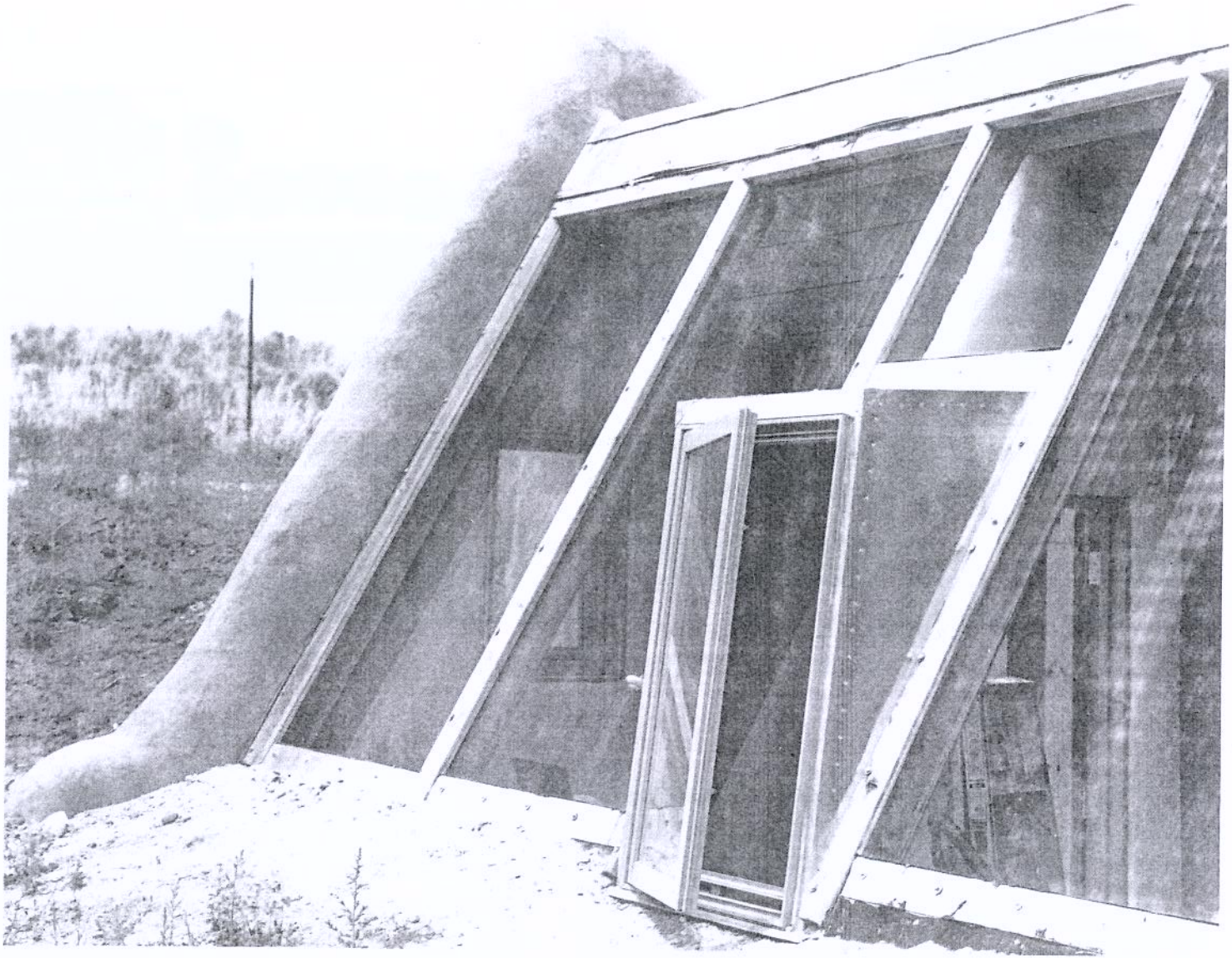
7. THE GREENHOUSE

HOW TO BUILD THE GREENHOUSE-HALLWAY-HEATING DUCT

The greenhouse - hallway - heating duct is mostly carpentry work involving relatively common carpentry skills to build the window framework on top of a tire foundation. This chapter takes you step by step through the construction and detailing of this part of the "U module".

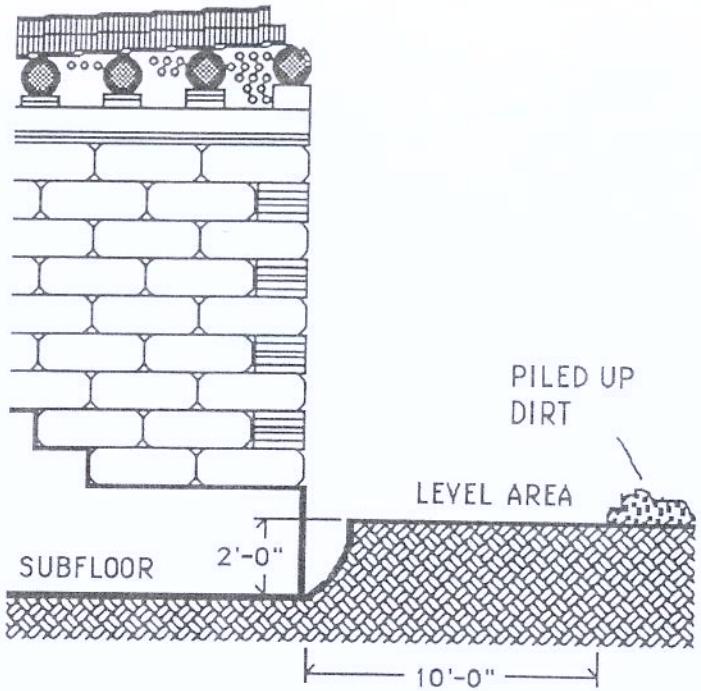
Beginning of Greenhouse.

Finished Greenhouse - interior.



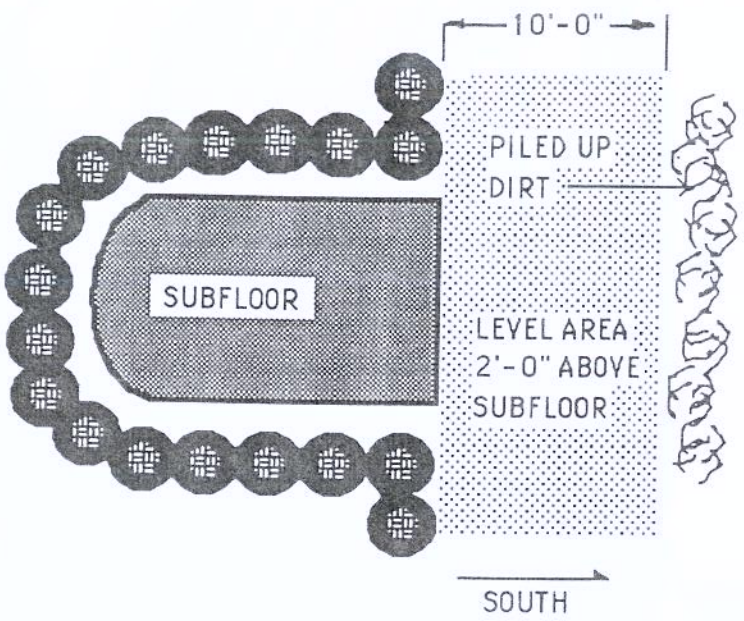
Finished Greenhouse - exterior.

Fig. 1



SECTION

Fig. 2



PLAN

EXCAVATION

The first step in building the greenhouse is to layout the tire foundation for it. Preparation for this tire work involves a second excavation where a level area is created for about 10'-0" south of the "U". This level area is usually about 2'-0" above the sub floor. The subfloor is the level of the dirt excavated inside the "U". In preparation for pounding the tires, loose dirt should be piled up east to west along the south side of the leveled area (Fig. 1 & 2).

Fig. 3

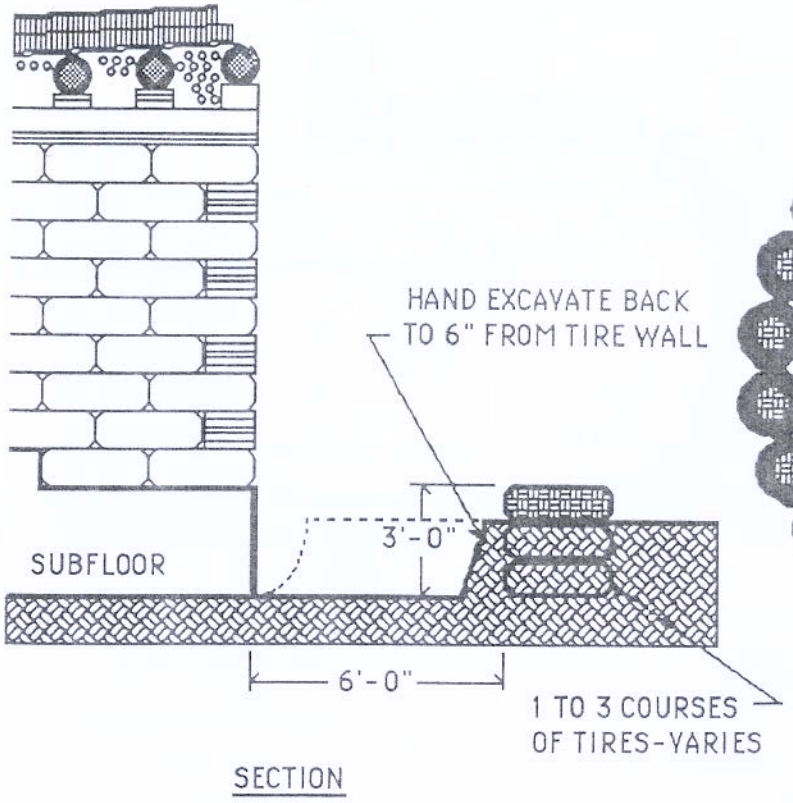
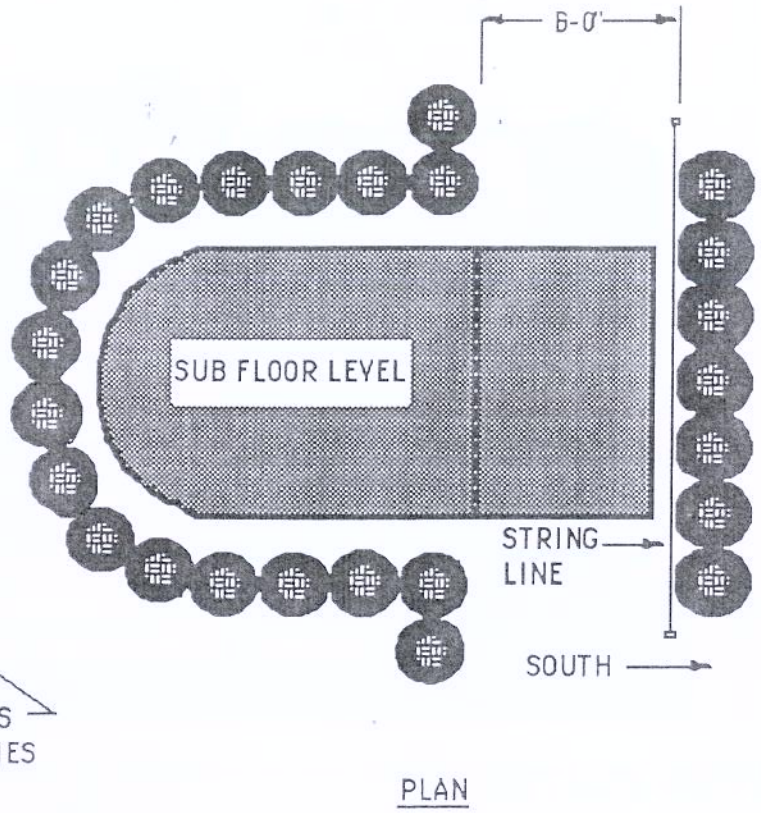


Fig. 4



TIRE FOUNDATION

Now install a row of pounded tires placed 6'-0" to the south of the "U" (Fig. 3). This row will be one to four courses high depending on the existing terrain. Use a string, east to west, on the inside of the row of tires as a guide (Fig. 4). The top of the top course must be about 3'-0" above the subfloor (Fig. 3). It is very important that this top course of tires be perfectly level (see Fig. 14 & 15 Chap. 6). Now you can hand excavate the subfloor level back to within 6" of the tire foundation (Fig 3).

Fig. 5

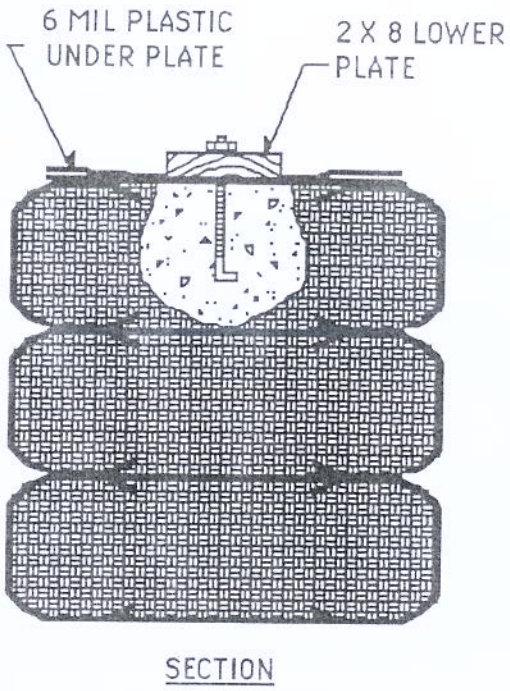
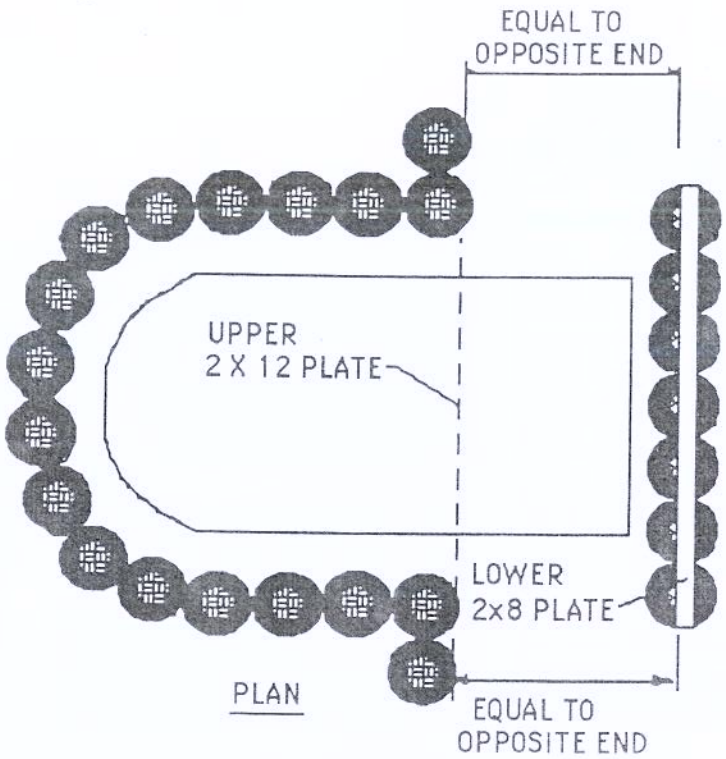


Fig. 6



WOOD PLATES

Now you are ready to install the upper and lower wood plates that receive the carpentry for the front face of the greenhouse. This process requires some fairly conventional carpentry skills. We suggest you consult a carpenter for this phase. It is very important that these plates be level and parallel to each other. The lower wood plate is a pressure treated 2x8 (Fig. 5) installed the same as the 2x12's on the top of the tire wall of the "U". Anchor bolts occur in every other tire (See Figures 35 and 36 Chap. 6). Put down two layers of 6 mil. plastic over the tires first.

