Chapter Six
Constructing the Wall Collector

Introduction

A wall collector has several advantages over a roof collector. First, since it is close to the ground, it is accessible by staging. It is easier to build. Second, during the heating season the vertical collector can gain from sunlight reflected from snow on the ground, or light colored gravel if there is no snow. The double glazed system means better performance than a single glazed system, so the collector square footage can be smaller, yet gather the same amount of heat. Third, since the summer sun is higher than the winter sun, much of the sunlight will be reflected off the glazing (rather than passing through it), resulting in lower stagnation temperatures. This means the power venting mode in the summer can be eliminated, saving money not only in installation costs, but also in the annual operating costs.

The instructions on how to build the MODEL-TEA wall collector are meant for those persons familiar with wood frame construction -- skilled contractors, carpenters, or owner-builders. The key word is skill -- the ability to perform the tasks, based on working knowledge gained from carpentry experience. The more experience, the easier these instructions will be to follow.

This chapter, plus Chapter Seven on Constructing

the Rock Bin (if there will be remote storage), and Chapter Eight on the MODEL-TEA System Control Wiring, should all be read through thoroughly. This should be done before beginning to order materials, and before beginning any stages of construction.

The experienced carpenter will have most of the tools necessary to build this collector, but may have to borrow or rent a few of the special ones. Among the tools needed are:

hammer, screwdriver, tapes, pliers, tin snips, etc.

plumb bob, levels, chalk line, caulking gun, staple gun

Hand saws, circular saw, table saw, sabre saw (optional), soldering iron (optional), paint sprayer, router, power screwdriver or variable speed/reversible drill

The MODEL-TEA can be built into new construction or retrofitted into existing buildings. The instructions are directed toward new construction, with indented sections if there are additional special instructions for retrofit.

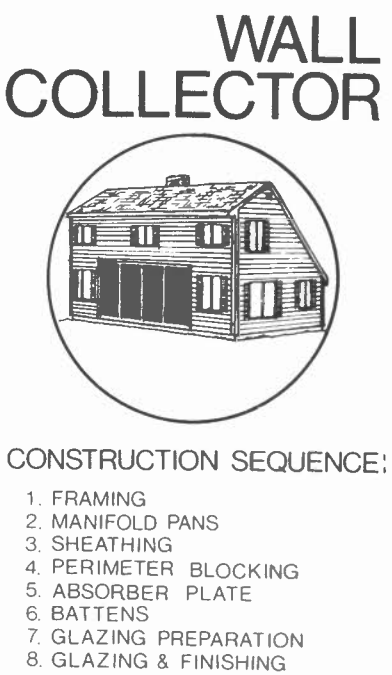


Figure 6.1

RETROFIT: The instructions for retrofit begin with the word RETROFIT, and are indented to set them apart from the normal instructions. These indented sections must be read by those who are retrofitting the MODEL-TEA, and can be skipped by those building into new construction.

The collector will either be connected to remote storage, or be connected directly to a living space. The drawings and instructions assume that ducts will connect to the bottom of the manifold pans (see wall drawing no. 2, detail 4); the ducts running to remote storage or to a living space. The duct "collars" penetrate the floor and connect to the manifold pans located in the wall cavities at either end of the collector. This floor could be the first floor, with the ducts running into the basement where the remote storage is located. Or this floor could be the second floor of a two story house, with the ducts running above the first floor ceiling, connecting the collector to the living space. Another option is for the collector to be on the wall of the first floor, but connect the duct collars to the tops of the manifold pans. Again the ducts could be run in the second floor. If the wall the collector is built into sits on a slab, the duct collars can either enter at the top of the manifold pans, or enter through the back of the pans. In the latter case, the ducts will intrude upon the living space, and will have to be boxed in and finished to match the space. These ducts can either run across the floor or across or into the ceiling.

There are many variations which can be made, depending on the site, the location in relation to living spaces, framing, or even personal taste. If making a change to the collector, think the changes all the way through, and mark those changes on the drawings before beginning the constructing process.

Before installing the collector on the wall, certain calculations must be done, and decisions must be reached. First, the system must be sized according to the percentage of the heating load it is to provide. This should be done using the rules of thumb in Section 4.1, resulting in a square foot area

for the collector.

