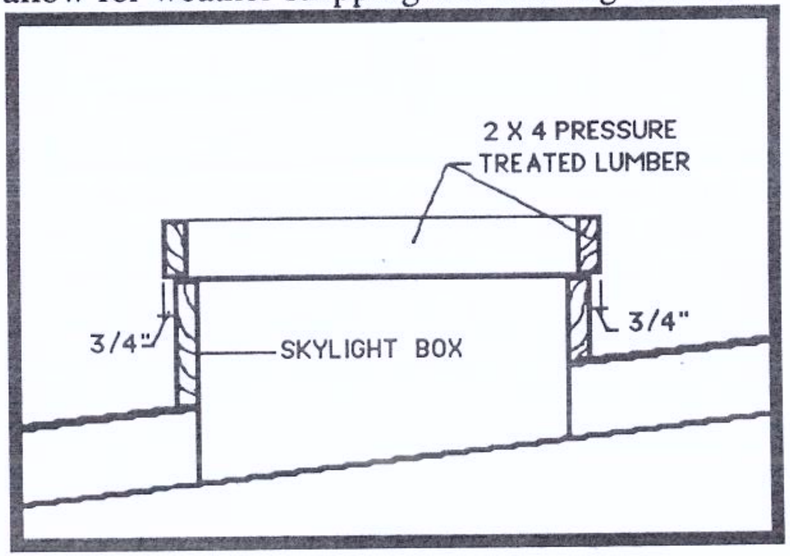
The skylight is a custom made, operable roof window, counter balanced with weight on a lever arm. It opens by the force of gravity when released and simply pulls shut.



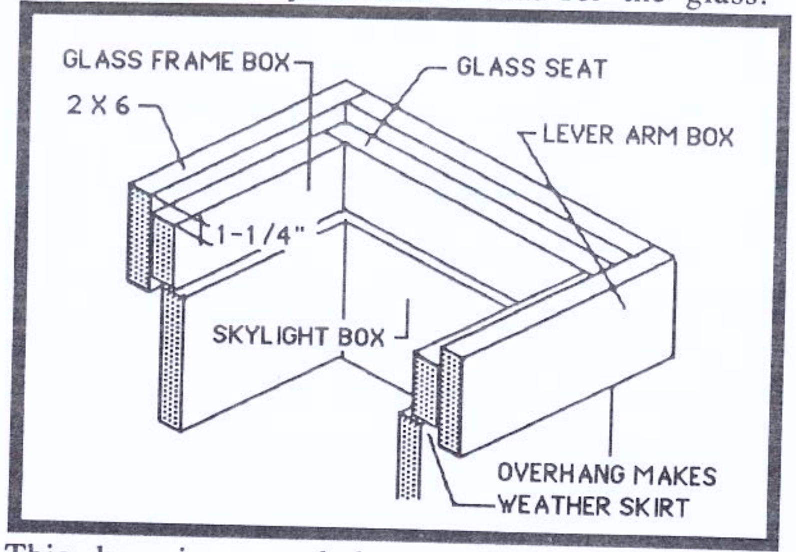
Installation of the initial skylight box (roof opening) is described on pages 114 & 115 of Earthship Volume I. The next step is the glass frame. This frame is made from pressure treated 2x4 stock dimension lumber.



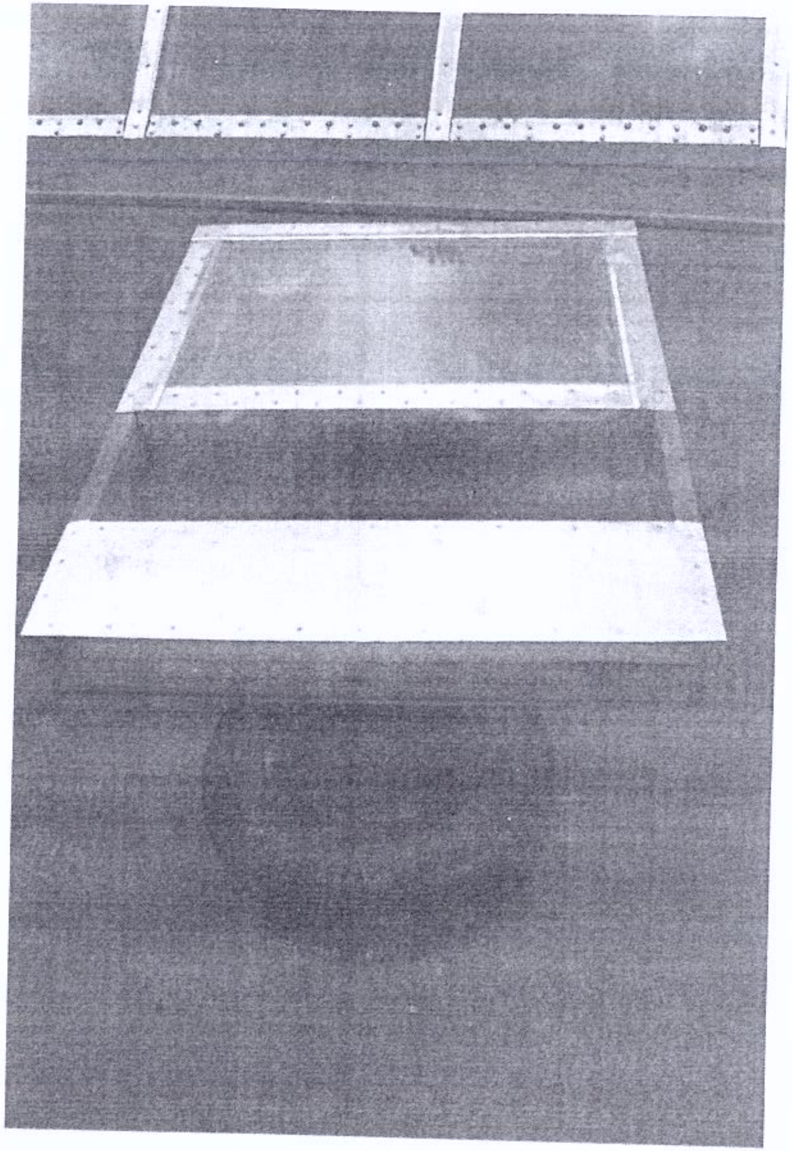
It is sized slightly larger than the skylight box to allow for weather stripping and flashing details.