Fig. 7

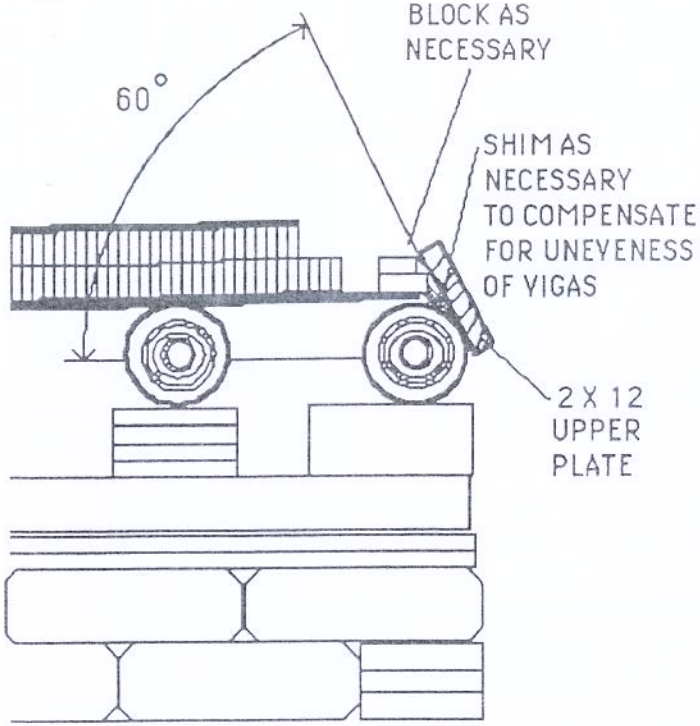
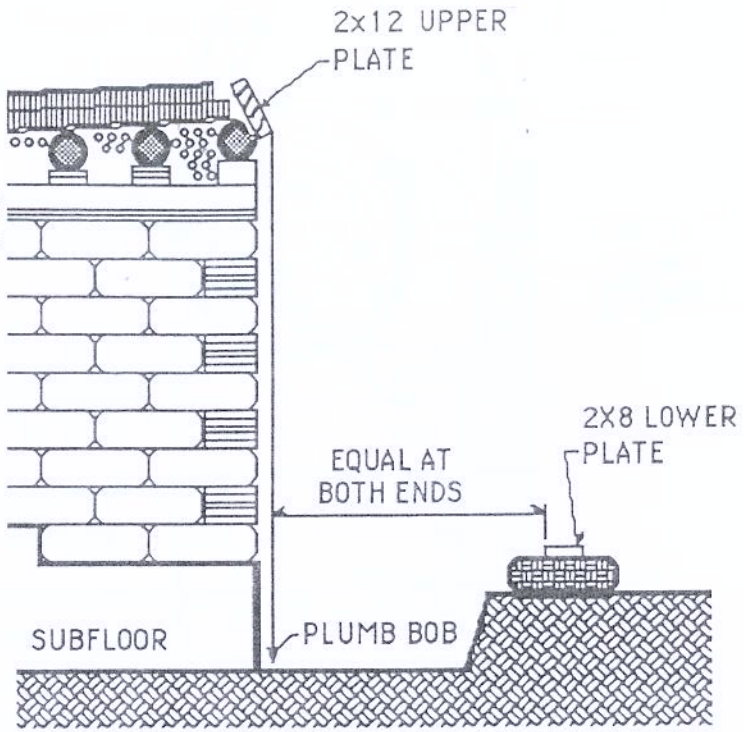


Fig. 8



The top plate is a 2x12 installed on the front viga or beam at a *60° angle to the horizontal (Fig 7). The board is simply nailed to the beam with 16cc nails. It must be perfectly level and parallel to the lower 2x8 plate. To achieve this, drop a plumb bob off both ends and measure over to the lower 2x8 plate on the tires (Fig. 8). Minor adjustments can be made with shims between the beam and the 2x12 plate (Fig 7). Place 2x4 blocking behind the 2x12 plate to help support and anchor the top of it. Nail the blocking into the deck and the 2x12 plate into the blocking. Be careful not to punch nails through the decking since they may be visible below.

*** This angle is perpendicular to the lowest winter sun for your area. If the low winter sun is coming at 30° this angle is 60°. Check the angle of the sun at the winter solstice for your latitude. See chap. 2.**

Fig. 9

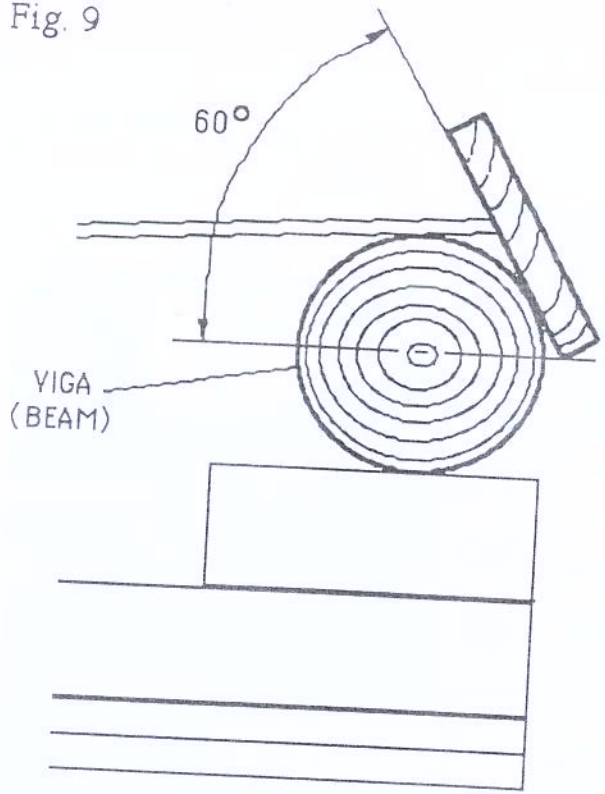
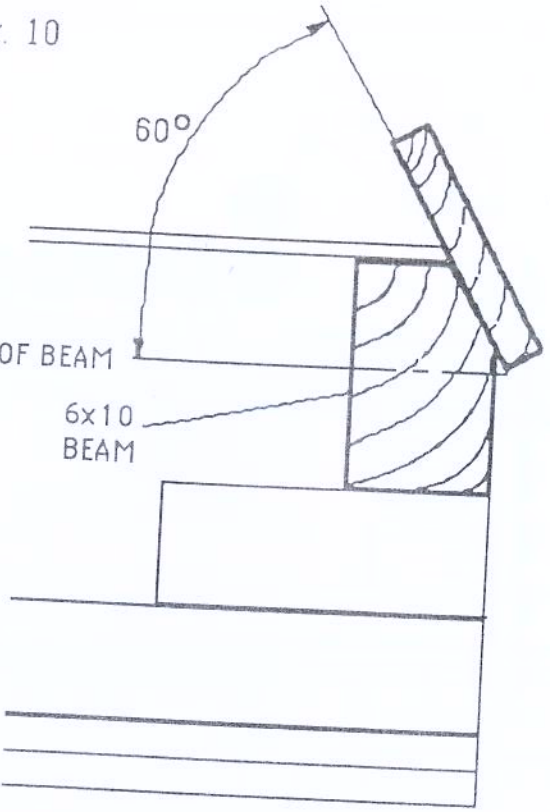
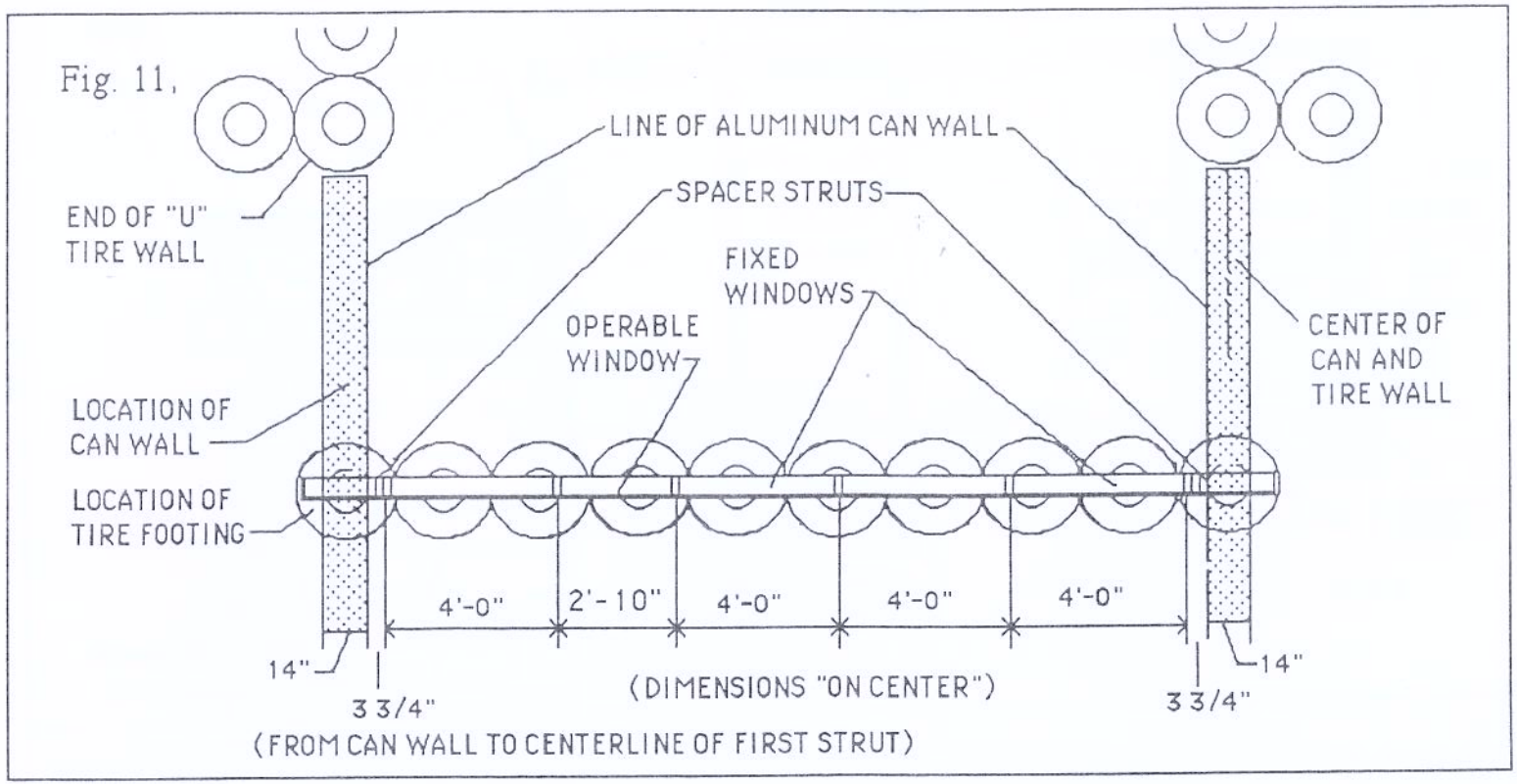


Fig. 10



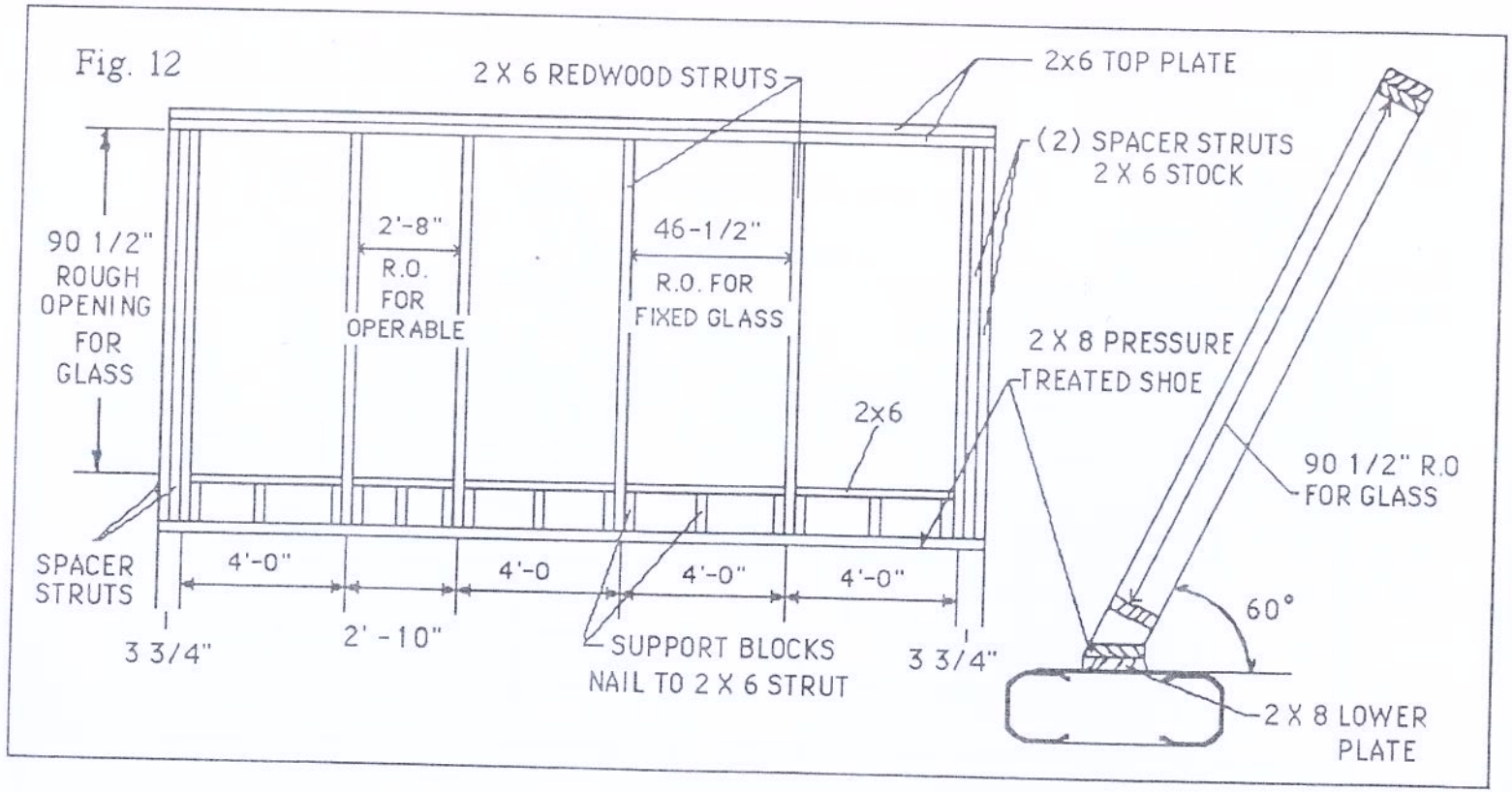
UPPER PLATE VARIATIONS AND LOCATION

In cases where round vigas (beams) are not available square timbers are often used. This requires the appropriate angle (60° in this example) to be cut off at the corner of the beam to receive the 2x12 plate. In both cases notice that the 2x12 is placed with the bottom corner at the approximate center of the beam. This allows the ceiling decking to stop or butt into the beam and also allows for other roof detailing later. Have a builder size your beams for you. In most cases 6x10 roof beams are used. The size of the beam is related to how far it has to span and what loads it has to carry relative to snow, additional stories, etc.