Second, the size of the glazing must be selected to fit the square foot size of the collector, and to fit on the wall. The glass comes in two standard sizes (in inches): 34 x 76 and 46 x 96. In conjunction with the CY/RO Universal Glazing System, you must allow 3/4 in. between each sheet of glass, plus an additional 3-1/4 in. for the sides (or top and bottom, not including the cant strip or the sill), plus the width or height of the glass itself. Use the following formulas to calculate the width and height of the collector:

Collector width in inches = (glass width in inches x no. of panels) + (3/4 x no. of panels) + $2\frac{1}{2}$ in.

Collector height in inches = (glass panel height in inches) + $3\frac{1}{2}$ in.

For example if the collector were to be glazed with four panels of 46 in. wide glass side-by-side, the collector would be:

(46 x 4) + (3/4 x 4) + $\frac{1}{2}$ = $189\frac{1}{2}$" or 15'-$9\frac{1}{2}$" wide

If the collector were to be glazed vertically with one panel of 96 in. high glass, the collector would be:

(96 x 1) + $3\frac{1}{2}$ = $99\frac{1}{2}$" or 8'-$8\frac{1}{2}$" .

Although it is possible to build a two story collector, the drawings only show a one story high collector. We recommend building the two collectors as separately manifolded units, or inserting a duct connection (much like the duct collar detail described in Section 6.2 and on wall drawing number 2) the floors as shown in the sketch below. Support is needed across the bottom of each pane of glass, and that support must have setting blocks and weep holes (see sketch).

Compare the calculated width to the width of the space the collector is to fit into. A minimum distance should be left between the side of the collector and the end of the wall to allow for the intersection

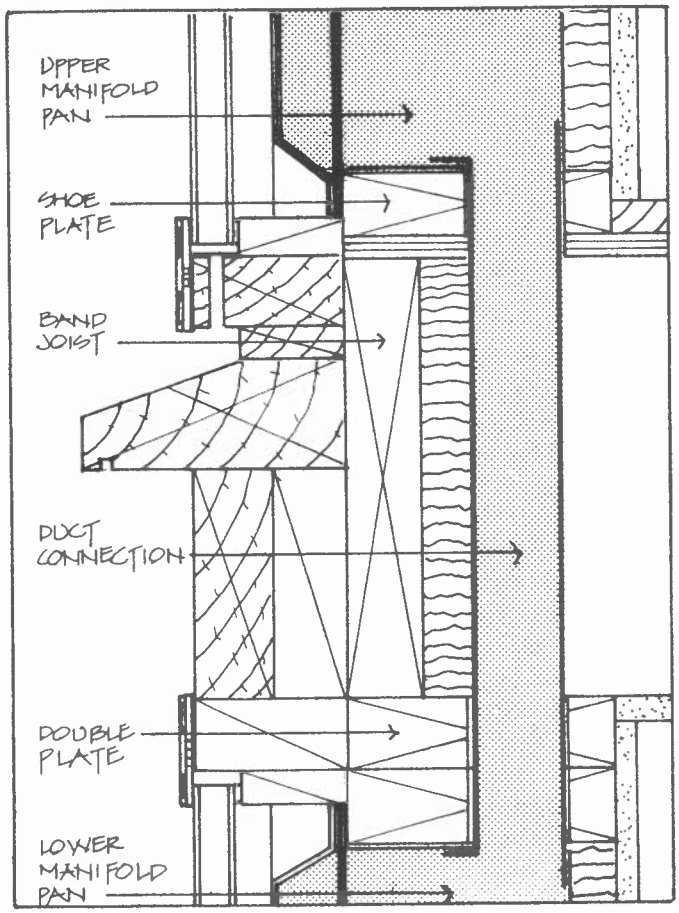


Figure 6.2 Vertical Section of Two Story Wall Collector at Intersection With Floor

of the east or west wall with the south wall. Allow approximately 9 inches above the collector for the cant set and flashing.