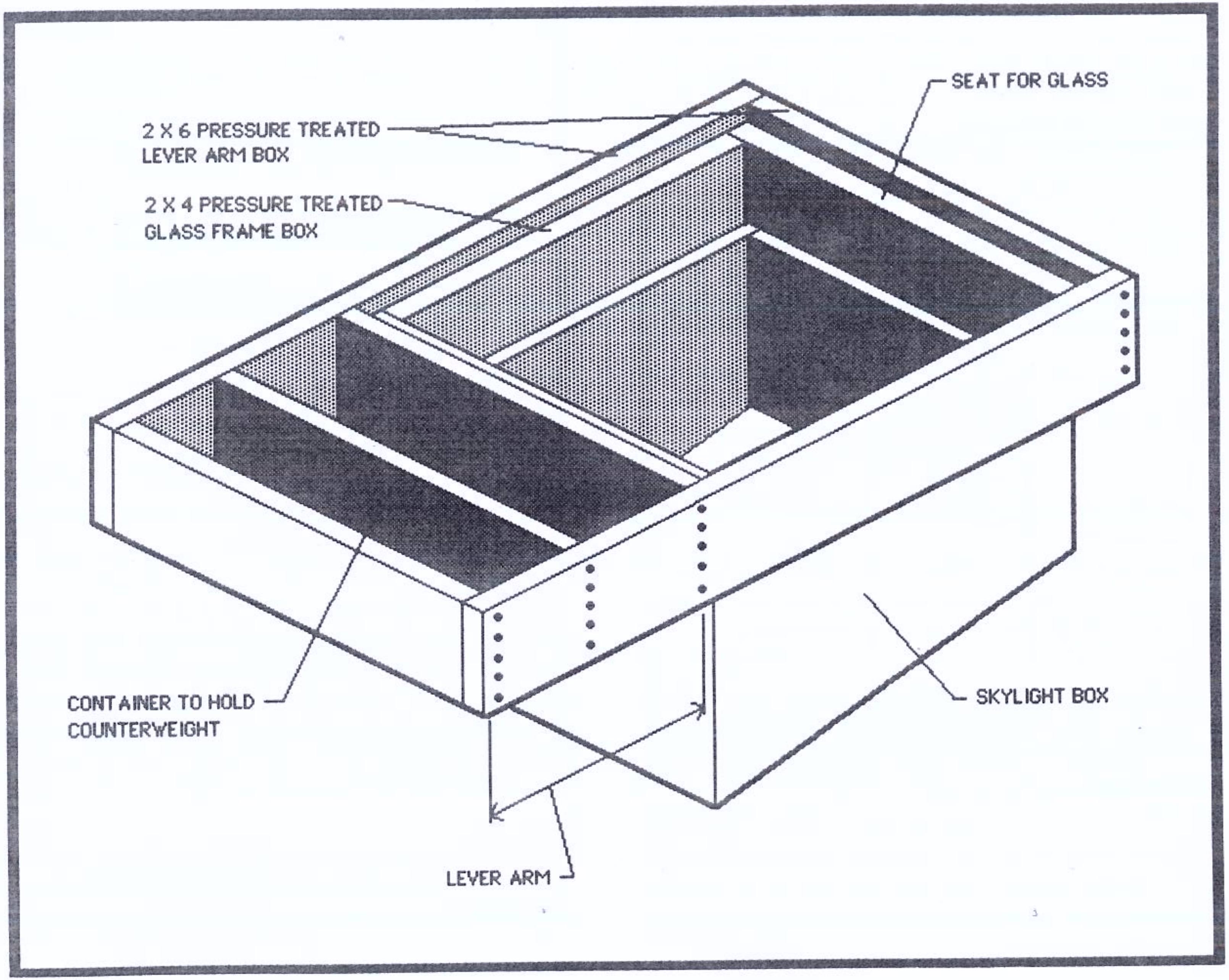


The glass frame box now has the lever arm box built around it with pressure treated 2x6 stock. This box also serves as a weather skirt. By locating this box 1-1/4" above the 2x4 glass frame box you form a seat for the glass.