GLAZING LAYOUT

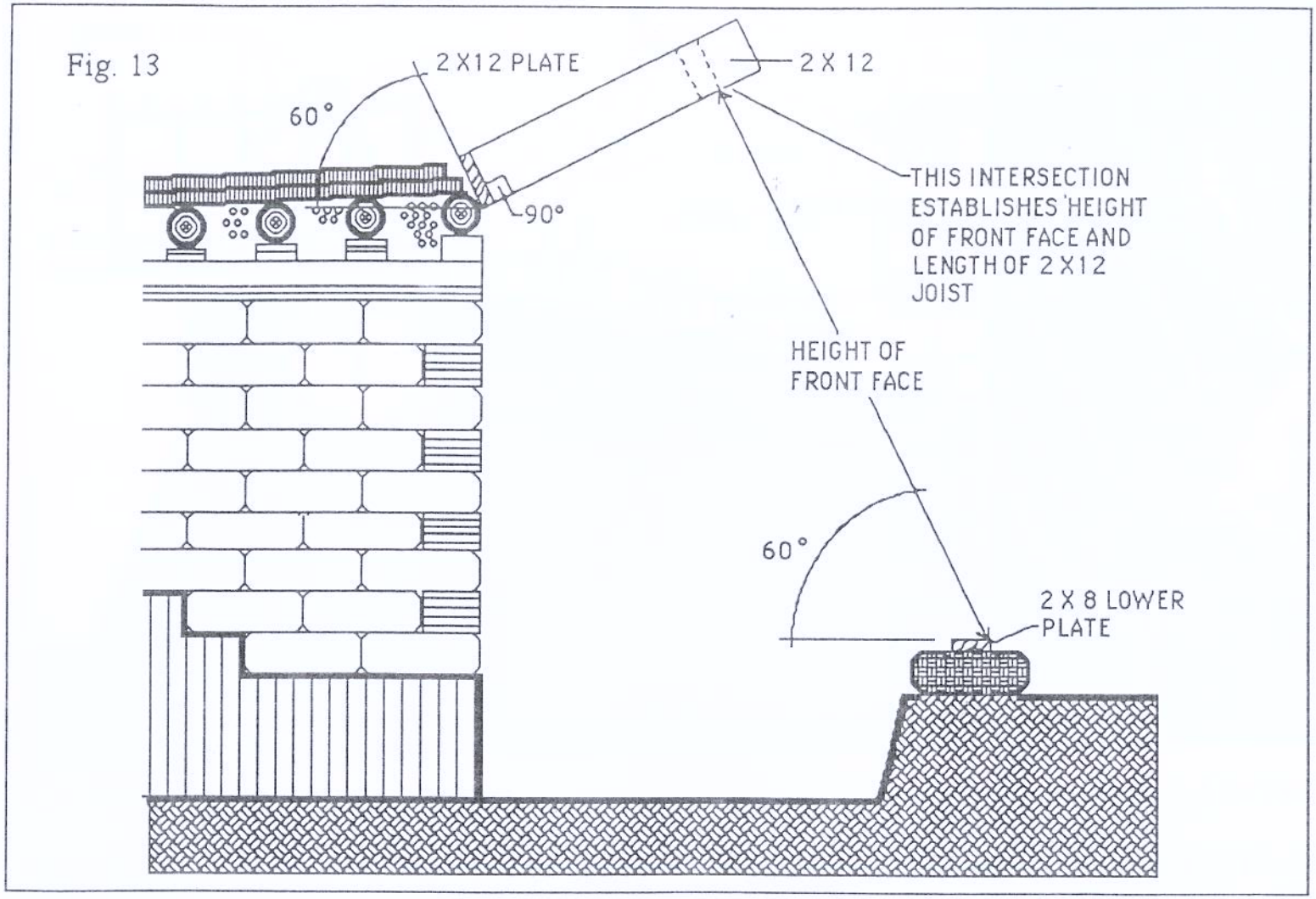
You are now ready to lay out the front face on the wood sill plate. The end walls of the greenhouse (which are made of aluminum cans) must be located on the plate first. These walls are 14" wide and are centered on the tire walls of the "U". Locate these can walls and project them to the lower wood plate. Next allow for two spacer struts on each end. These take up 1 1/2" each. so allow for a 3" space on each end next to the can wall. The first structural strut will go next to the spacer struts. Each strut is 1 1/2" wide. Structural struts are located relative to the center of the strut so the center of the first strut must be established. This is done by measuring over 3/4" from the spacer struts. **You now have the center of the first strut established 3 3/4" from the can wall.** Strut dimensions for fixed glass are 4'-0" on center and operables call for 2'- 10" on center. You can now layout as many of each as you want. Only one operable window per "U" is needed. Stock glass sizes are much cheaper than custom sizes.The 4'-0" dimension allows



for a stock 46"x 90" glass size available all over the country. Struts should be placed with this in mind wherever possible.Three easily accessible stock glass sizes are 34 x 90, 46 x 90, and 58 x 90. Rough openings must be 1/2" larger each way.

FRAMING THE FRONT FACE

The front face is now framed much like a regular frame wall. A framing carpenter should be consulted here. The wall is framed flat on the ground as a unit out of redwood 2x6 stock. The pressure treated 2x8 is attached to a 60° angle cut on the bottom of the strut. For this example the angle is 60° (see chap. 2 for your angle). This shoe will then be nailed flat on to the 2x8 plate. Notice the support blocks (from 2x6 stock) under all rough openings. Use galvanized nails for all connections in framing the front face. **The critical point in framing the front face is to have square openings for the glass.**



ESTABLISHING THE HEIGHT OF THE FRONT FACE

The dimension height of the front face frame varies with your specific situation. To establish it simply project a 2x12 straight out from (at 90 degrees to) the upper 2x12 plate.

Measure up from the outside edge of the lower plate at 60°. Where these meet, is the measurement for the height of the front face frame wall, and the length of the 2x12 joists.

Fig. 14

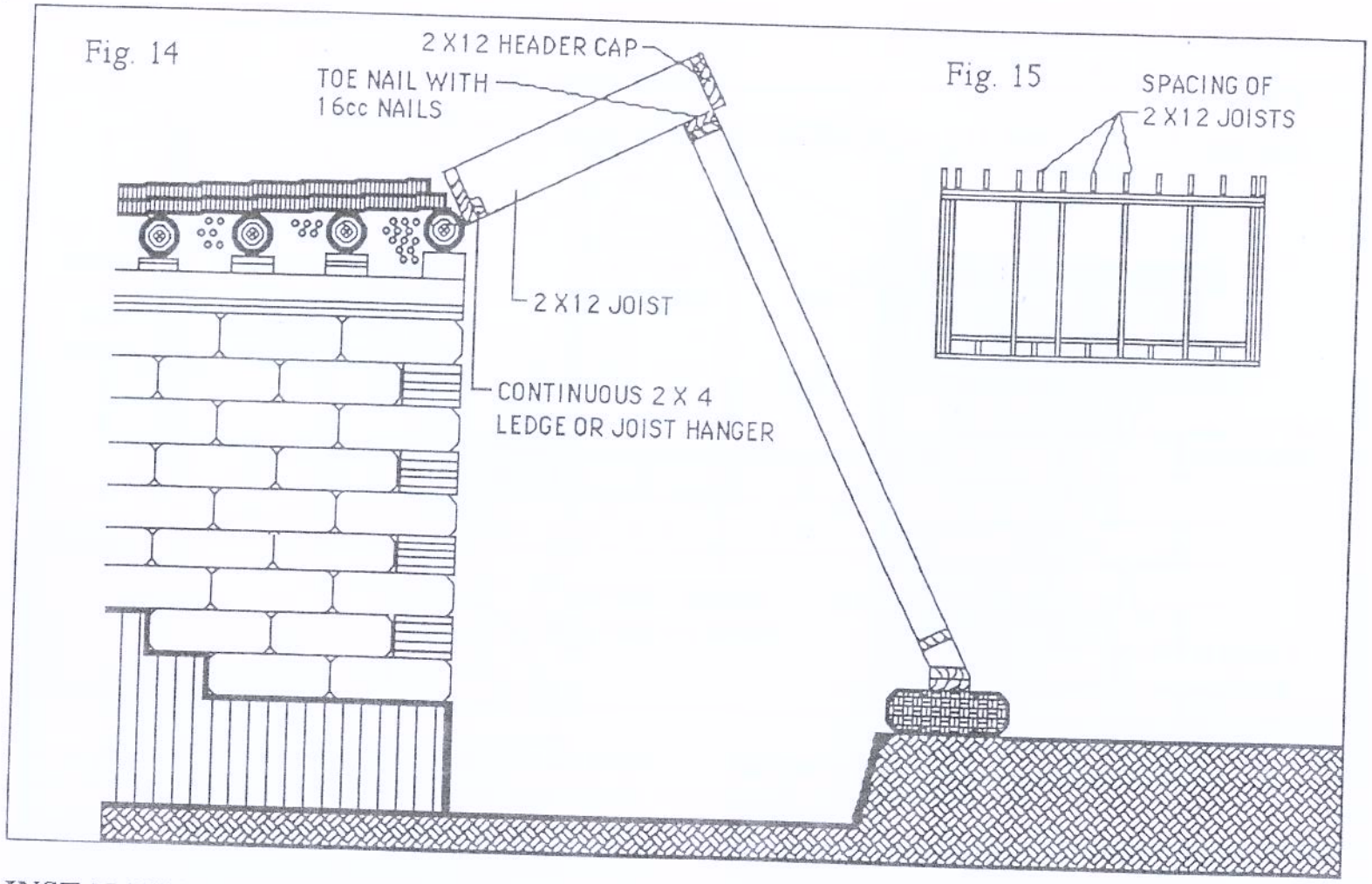
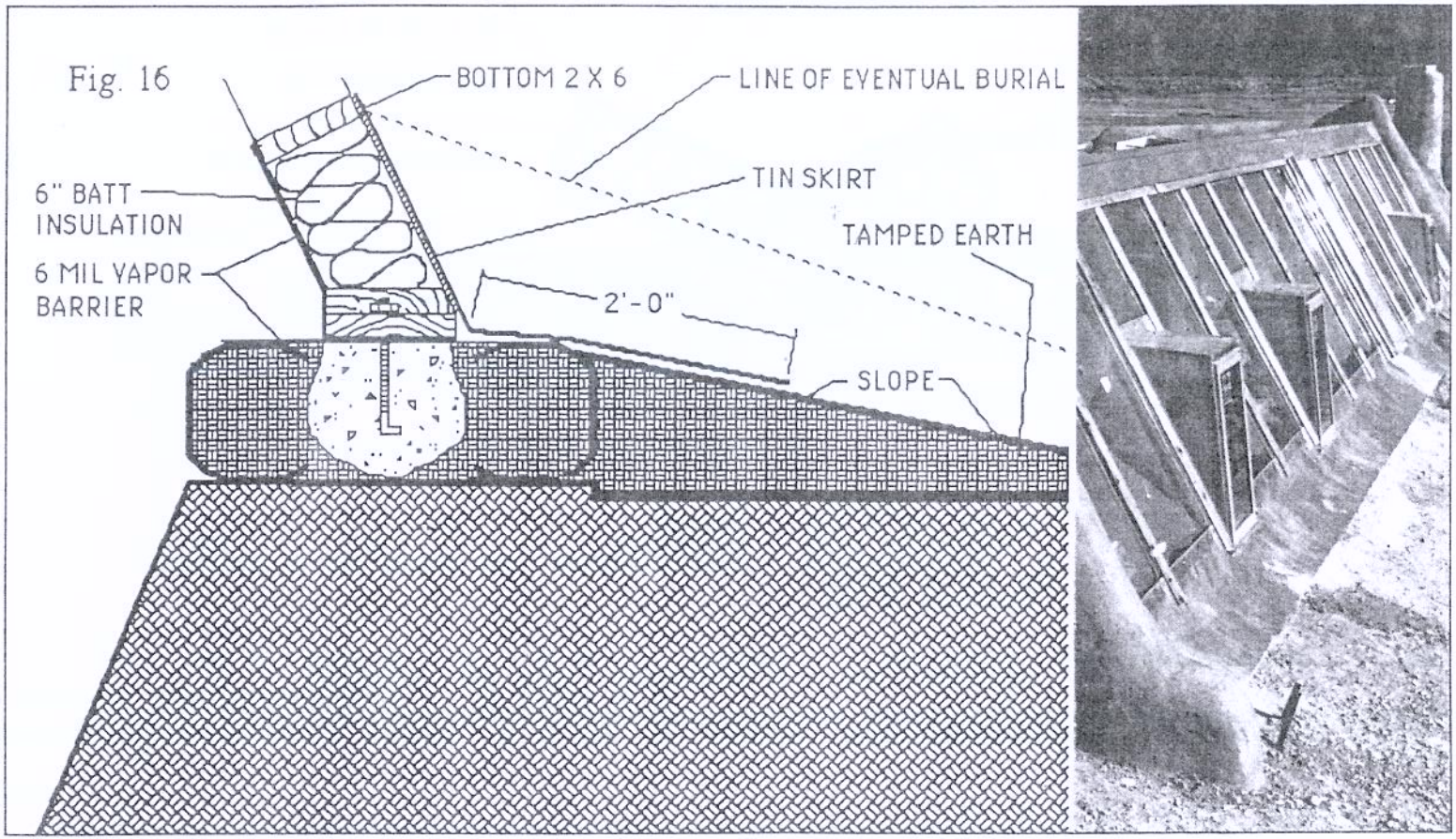