Third, determine the number of manifold pans that will be needed, and their size. In an average width collector (about 24 feet wide) there are two manifold pans built into the wall: one to supply cool air to the collector, and one to take the hot air away. The manifold pan which is closest to the remote storage, or living area to be heated, will be the return pan. The shorter the duct run, the less the heat loss. It is next to this pan that the temperature sensors (discussed below) will be located. The maximum distance

between the outsides of the supply and return manifold pans should be 26 feet. If the collector is longer than this, additional manifold pans must be introduced at the center-line of the collector. The two manifold pans at the sides of the collector will be the supply pans, and the two at the center of the collector will be the return pans. In this case, the temperature sensors (discussed below) will be located next to one of the center pans.

The size of the manifold pans depends on the area of the collector. Section 4.1 discusses how to size the manifold pans. Two things must be remembered when sizing the pans for a wall collector. One, the actual depth of the pan in a 2x6 stud wall will be 4-3/4 inches, and in a 2x4 wall it will be 2-3/4 inches. This dimension allows for the 3/4 inch thick insulation that is located between the back of the manifold pans and the interior face of the studs. The second thing to remember is that the area of the collector used in the calculations is the area between manifold pans. If there is one supply and one return manifold pan, the area used in the calculations is the full area of the collector. If there are two supply pans and two return pans, then the area used in the calculations will be half the actual area of the collector.

The dimensions arrived at in Section 4.1 will be the inside dimensions of the pans. Allow for the thickness of the pan material itself when determining the actual "manifold pan width" used so often later on.

Fourth, determine the width of the rib on the industrial siding used as the absorber plate (see Section 6.5). If the collector is less than 16 feet wide, the 4 in. rib should be used. If the collector is equal to or greater than 16 feet, the rib should be 8 inches. The 4 in. rib comes in sheets that are 45-5/8 in. wide, with an "actual coverage" of 44 in. (the sheets are overlapped when put together). The 8 in. rib comes in sheets that are 49-5/8 in. wide, with an "actual coverage" of 48 inches.

Fifth, decide whether the system will have remote storage or not, and if it will have a domestic hot water (DHW) pre-heating system. If the collector is connected directly to the living space without

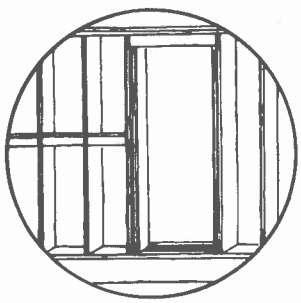
using remote storage, it is called a "Daytime System." These systems will have a relatively small collector area (less than 200 square feet), and the domestic hot water pre-heating mode will probably not be included, because it wouldn't be cost effective. This means that only one temperature sensor will be connected in the collector. If there is a domestic hot water pre-heating system, there will be two sensors connected to the plate. These sensors will be located near the return manifold, as discussed above.

It is very important to remember that unless the pieces are put together very carefully, the glass panels will not fit into the spaces allotted for them. There is a 1/4 in. gap (shown on the drawings and called for in the instructions) around each panel of glass. This is vital to allow space for the glass to expand. If it is not allotted, the glass will crack. Therefore, be absolutely sure that all dimensions are correct, and that all blocking is square. The constant use of a plumb bob and line level is highly recommended. Check at the end of each step that the materials put on in that step are square and level.

Go through the drawings step-by-step with the instructions, until everything is clear. The drawings are not meant to be used without the instructions, nor are the instructions meant to be used without the drawings. Make notes on the drawings of those things that are changed due to site conditions. Write in the actual dimensions found above. Determine how much of each material needs to be ordered, and order through the manufacturers found in Appendix A.2, and in the sequence described in Section 4.4, Purchasing Materials and Scheduling Construction. Read through the descriptions in Appendix A.1 to become familiar with the materials. Such things as which types of caulk should be used with which type of joint are discussed there.

The following step-by-step instructions are keyed to the construction drawings at the end of the chapter. Each construction step has a key number, and a corresponding key sketch in the margin where the step begins. Each construction step also has a corresponding drawing with the same key number, and the same key sketch in the upper right hand drawing of the page.