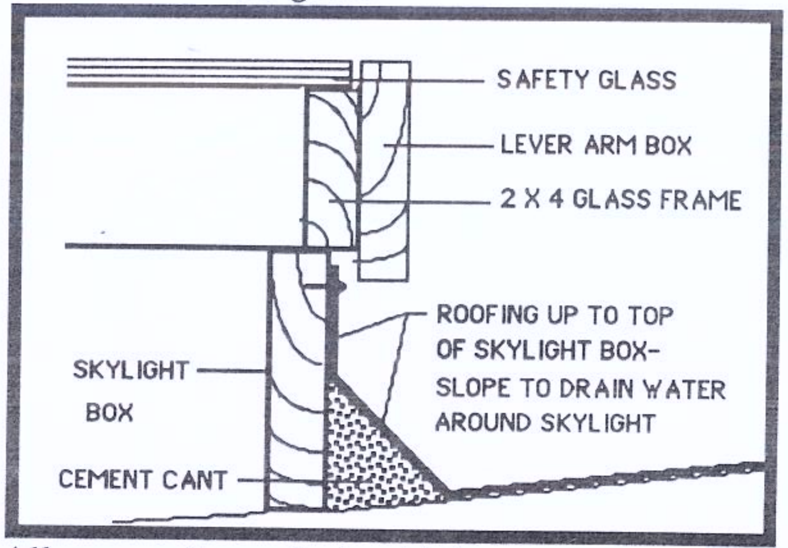


This box is extended to form the lever arm and weight as shown opposite. The length of the lever arm (as well as the weight) varies with the skylight size and weight. A shorter arm means more weight and a longer arm means less weight.



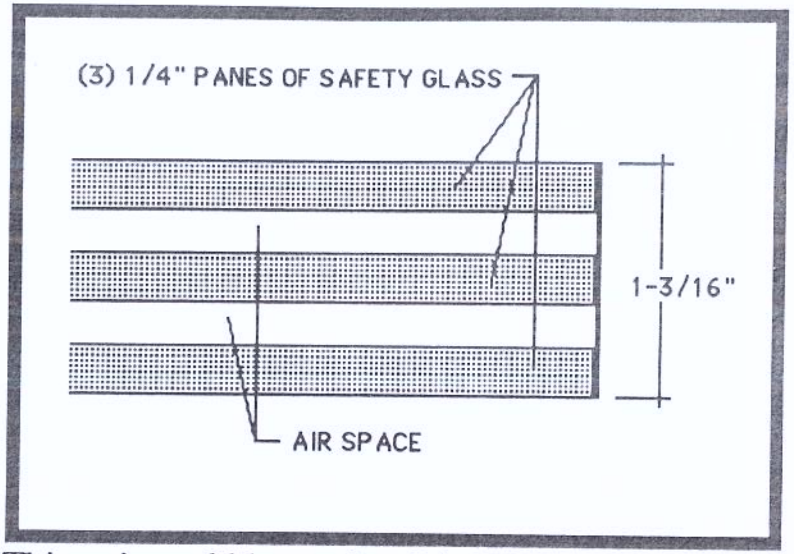

SEAT FOR GLASS
2 X 6 PRESSURE TREATED
LEVER ARM BOX
2 X 4 PRESSURE TREATED
GLASS FRAME BOX
CONTAINER TO HOLD
COUNTERWEIGHT
SKYLIGHT BOX
LEVER ARM

Roofing must come up to the top of the skylight box. The 2x6 lever arm box overhangs this roofing for the weather skirt. On top it forms a seat to receive the glass.



All exposed wood should be pressure treated and/or oiled for protection as wood on a roof takes a lot of abuse.

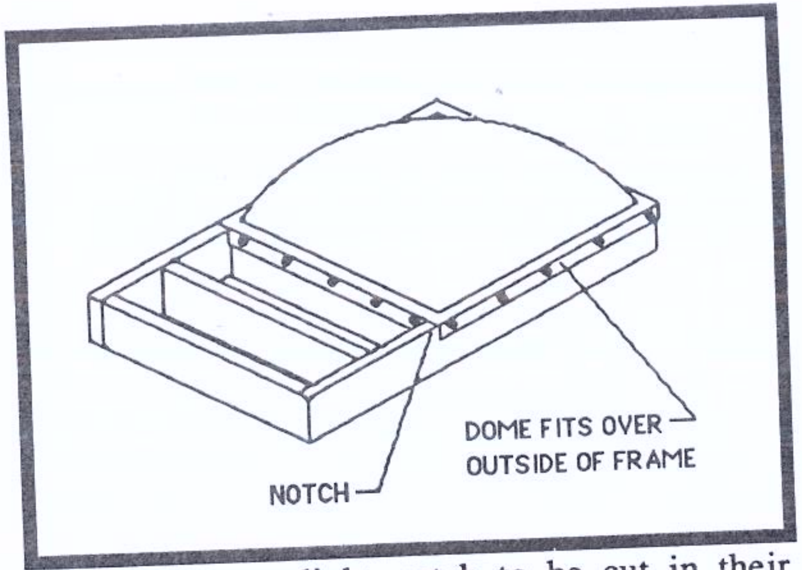
The glass is a 1-3/16" thick unit made up of three layers of 1/4" safety glass (non-shattering). The use of safety glass is very important since the unit is overhead.