Fig. 15

INSTALLING THE FRONT FACE

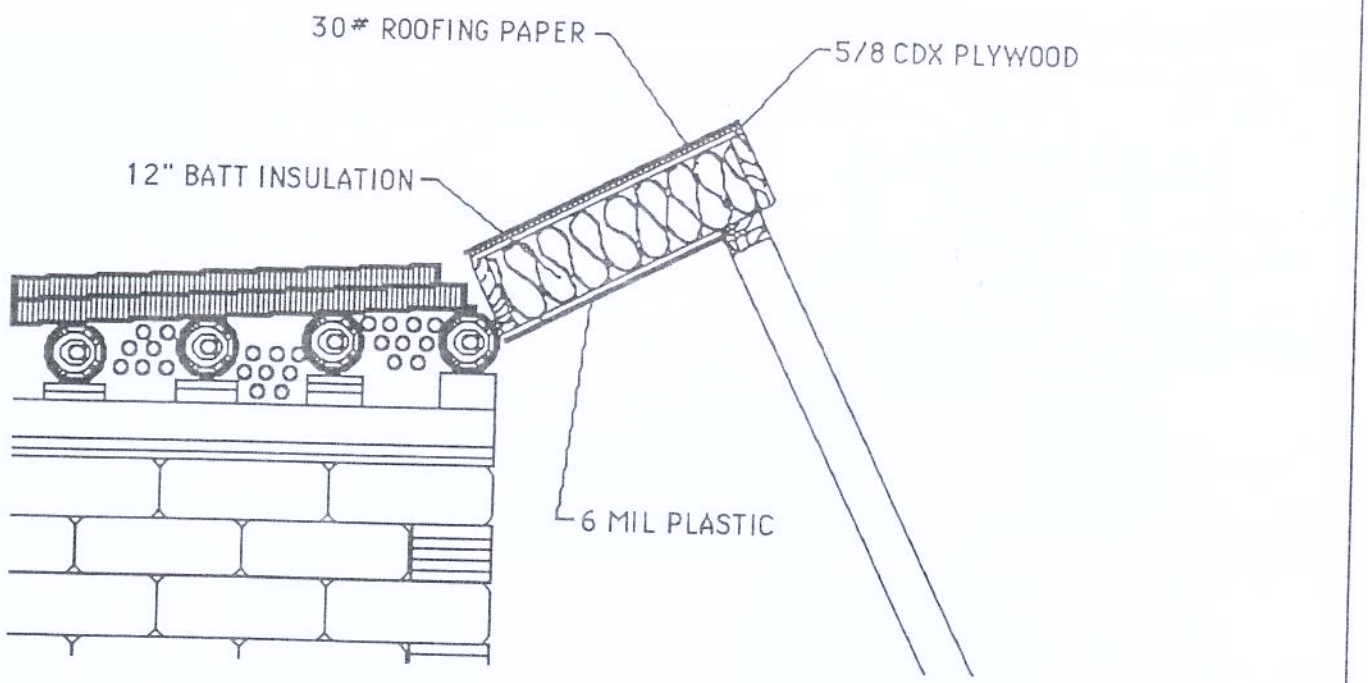
The 2x12 joists are notched to rest on a 2x4 ledge nailed directly to the upper 2x12 plate. Typical metal joist hangers are also an alternative to this ledge. The other end of the 2x12 joists rest on the top of the framed front face wall with a toe-nailed connection using 16cc nails. Joist hangers can also be used upside down here for a better connection. The 2x12 joists occur directly above each vertical 2x6 framing strut and are in the middle of each rough opening (Fig. 15). Now a 2x12 header cap can be nailed across the top of the front face.



TIN SKIRT

After the front face framing has been installed, a tin sheet is nailed on from the bottom horizontal 2x6 down and out, sloping away from the building about 2'-0". Earth must be back filled and tamped to create a slope away from the building for this tin to lay on. This is 28 gauge sheet metal usually from a 3'-0" x 50' roll. It is painted with liquid tar on the underneath side before installation. After installation it is painted on the top side. The tar is to prevent the galvanized sheet metal from deteriorating. The eventual burial will cover all of this sheet metal. Next install 6" batt insulation under the bottom 2x6 and staple a 6 mil vapor barrier over the inside cavity formed by the tin and the wooden sections under the window frames (Fig. 16).

Fig. 17



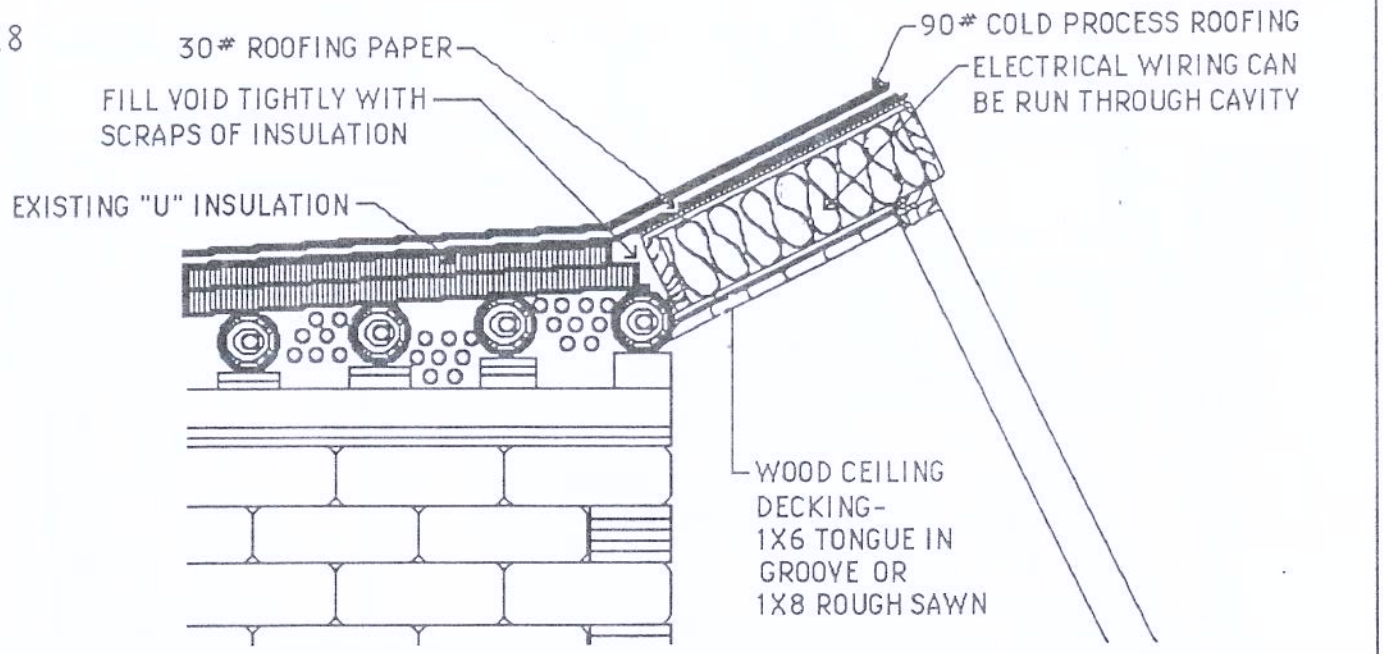
DECKING AND INSULATING ROOF

Staple a layer of 6 mil plastic vapor barrier on the under side of the 2x12 joists. Next lay in 12" of fiber glass batt insulation from the top. The pieces should be neatly cut to fit in the spaces. This is your insulation. Make it fit tightly, but keep it fluffy. The fluffiness is what makes it work. The top of the 2x12's can now be decked with 5/8" CDX plywood installed with 8cc nails.

The plywood should be immediately protected by stapling on a layer of 30# roofing paper.

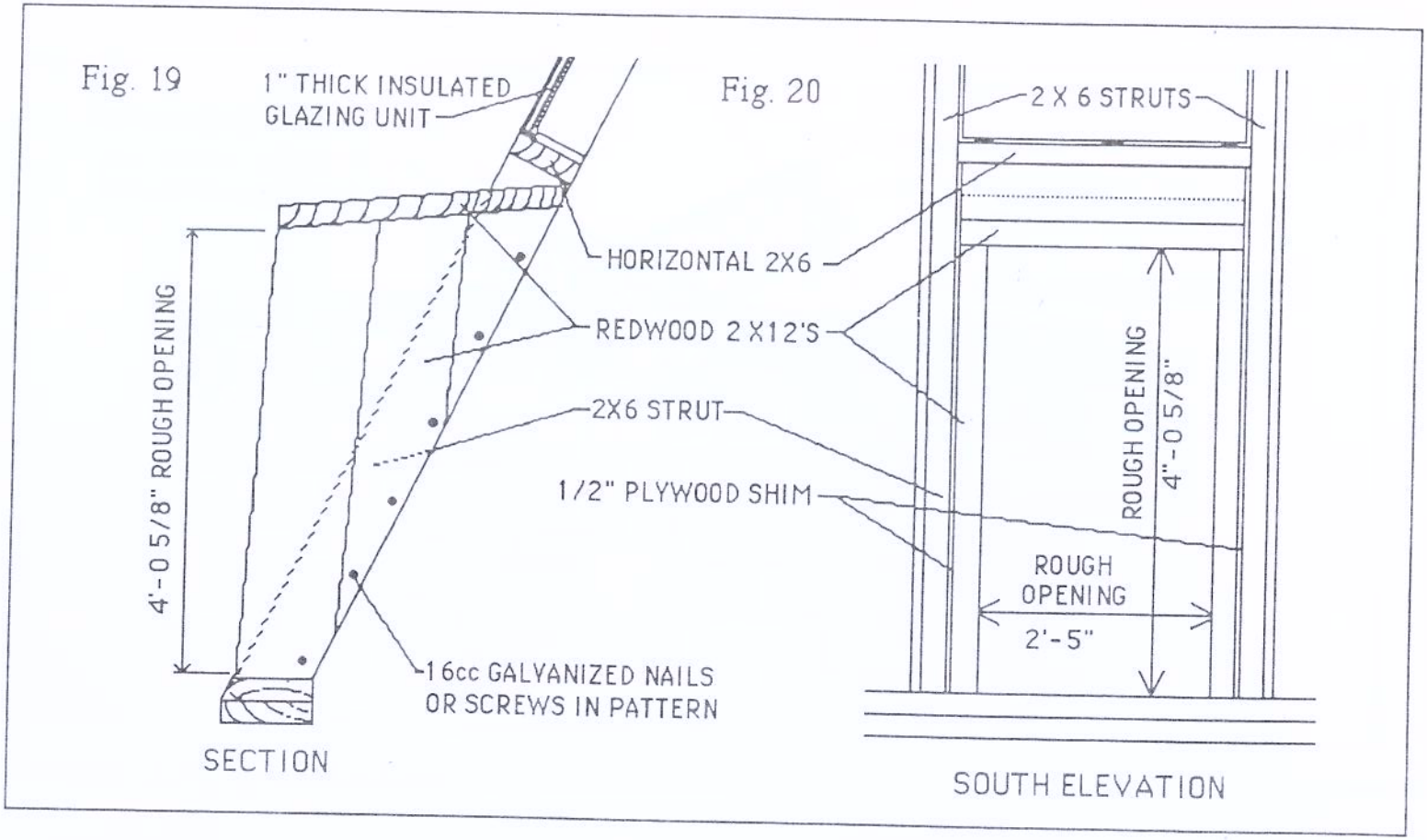
The insulated cavity of the greenhouse roof can be used to run electrical wiring. So, before you close up this area below consult your electrician.

Fig. 18



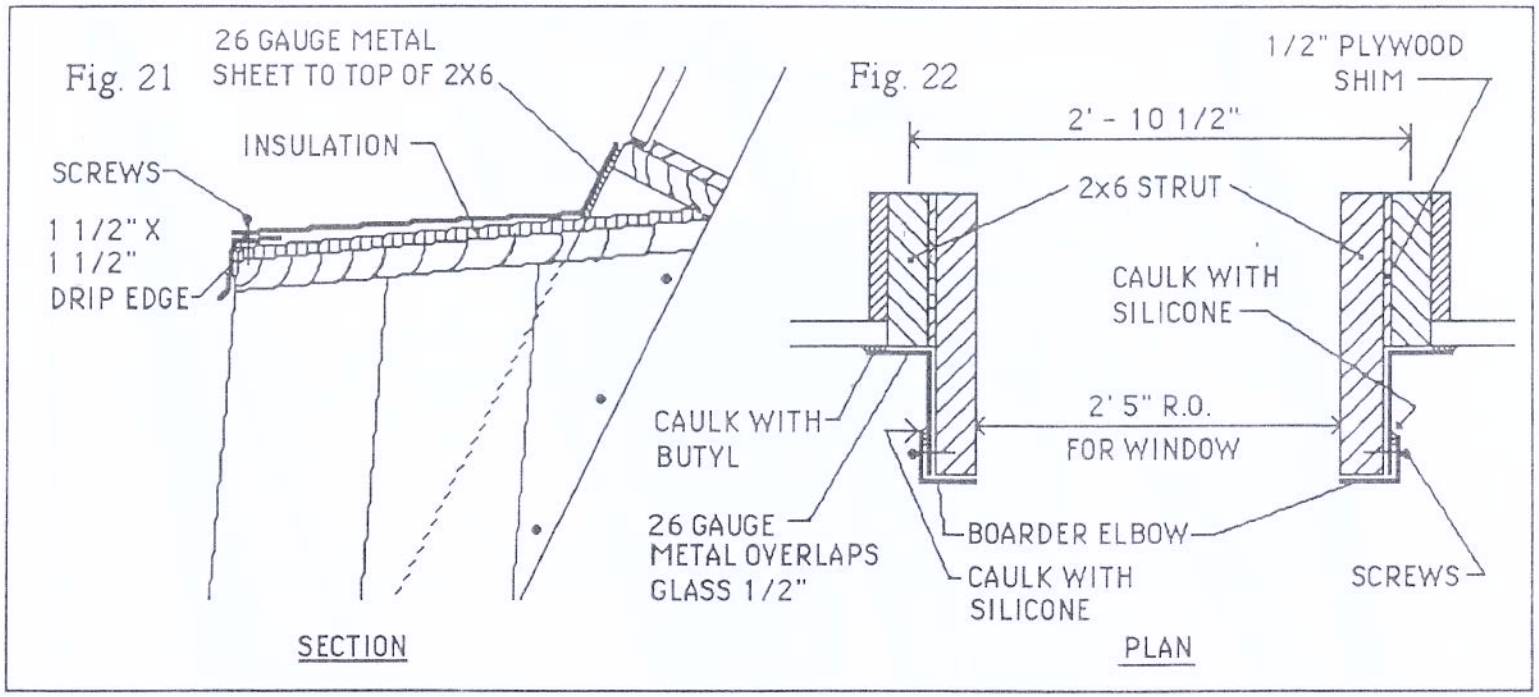
ROOFING

Now the void between the new greenhouse roof and the existing insulated "U" roof can be filled with scraps of 4" thick urathane insulation (R-30 per 4" sheet for a total of R-60). Make this a tight, neat job since sloppy gaps in the insulation allow your warm air to leak out. You are now ready to roll out more 30# roofing over this newly filled patch and install a cold process 90# roof or a rubber roof, which can be installed by a roofer. Wood ceiling decks can also be installed now. Any 1x6 dimension decking can be used.



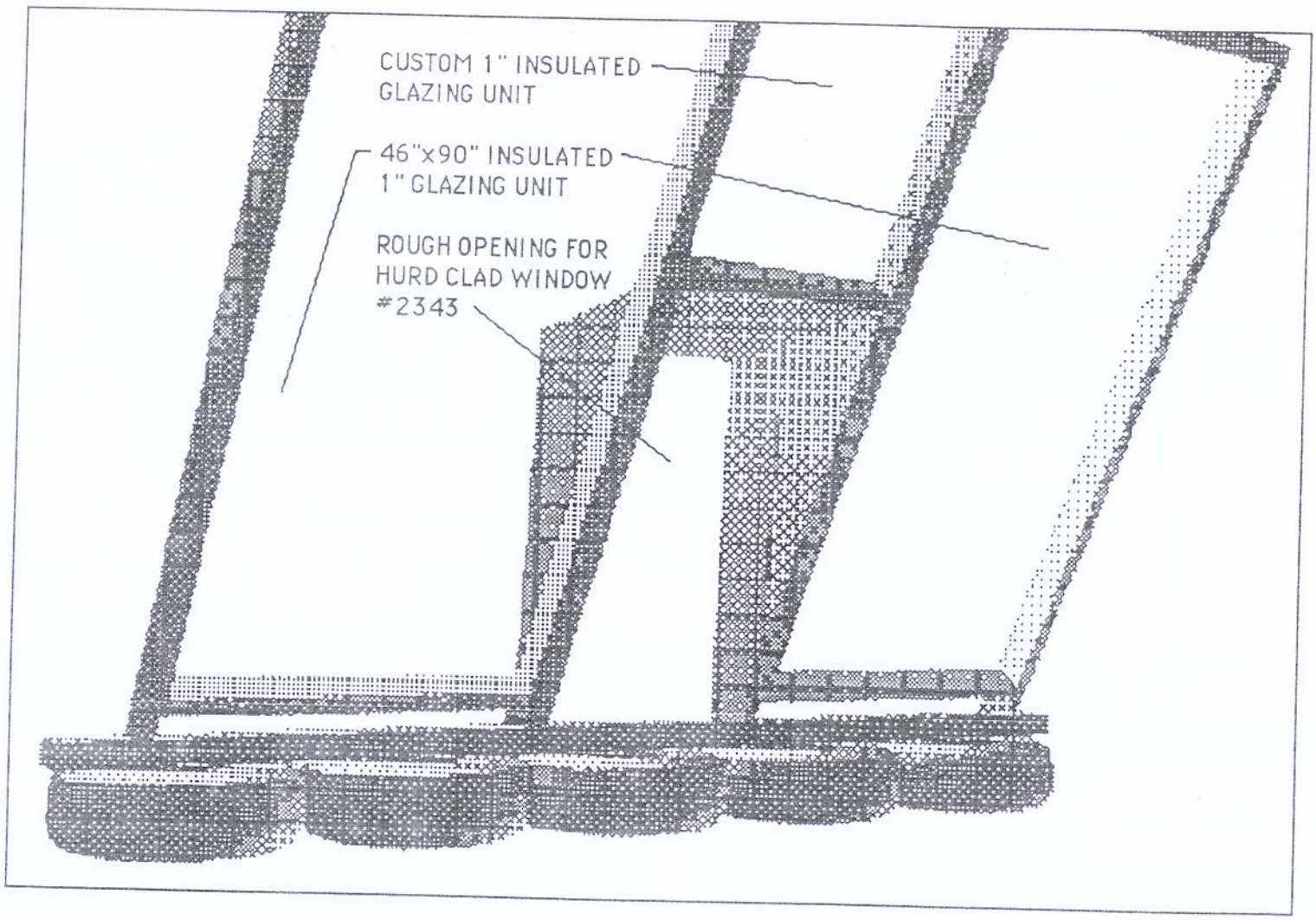
DORMER BOX FOR OPERABLE WINDOW

The dormer box for the operable window is sized for a Hurd metal clad casement window. It is simply a box made of redwood 2x12's built into the existing framing as shown above. A horizontal 2x6 is installed above it as the bottom sill for a fixed piece of glass. This upper opening is then set up for glazing in the the same way as for the 46 1/2" x 90 1/2" openings described on the following pages.The Hurd window is #2343 with a rough opening of 4'-0 5/8" x 2'-5" (Fig. 20). Note the 1/2" plywood shim between the 2x12 dormer box and the 2x6 strut (Figs. 20 and 22). This is necessary to provide a good fit for the glazing covers discussed on the following pages.

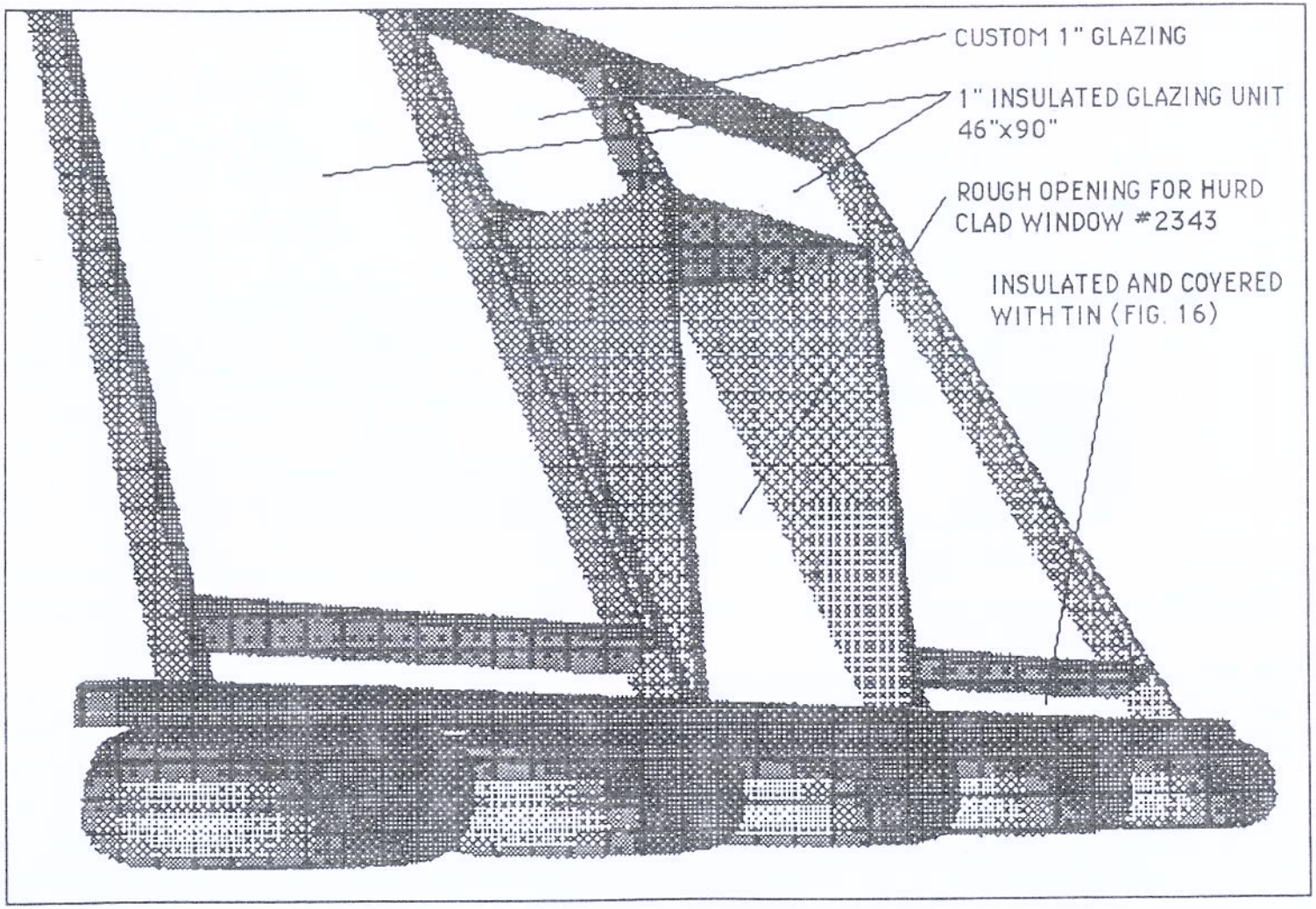


INSULATING AND SHEETING THE WINDOW DORMER

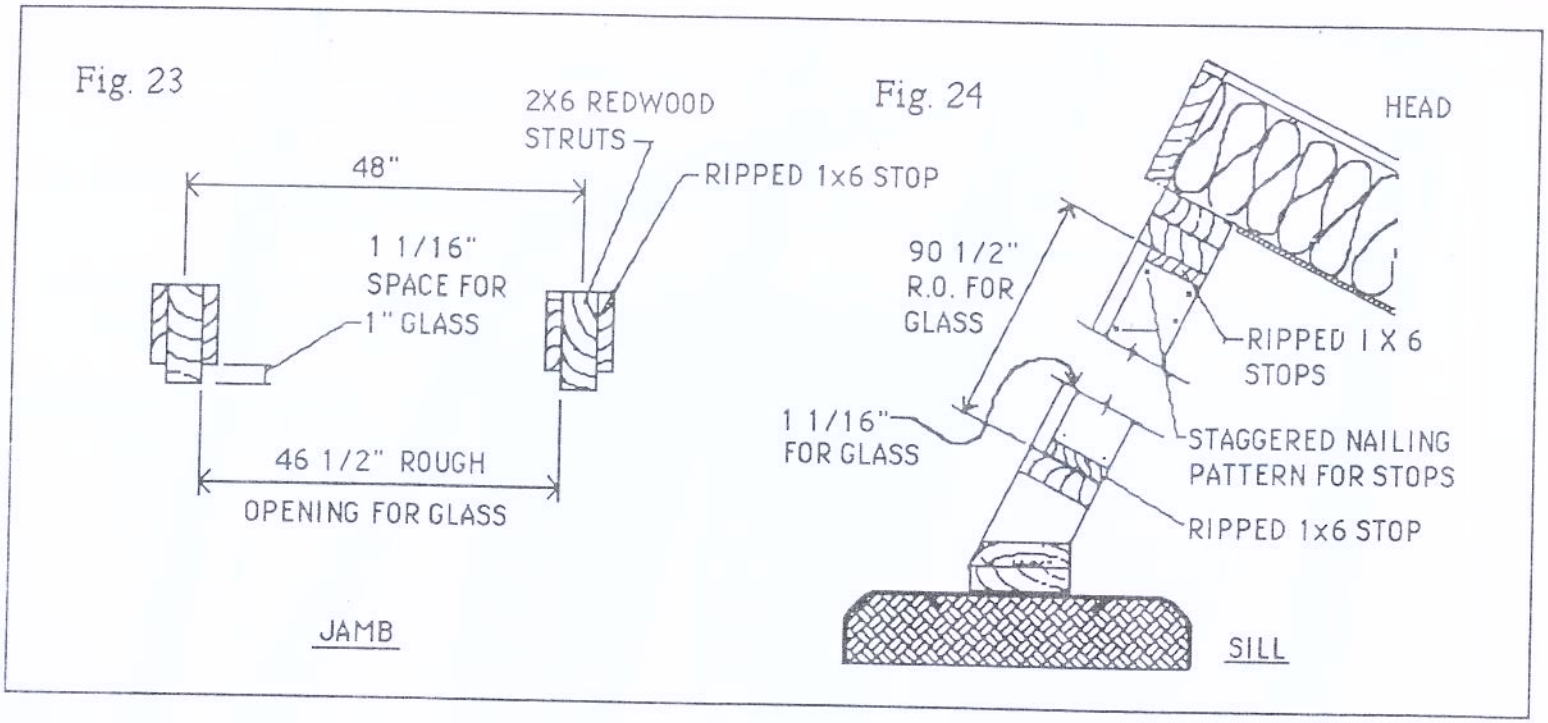
The dormer box should first be wrapped and stapled with a layer of 6 mil plastic. Next, the top is insulated with 1" foam (R-7 or equal) rigid insulation (Fig. 21). Now the sides are sheathed with 26 gauge sheet metal. The flashing should overlap the glass 1/2" as shown (Fig. 22). Caulk this joint with clear butyl caulk between glass and metal. A border elbow of 26 gauge flashing is now installed over the side sheathing. Caulk where this elbow overlaps the side sheathing as shown (Fig. 22) with silicone caulk. Screw this elbow on as shown. Next a 1 1/2" x 1 1/2" drip edge goes on the front top edge of the box over the insulation (Fig. 21). Now sheath the top with 26 gauge metal as shown (Fig. 21). This sheath laps down over the east and west side of the dormer 1 1/2" and is screwed on there. Note that clear butyl caulk is sometimes called for and clear silicone caulk is sometimes called for. This is because silicone caulk causes a reaction with the seal on some glazing units. For this reason avoid all contact between glazing units and silicone caulk.



Inside view of dormer box.



Outside view of dormer box.



GLAZING

The 46" x 90" standard insulated glazing units can now be installed. These are stock glass units, 1" thick, sold all over the U.S.A. See your local glass dealer. The rough opening for this 46" x 90" glass is already built into your front face framing. It is 46 1/2" x 90 1/2". The front face framing must be square to allow this glass to fit with 1/4" tolerance on all sides, thus the 46 1/2" x 90 1/2" rough opening. The redwood stops for this glazing unit must be installed first. They are made from redwood 1 x 6 stock ripped down to the appropriate size to allow a very accurate 1 1/16" space for the 1" thick glass to fit into (Fig. 23). These stops occur all the way around the rough opening (Figs. 23 & 24). They are nailed into the 2x6 strut with 6cc galvanized finish nails with a staggered nailing pattern (Fig. 24).