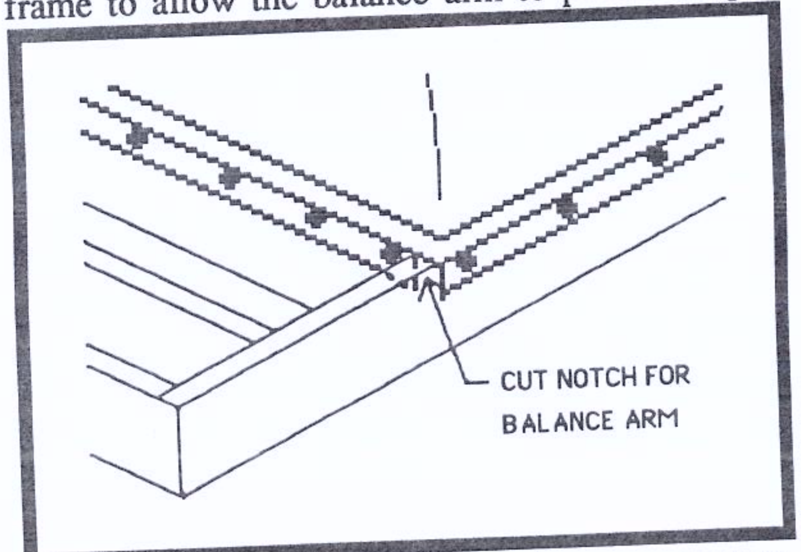
This unit could be made of the new types of glass that are on the market which retain more heat.* In this case it would be double pane and would only be 1" thick. These new types of glass are more expensive and take longer to get. Check with your local glass dealer. The triple paned unit is almost equal in performance and usually easier to obtain. The important factor is that all the pieces of glass be shatter proof for safety. **Remember this glass is over your head.** Wire glass (glass with wire mesh formed inside of it) can be used in cases where hail is a problem.

There are manufactured skylight domes that can be used here. They simply fit over the outside 2x6 skirt.

*2 see Appendix, Chapter 8

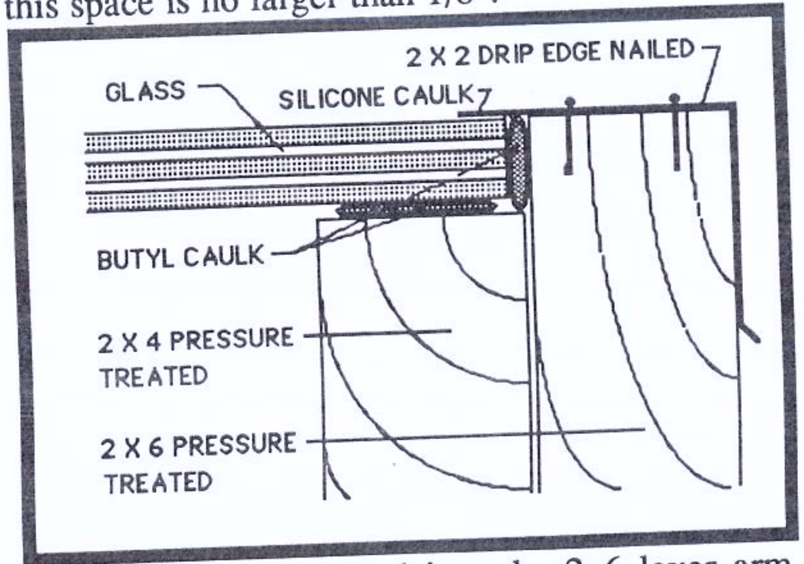


They require a slight notch to be cut in their frame to allow the balance arm to pass through.



For both cases (manufactured dome or custom glass) **it is best to install the weight in the box after the skylight has been totally detailed.** This is the only way to get the right amount of weight for the counter balance.

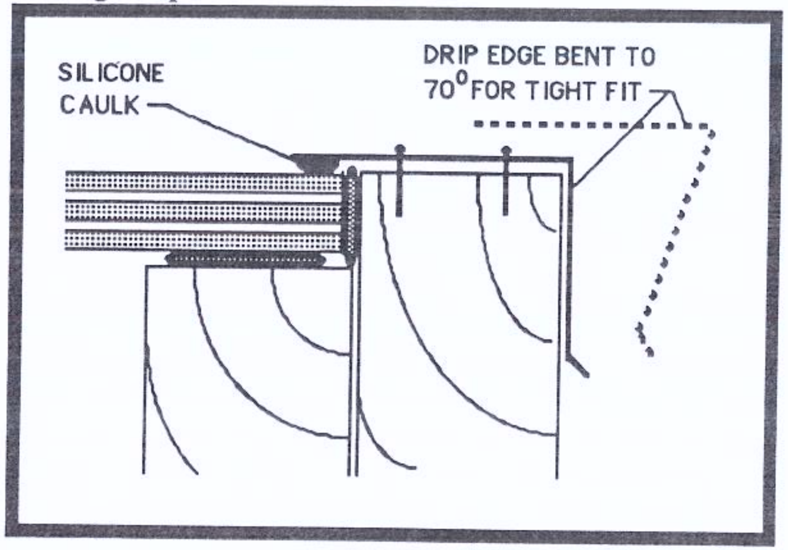
If a regular custom glass unit is used, the unit should be seated on the lid frame in clear butyl caulk and held in with a piece if 2x2 drip edge flashing. Before installing the flashing fill the gap between the glass and the 2x6 with butyl caulk. Fill it solid so the unit will not leak even without the flashing. The glass should be sized so this space is no larger than 1/8".