Fig. 25

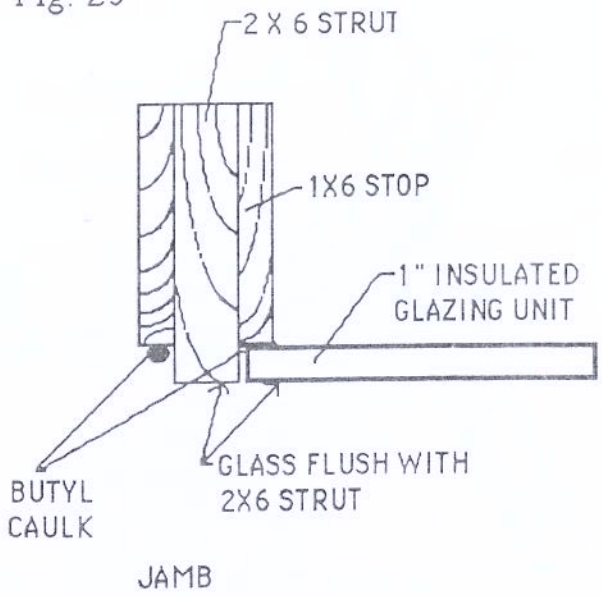
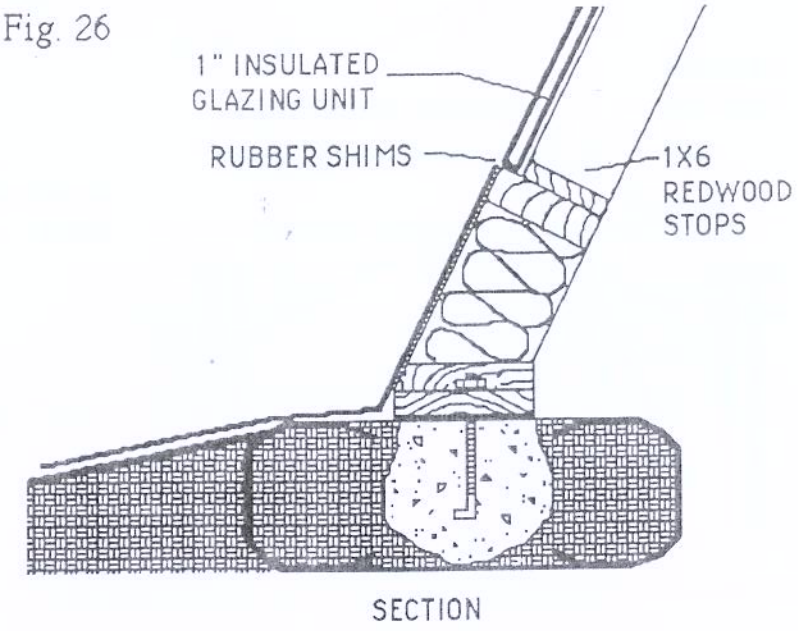


Fig. 26



GLAZING CONT.

The stops must now be caulked with clear butyl caulk (Fig. 25) just before the glass is installed. The glass must sit on rubber shims which come with the glass (Fig 26). Your local glass dealer should be consulted for this procedure. In most cases they install the glass upon delivery. The glass is 1" thick. The caulk takes up about 1/16". This results in the glass being perfectly flush with the 2x6 strut (Fig.25).

These insulated glazing units should cost between $110 and $120. Be sure that you get tempered, regular glass. The new special formula glass types on the market retard solar gain. It would not be advisable to use these if you have a serious winter.

Fig. 27

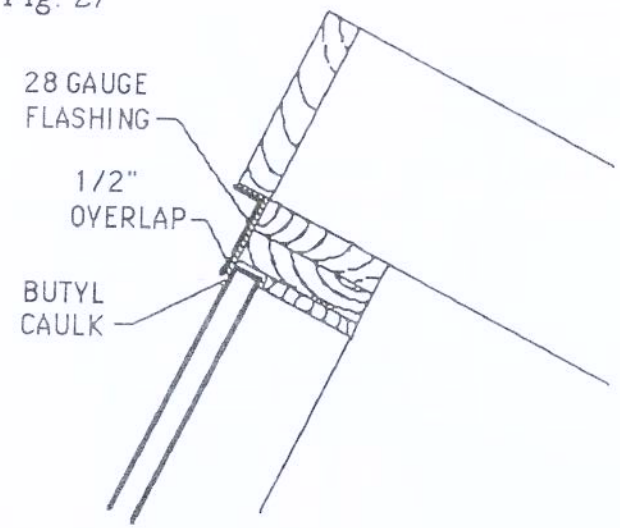
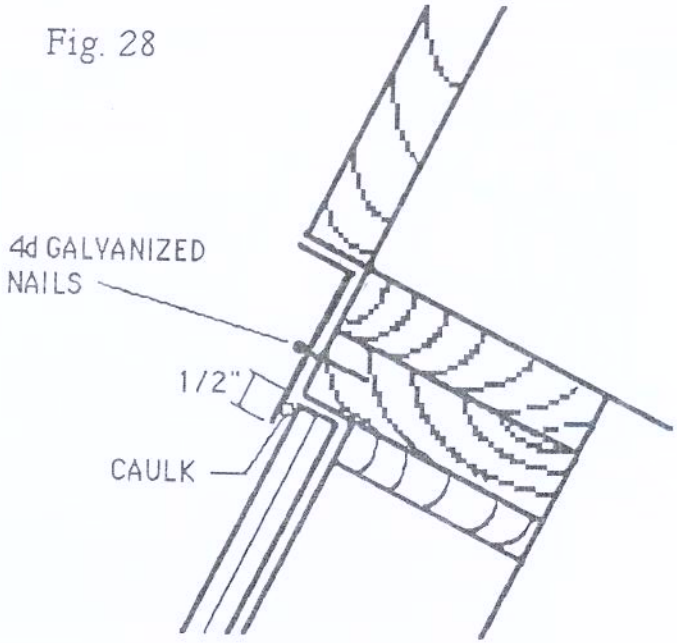


Fig. 28



TOP FLASHING

Preparation for the top glazing board involves flashing the top of the windows with 28 gauge sheet metal flashing as shown (Fig. 27). 28 gauge sheet metal flashing comes in 50 foot rolls in almost any width. Get the width you need and cut it into a manageable length (8 to 10 ft.) and make the 90 degree bend over a straight edge. These pieces can also be purchased pre-bent from a sheet metal shop. These pieces are then tacked in place with 4cc galvanized nails as shown (Fig. 28). Overlap the joints as these pieces are installed. First caulk the top 1/4" of the glass with clear butyl caulk. Next, install the flashing with 4cc galvanized nails. The lower part of the flashing must overlap the glass about 1/2". As it is nailed down, the caulk will ooze out. It can be trimmed later. Lengths of flashing should be tacked up and positioned first and then permanently nailed from the middle out towards the ends. This will avoid a crooked installation of the flashing.

Note that it is a good idea to do all metal work on a hot day so that the metal is hot and fully expanded, otherwise, when you do get a hot day the metal will expand in place and buckle.

Fig. 29

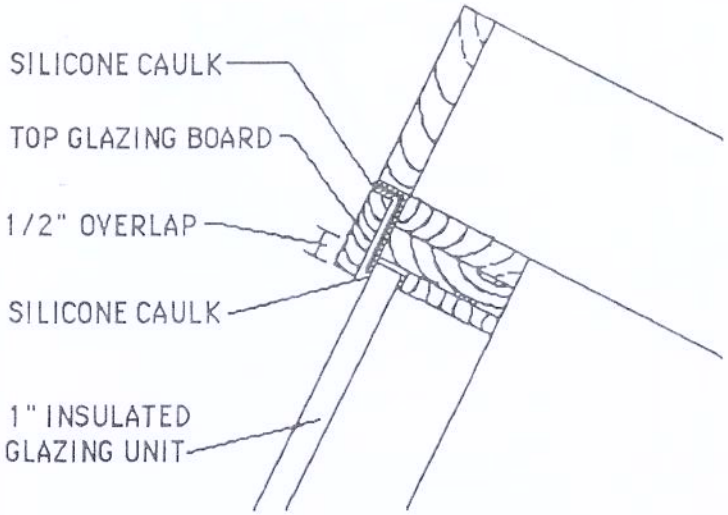
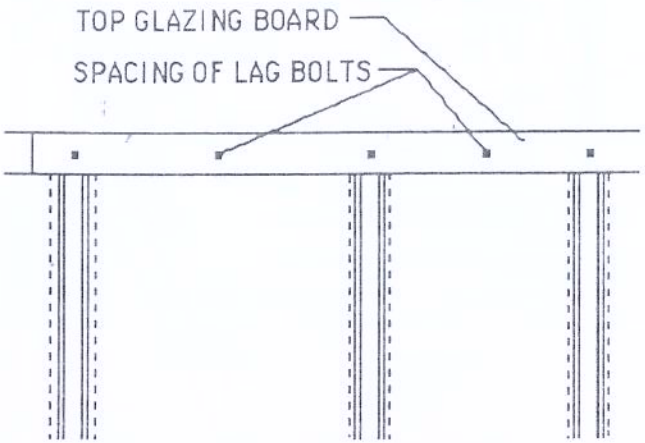


Fig. 30



TOP GLAZING BOARD

The top glazing board is ripped from a redwood or pressure treated 2x6. It is about 4" wide and must overlap the glass about 1/2" like the flashing. It is installed with 5/16 x 4" lag bolts. Predrill it with 5/16" holes for the lags spaced as shown (Fig. 30). Hold it in place and predrill the structure with 3/16" holes as pilot holes for the lag bolts.

Apply silicone caulking on the bottom underneath side and top as shown (Fig. 29) and install it. Lags with washers occur above each strut and in the middle of each strut (Fig. 30). Fill the lag holes with silicone caulk as you install the lags.

Fig. 31

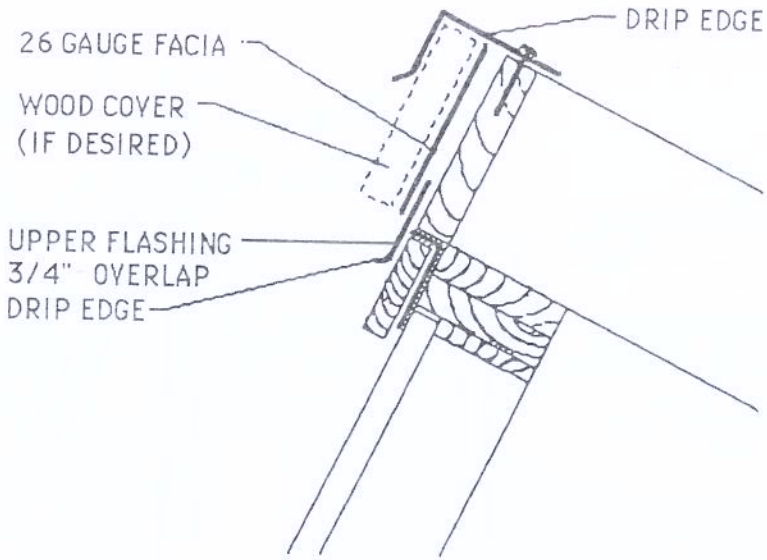
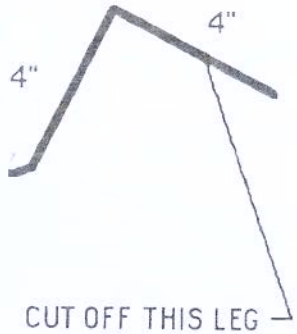
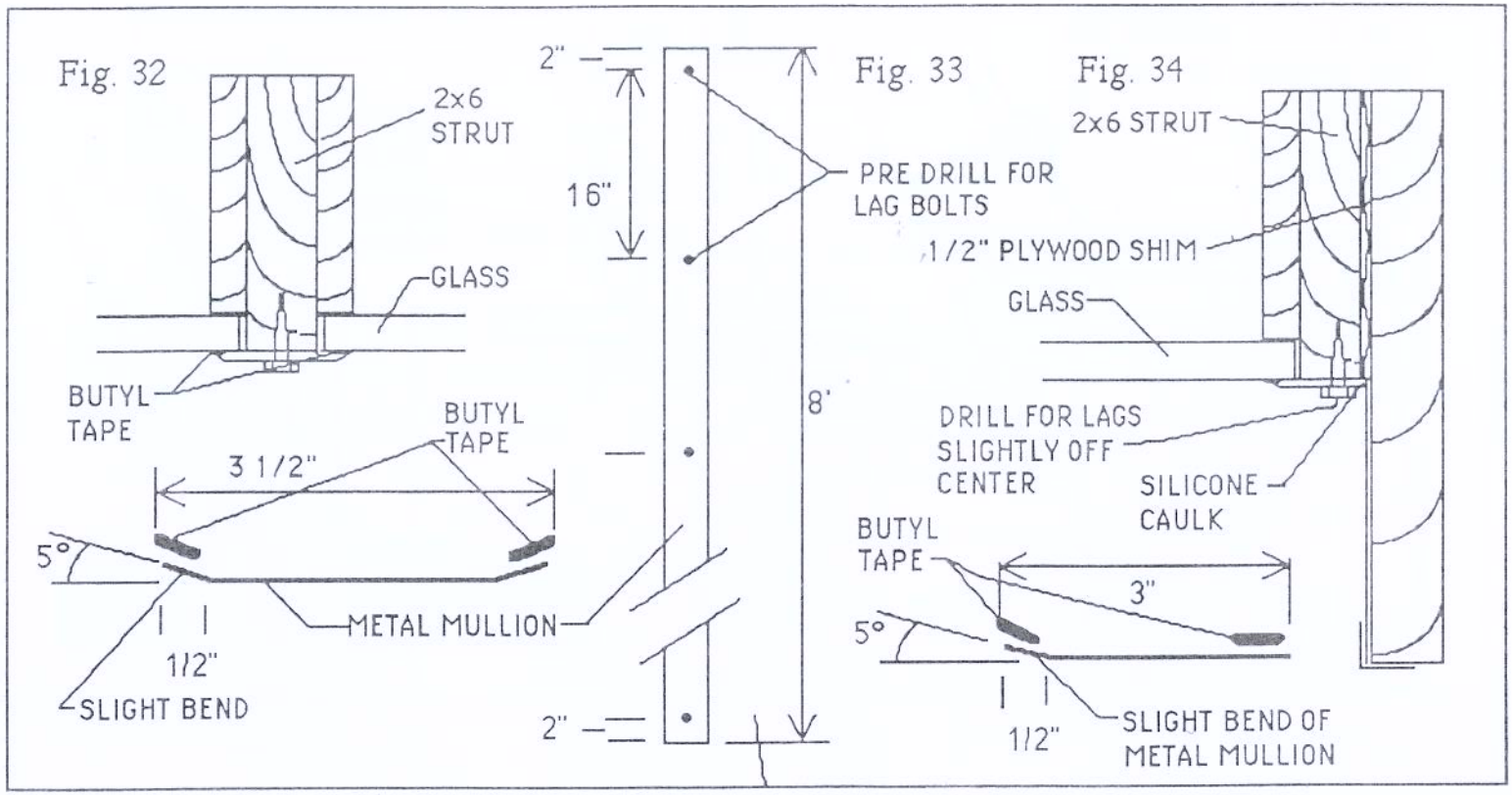


Fig. 31a

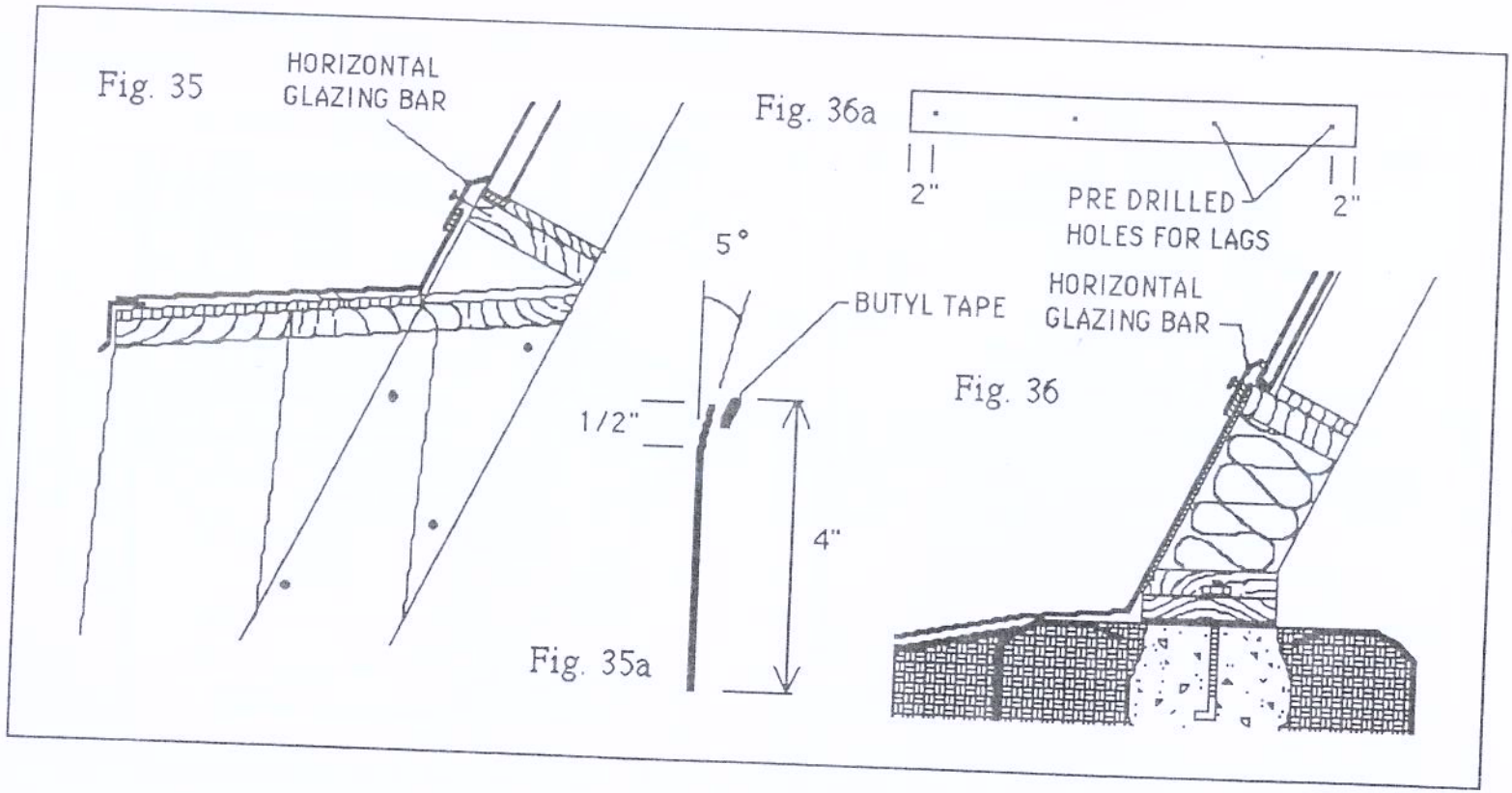


Now, the upper flashing can be installed. It overhangs the glazing board 3/4". It is made by cutting off one leg of a 4x4 standard drip- edge flashing (Fig. 31a). The piece with the drip edge is then nailed into place as shown (Fig. 31). Next a 26 gauge metal facia piece can be nailed on with a wood finish facia cover as desired. A drip edge cap is now installed with galvanized roofing nails, capping the finished wood facia and the roofing. Install all flashing in manageable lengths tacked first then nailed from the center out as described before on page 147.



VERTICAL MULLIONS

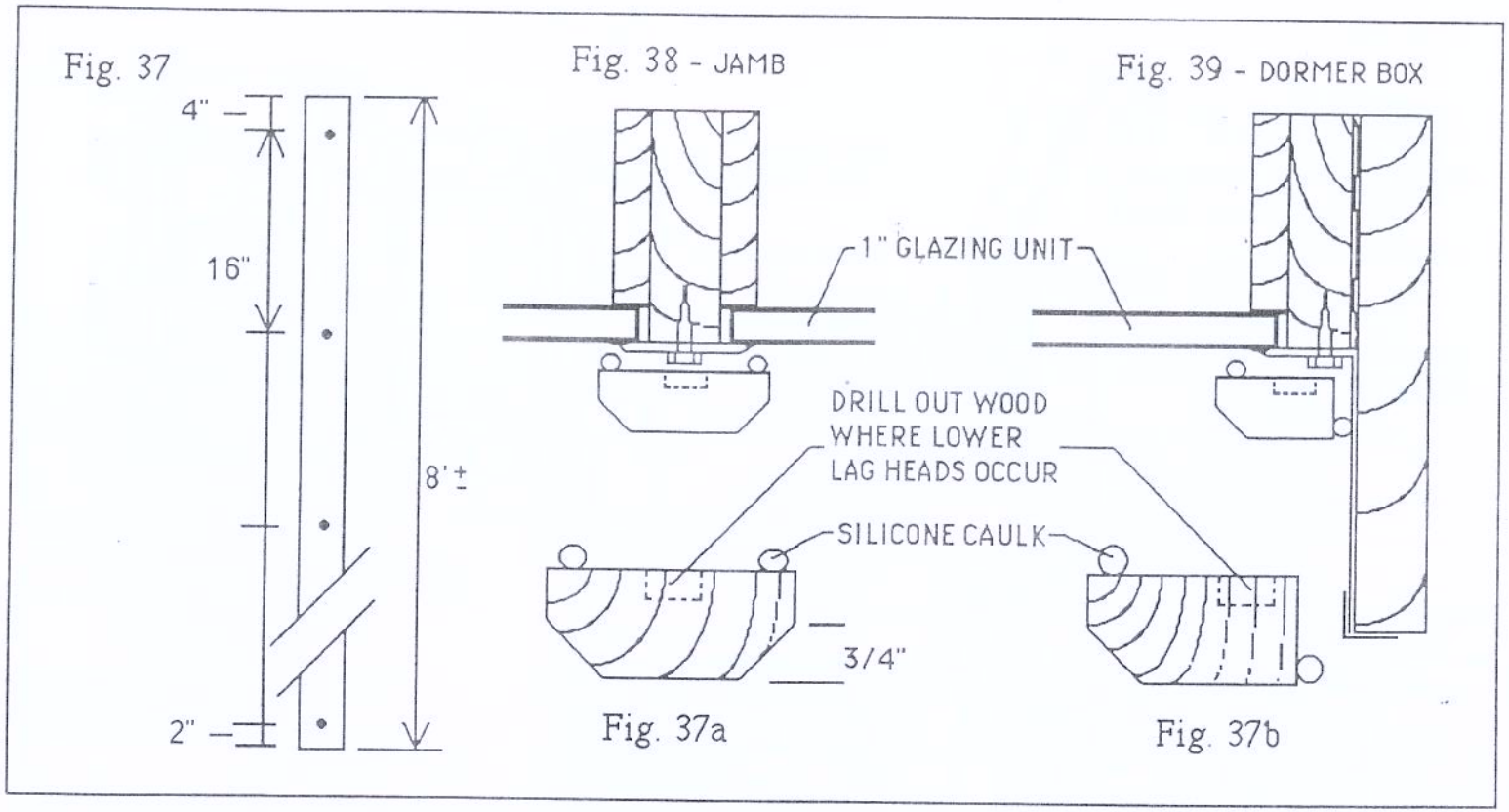
There are two vertical mullion conditions. One is between two pieces of fixed glass (Fig 32) and one is between fixed glass and an operable window box (Fig. 34). Both require 18 gauge metal strips fabricated in a sheet metal shop. The length is determined by measuring from the top glazing board down to the bottom of the front face. The width is shown above. The slight bends illustrated above are very important as they create a better seal when the metal mullions are tightened down. Pre-drill the metal mullions for 5/16" x 3 1/2" lags every 16" starting 2".from the top. Hold the metal mullion up and predrill the strut with 3/16" holes as pilots for the lag bolts. Drill in the center for Fig. 32 and slightly off-center for Fig 34. This is to insure that the lags will hit the center of the appropriate strut. Install butyl tape (from your local glass dealer) as shown on the metal



mullion and lag screw it to the struts. Run a bead of silicon caulk down against the metal sheeting on the dormer box (Fig. 34). There are some glazing systems on the market that are prefabricated to work in much the same way as this method. Consult your local glass dealer for more information.

HORIZONTAL BOTTOM GLAZING BAR

The bottom glazing bar occur at the bottom of the large fixed glass units (Fig. 36) and at the bottom of the small fixed glass units above the dormer (Fig. 35). They are made of 18 gauge sheet metal fabricated in a sheet metal shop. Width is 4" with a 5 degree bend (Fig. 35a) and length is measured between vertical mullions. They are installed with butyl tape and 5/16" x 3 1/2" lags much the same as the vertical mullions. Spacing is as shown in Fig. 36a for all openings.



FACING VERTICAL MULLIONS

The metal vertical mullions can now be rubbed with *vinegar and painted or faced with pressure treated 2x4's with the corners ripped off as shown in (Fig. 37 and 37a). The back side of the 2x4 mullion covers will be drilled out to accommodate the lag bolt heads already installed. Pre-drill the 2x4's for 5/16 x 4" lags. Pre-drill thru the metal mullion with a 5/16" bit and into the wood strut with a 3/16" bit to receive the lag screws. Shift the same lag pattern (16" apart) down 4" this time (Fig. 37) so that you do not hit the lags already in place. Run a bead of silicone down both sides of the wood mullion cover and screw it down with lags. The wood mullion cover against the window box is similar (Fig. 38 and 39).

***Galvanized sheet metal must be thoroughly washed with vinegar to prepare it for exterior metal paint, otherwise the paint will peel.**

Fig. 40

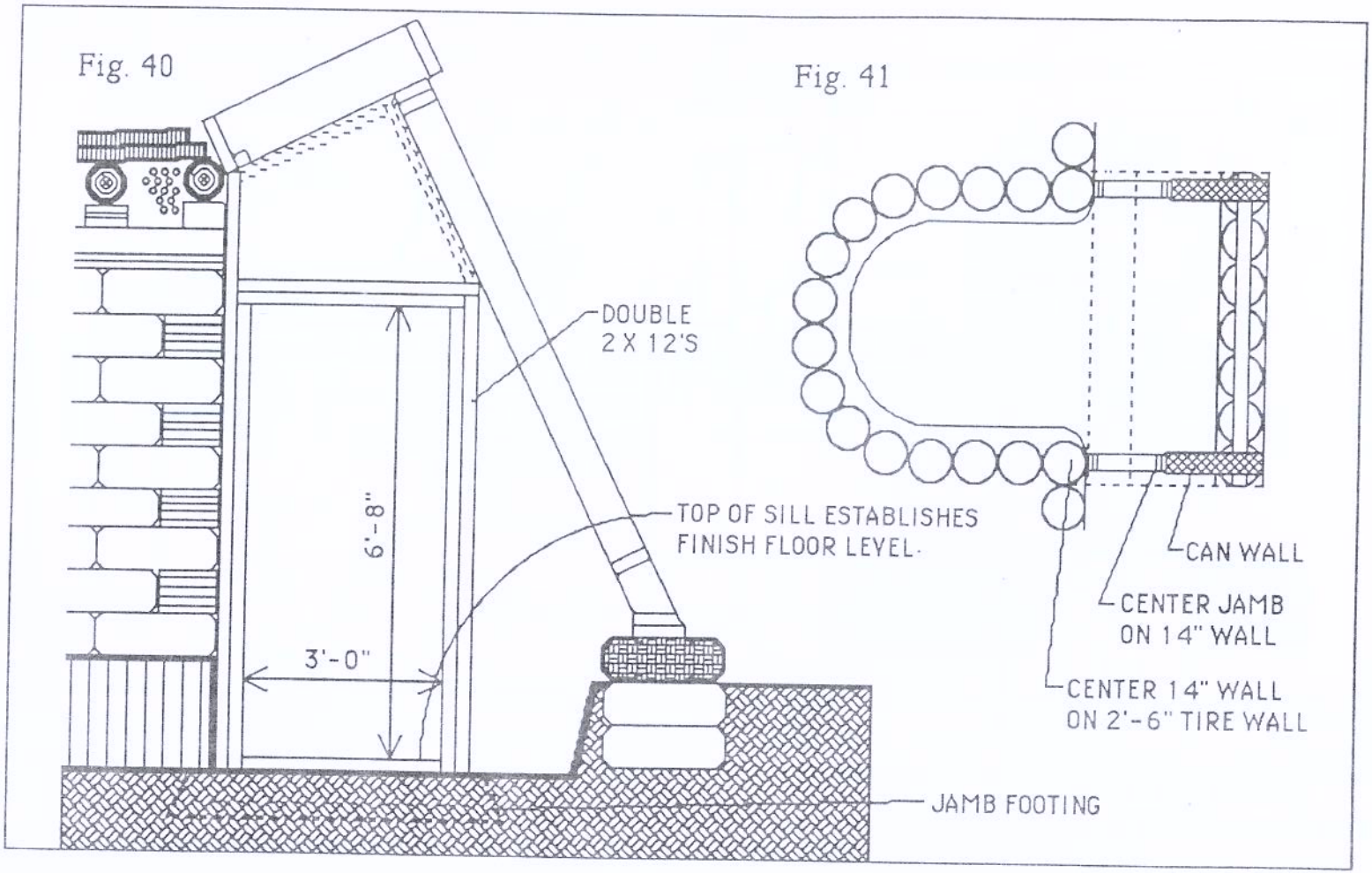
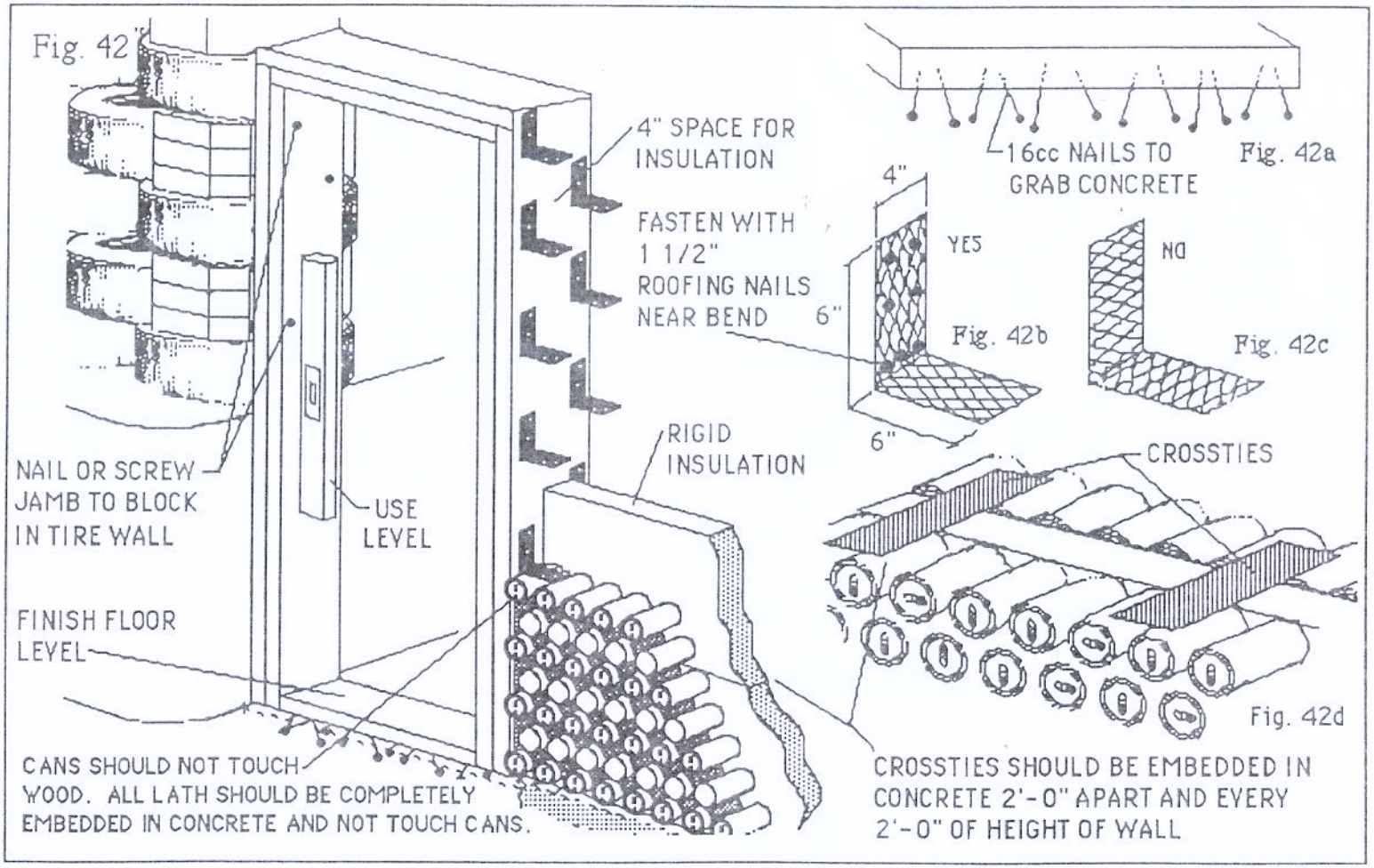