The flashing is screwed into the 2x6 lever arm box. The 2x2 drip edge must be sealed to the glass with a generous bead of silicone caulk. The silicone caulk sometimes interacts with the material used to laminate the three panes of glass. Therefore, it can not be used where it touches the laminating material on the edges of the glass unit.

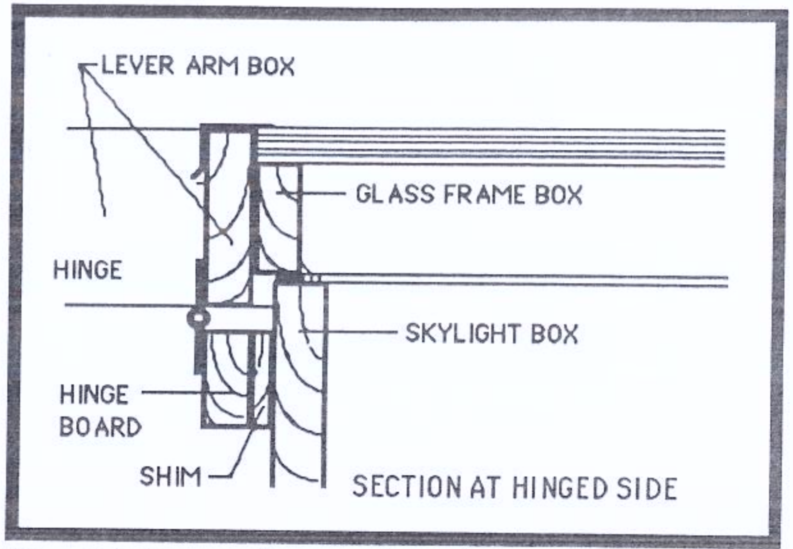
Silicone caulk can be used where it does not touch the edges of the glazing unit.

The 2x2 drip edge comes with a 90 degree bend. This 90 degree bend must be carefully squeezed in to about 70 degrees. Upon installation, it makes a tighter fit when it is forced back to the 90 degree position.

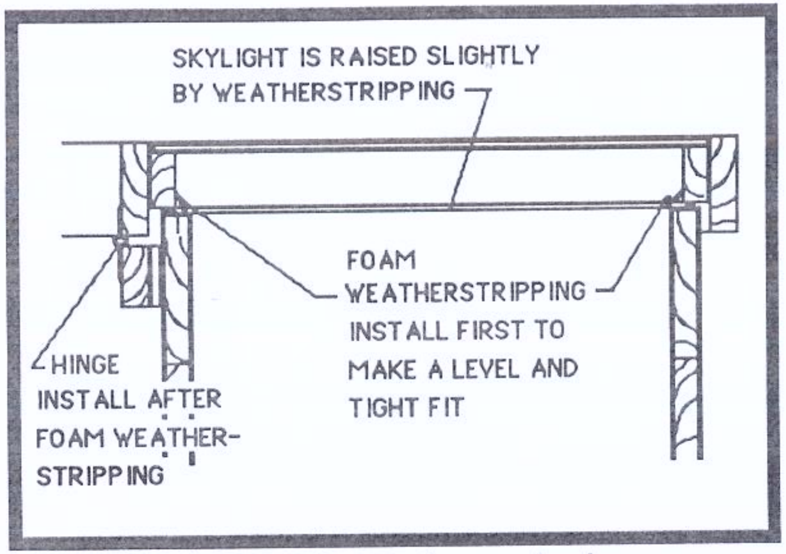


HINGING

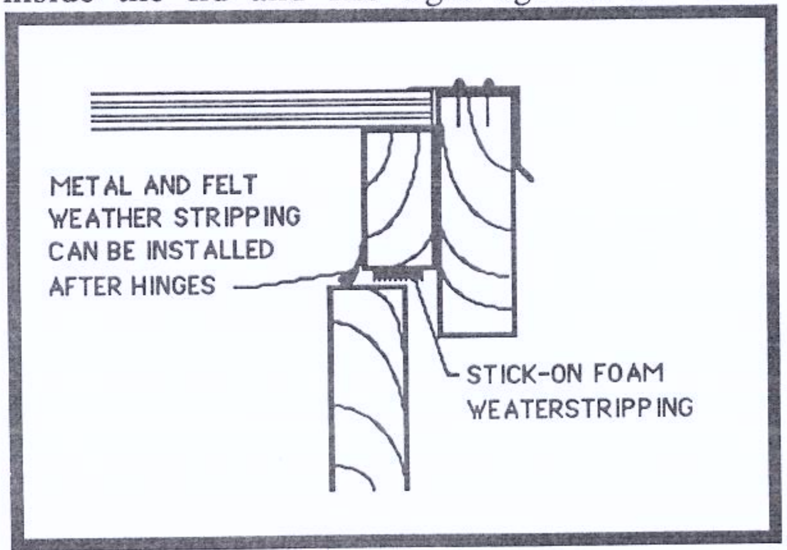
The skylight box must be shimmed on the hinge side (usually south) to allow the hinge board to fit flush with the lever arm box. 3" to 4" butt hinges are used - 3 per skylight. Hinges must be installed **after** weather stripping (described later) as the thickness of the weather stripping slightly re-positions the skylight lid.