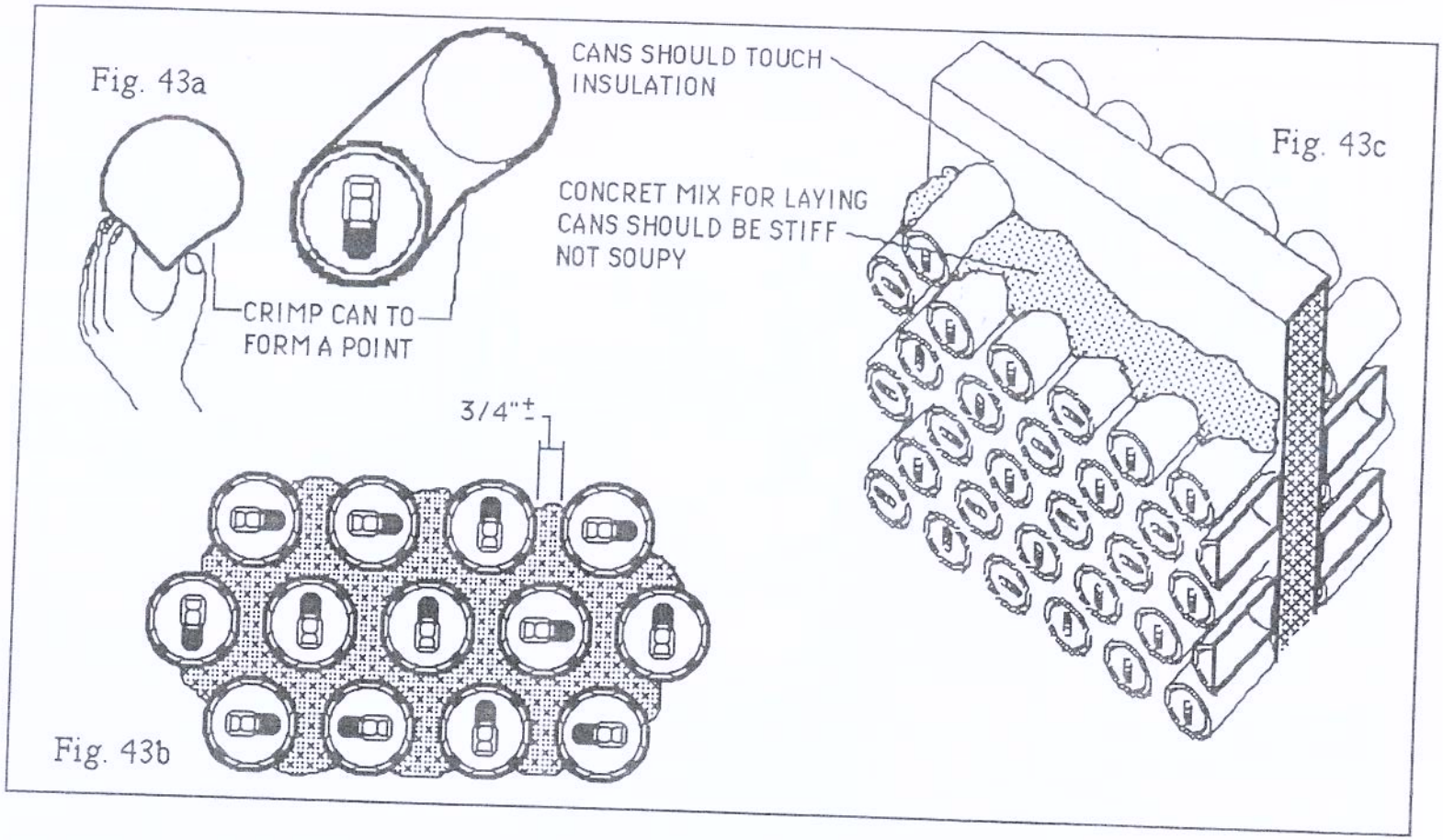
Fig. 41

INSTALLING DOOR JAMB

The door jamb is made from 2x12 pine stock. Both sides are double 2x12's as shown (Fig. 40) with the side against the tires extending all the way up. The jambs are made to door size 3'-0" x 6'-8" and installed on the center of the 14" can wall on either end of the greenhouse (Fig. 41). The can wall (discussed on the following pages) is 14" wide and centered in the tire wall of the "U". The door jamb sets on an 18" deep concrete footing with (2) 1/2" rebar. The top of the door sill establishes finish floor level. The bottom of the door sill is treated with wood preservative and "porcupined" with 16cc nails (Fig. 42a). This involves driving 20 or 30 16cc nails in about 1" at various angles. This is then set onto the wet mound (2" or 3" higher than



finish) of the concrete footing so that the door box sinks in and down. This gives you room for plumbing and leveling. Screw and or spike the door jamb to the end blocking of the tire wall. This jamb must be installed level and plumb. Allow concrete to set up. Lath tabs are now installed on the door jamb to receive the can work. They are installed every 16" on both edges of the jamb in a staggered pattern (Fig. 42). They tie the can masonary to the door jamb. Tabs are cut from expanded metal lath. They are dimensioned as shown in Fig. 42 b and c, and are nailed on with 1 1/2" roofing nails as shown. Make sure the "diamond" pattern in the metal lath is running the way it is shown in Fig. 42b, since the other way allows the lath to expand like an accordion and renders it



worthless as a masonry tie. Place the lath 4" apart horizontally in order to accomodate 4" of foam insulation (R-30) placed in between the double can wall. The insulation is cut and positioned tightly against the door jamb first (Fig. 42) and then plumbed using a level. This acts as a guide for laying cans. Use 2'-0" high sections of insulation at a time so that crossties made of lath can be embedded every 2'-0" between walls (Fig 42d).

LAYING ALUMINUM CANS

You are now ready to lay an insulated aluminum can wall. Cans are layed with a stiff (not soupy) mix of 1 part portland cement to 3 parts sand. Cans should never touch. They are layed 3/4" apart. The cement is the strength of the wall so if the cans touch there is no strength. Cement is placed in a little ridge right along the middle of the previous row of cans. Each individual can is then crimped

Fig. 44

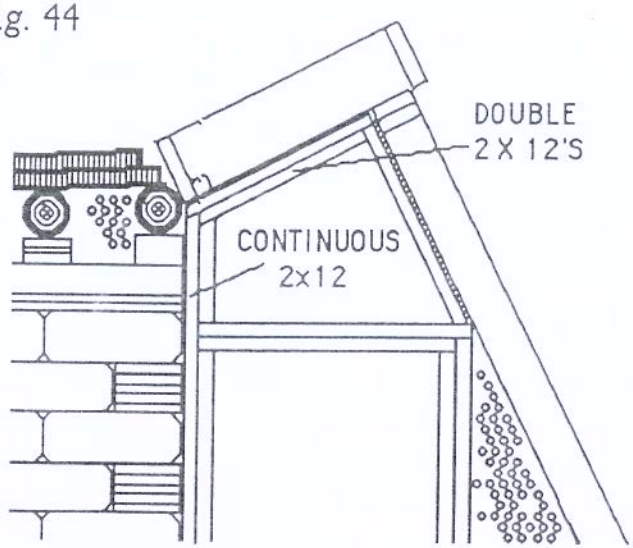
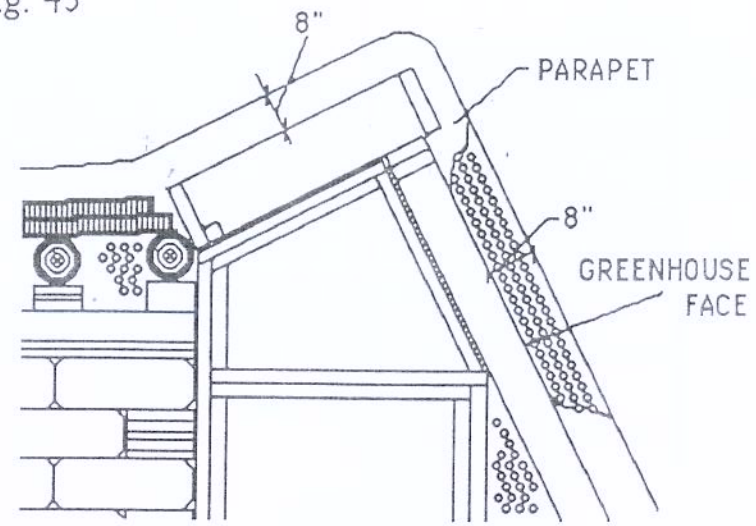


Fig. 45



(Fig. 43a) to form a "V" or point to push into the mortar. Keep cans against the insulation - it is your guide. If the mortar is stiff enough you can lay 2 courses on one side of the insulation and then 2 courses on the other side and switch back and forth until you have gone 5 or 6 courses high. If the mortar is too soupy you will only get 2 courses high before it will start sagging. Constantly get back and look at your can work and check it with a level. Can walls, like any other wall must be installed level and plumb. Always lay the mouth piece of the cans to the outside. These act as a natural lath to receive plaster later.

UPPER FIXED WINDOW

The fixed glass window over the door can now be built of 2x12's and installed on top of the door jamb. Notice it is doubled 2x12's on the top and sides. The box is simply nailed to the top of the door jamb and to the continuous extended 2x12 on the tire wall side of the door jamb. Now take the can work 8" past the greenhouse face and 8" above the roof. This is a parapet wall. After it becomes an exterior wall (above and beyond the interior of the building) it is no longer necessary to keep using the insulation in the middle. You can simply fill with cement and cans between the two rows of cans.

Fig. 46

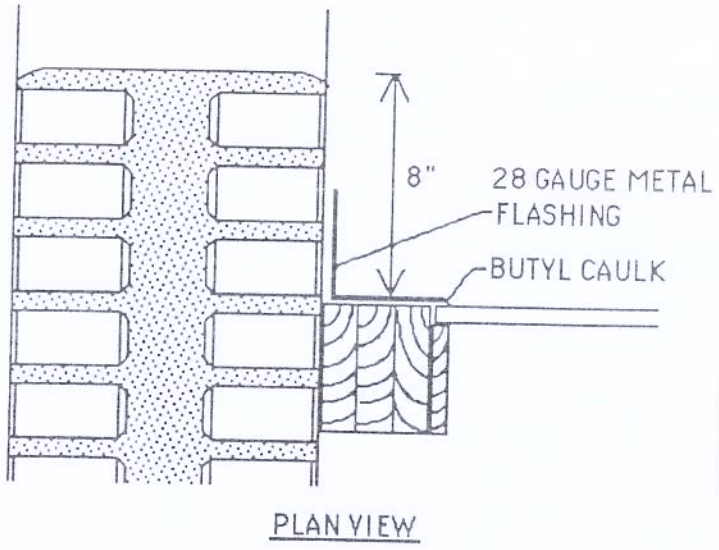
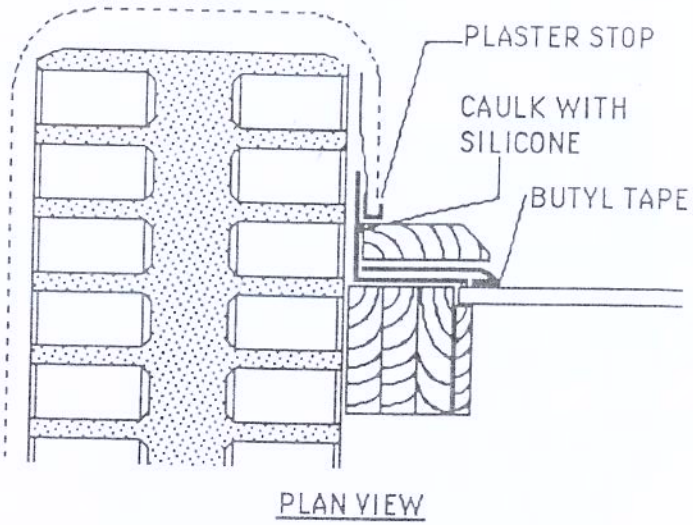


Fig. 47



PARAPET DETAIL

An "L" of 28 gauge metal flashing is now installed against the parapet over the spacer struts (Fig. 46) and 1/2" onto the glass with butyl caulk between flashing and glass. Now install an 18 gauge pre-bent sheet metal mullion with 5° bend as shown in Fig. 47. The width of this piece will be about 5 1/2". Measure your own condition and see. It is installed with 5/16" x 3 1/2" lag bolts and butyl tape in the same way as on Fig. 34 page 150.

Next install a wood facing made from a 2x6. Caulk with silicone between the wood and the metal flashing (Fig. 47). This is similar to Fig. 39 page 152. A piece of plaster stop must now be installed over the metal flashing. It can be purchased in any building supply store. It must be nailed into the can/cement wall with 16cc nails. Nail into the space between the can and the cement. If you nail into the can it will not hold. If you nail into the cement the nail will bend. Slip the nail in between the can and cement. Drive as many as you need to hold the plaster stop in place. You are now ready to plaster and stucco. These methods are covered in Chapter 9 - Finishes.