The lid is weather stripped in two places as shown. Foam "stick on" weather striping is stuck on the underneath side of the lid. If it is installed on the box side the sun will destroy it. **This foam must go on before the hinges are installed as it slightly raises the skylight.** If hinges are installed first, the lid will be too tight on the hinge side and not tight enough on the opposite side.



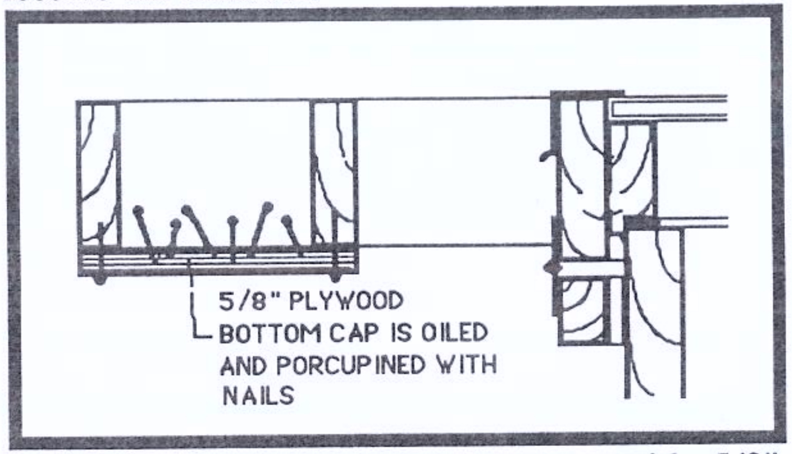
The other piece of weather stripping mounts inside the lid and fits tight against the box.



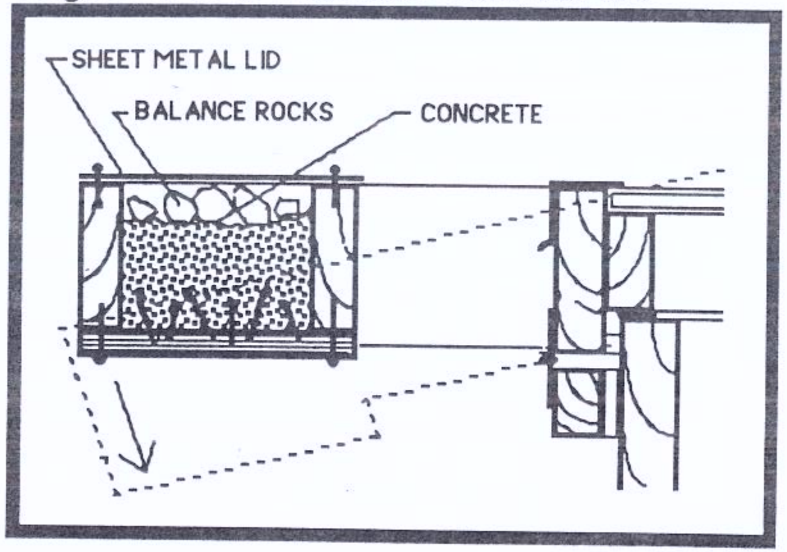
It can be installed after the hinges. Many types of weather stripping will work for this. The sun does blast this area so the best type is metal and felt neither of which will rot from sun abuse. Some plastics and rubber deteriorate in the sun.

WEIGHTING

The counter balance weight is usually poured concrete. The balance box is detailed as shown to receive the concrete.

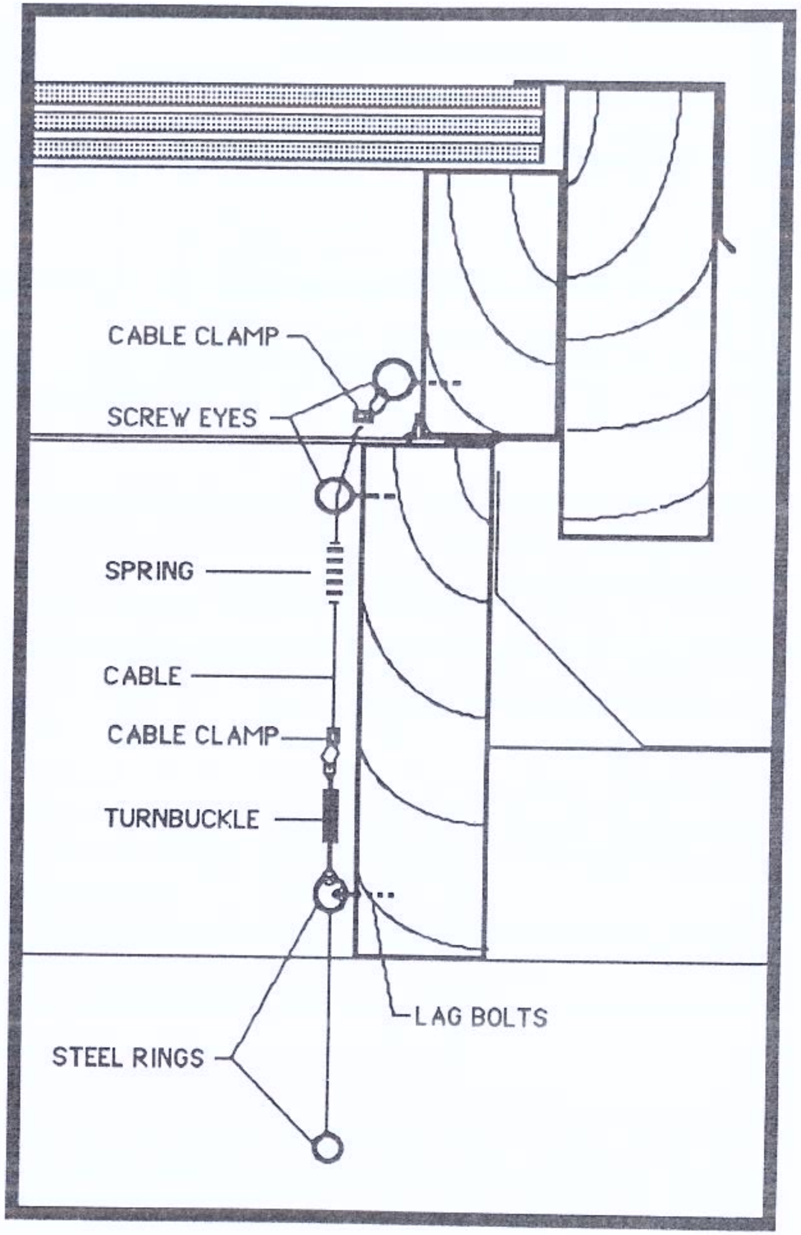


The box is capped on the bottom with 5/8" plywood to hold the concrete. It should be oiled (with linseed oil) and porcupined before pouring in the concrete. The oil is to prevent rotting and the porcupine detail (with 1-1/2" roofing nails) is to hold in the concrete. The weighting must happen after the glass is installed and all detailing is complete. This is to assure an appropriate counter balance weight. Simply pour in the concrete until the weight of the concrete opens the skylight. Shut the skylight. If it opens again by itself you have enough concrete. The concrete will get lighter as it cures so have it a little on the heavy side. You can adjust it with a rock or two later. A sheet metal lid should be installed on the weight box so it won't hold water and rot.



HARDWARE

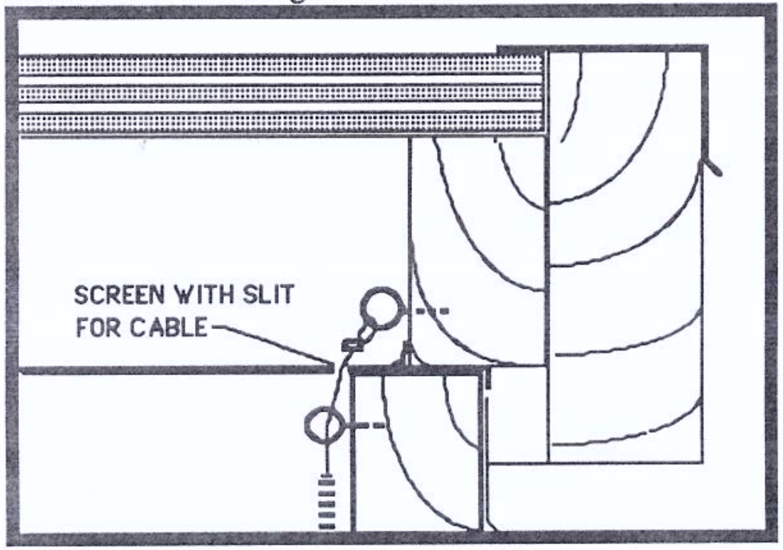
The skylight is pulled shut with a small cable. The cable is guided by screw eyes. A turnbuckle is installed to provide winter tightening. Small steel rings are used to hook the skylight to lag screw heads for different positions. A dowel (or long stick) with a hook on the end is used for operation. The spring illustrated above is a very important factor of the hardware. It allows a bit of tension and stretching to occur so the lid can be pulled over the lag heads.



The most common mistake in this hardware installation is that the spring is not heavy duty enough and fatigues. Be sure to get a sturdy, automotive type spring (see Appendix, Chapter 8).

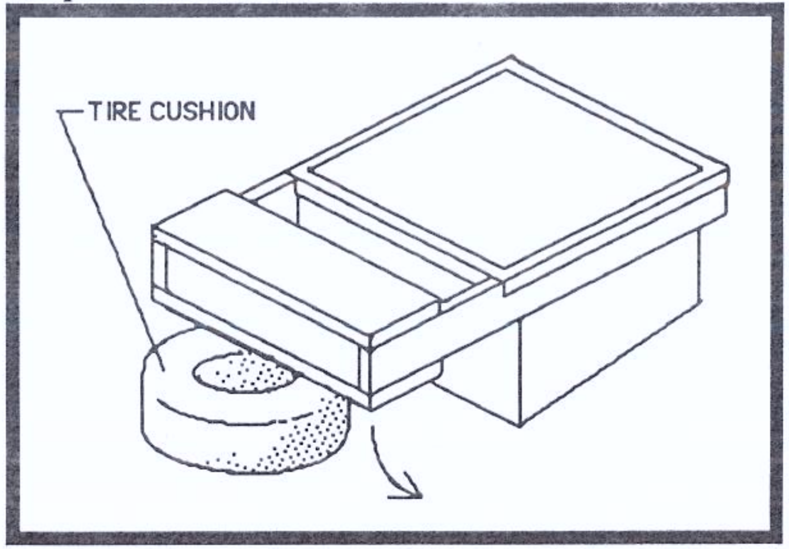
Install the hardware with the turnbuckle open all the way. This will allow tightening later.

A screen can be stapled over the skylight box with a small slit for the guided cable.

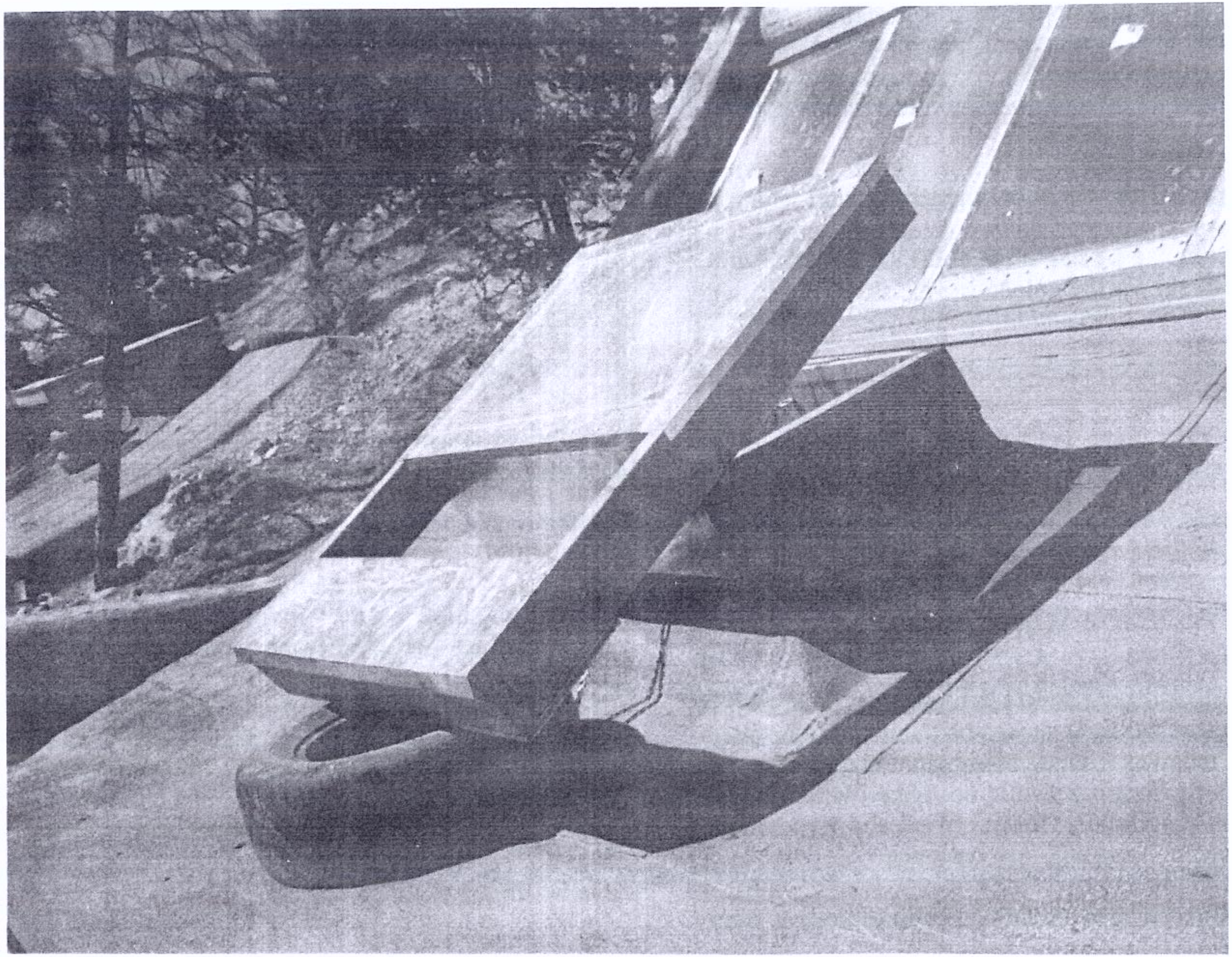


The entire skylight should be painted and or oiled for it receives a lot of abuse from the weather on the roof. Flashing should be rubbed with vinegar before painting. This removes the galvanized film so the paint will stay on longer.

The skylight must have a cushion to keep it from banging against the roof. One or two #13 tires are perfect for this.



You now have an operable skylight that will never wear out with two or more open positions and the only energy it uses is the free energy of **GRAVITY.**



APPENDIX

SPRINGS FOR SKYLIGHT
Order from SSA
Box 1041
Taos, NM 87571
(505) 758-9870

PEACHTREE WINDOWS
Model - A2418 Size - 18" x 24" R.O. - 18 1/2" x 25"
These windows take up to 2 months to get, order accordingly.
Order from SSA or your local glass dealer.
Box 1041
Taos, NM 87571
(505) 758-9870

DOME SKYLIGHTS
Order from SSA or your local glass dealer.
Box 1041
Taos, NM 87571
(505) 758-9870
Be sure to order triple pane for best heat retention.

HEAT MIRROR GLASS and LOW E GLASS
See your local glass dealer. There are many brand names for glass that reduces heat loss. They are expensive and take a long time to get.

The following photo includes a SUNFROST refrigerator (see appendix, Chapter 1)