As you read each section, you will be asked to refer to details on the construction drawings. For example, you might see (3-W6) at the end of a sentence. This would mean, refer to Detail 3, on Wall Collector drawing number 6. Turn to Wall Collector drawing number 6, and you will see a number 6 in the upper right hand corner with the word "WALL" below it. The key sketch is there, as well as the title of the page and the step: BATTENS. As you refer back and forth from instructions to drawings look for these four things: the drawing number, the word WALL, the key sketch and the title of the page. It is important that the instructions and the drawings are used together.



6.1 Framing

The framing doubles as a wall of the house and as the foundation of the MODEL-TEA collector (1-W1). The outer-manifold studs mark where the sides of the collector will be attached, and the horizontal blocking marks where the top and bottom will be attached. It is important to note that the studs be plumb (use a plumb bob to check) and the horizontal blocking be level (use a level) for the collector perimeters to start out square.

The manifold bays will house the manifold pans (2, 3-W1), so be sure they are a little wider than the outside manifold pan dimension. The insulation between the headers over the pan will help reduce heat loss directly through the wood (3-R1). The slot cut through the shoe plate and the subfloor is for the duct collar insert that will be attached to the pan. The insulation below it will help reduce heat loss from the duct collar to the outside.

STUDS: Lay out the 2x6 (nominal) wall plates (top and shoe) side by side, and mark across both where the center-line of the center stud. The two outer-most studs under the side edges of the collector will be the "outside collector studs." To locate these two studs, divide the total width of the collector in half, subtract 1-1/4 inch, and measure out this distance to each side of the center-line of the center stud. Mark the center-lines of the two outer collector

studs at these points. Mark the center-line of one stud, which will be flush inside each of the collector studs. These will be the "outer manifold studs" (2-W1). The distance from center-line to center-line of the studs is the same as the distance from outside edge to outside edge, or inside edge to inside edge.

The next studs to the inside of these will be the "inner manifold studs." Add 3 in. to the outside manifold pan width, determined in Section 4.1, and measure in this distance from the center-lines of the outer manifold studs. Mark the center-lines of the inner manifolds studs here. The space between the outer and inner manifold studs is the "manifold bay." This space must be as wide, or wider, than the outer dimension of the manifold pan (not including the nailing flanges).

If the manifold bay (pan) width plus 1-1/2 inches is greater than 24 inches on center, double the inner manifold stud, outside the manifold bay. These manifold bays will have to be framed with headers, whose sizes depend on the width of the bay. Use Table 6.1 to determine the size header needed (1, 3-W1).

Table 6.1 Header Sizes for Loads and Spans

SIZE	LOAD/SPAN		
two headers on edge	two floors and roof	one floor and roof	roof only
2x4	2 ft.	3 ft.	4 ft.
2x6	4	5	6

If the collector width is great enough to warrant inner manifold pans (greater than 26 ft.), mark manifold bays to each side of the center stud, as described above. If the manifold bay width is greater that 24 in. on center, triple the center stud, and double the outer manifold studs outside the manifold bays.

Lay out the glazing studs from the center-line of the collector, at a distance on center equal to the glazing width plus 3/4 inch. Mark the center-line on the plates. Fill in with studs between the glazing

studs, so that no distance will be greater than 24 in. on center, except in the manifold bays (1-W1).

Frame the 2x6 nominal studs between the two plates, on the center-lines marked, with 10d common nails. Fasten the headers (with 2-1/2 in. of rigid insulation and blocking in between them) over the manifold studs (3-W1). Tip the wall into place, brace and plumb.

RETROFIT: IMPORTANT: Turn off the electricity feeding to the south wall. Remove the siding in the general area where the collector is to be. Lay out the perimeter lines of the collector on the sheathing, using a line level and a plumb bob. Check the diagonals to be sure the lines are square. The width and height will be the full collector width and height.

Mark the center-line of the collector width on the sheathing, at a point 4 in. above and below the perimeter lines. Measure the width of the manifold pans plus 4-1/4 inches in from the side lines. Snap two vertical chalk lines at these points, parallel with the side lines. Set a circular saw to the depth of the sheathing, cut down the four side lines, and across the manifold width at the top and bottom between each pair of side lines. Remove the sheathing between the side lines. Remove anything within these spaces, including studs, blocking, insulation, electrical wires or boxes.

If the sheathing is uneven, remove all of it within the collector perimeter chalk lines. An uneven surface could cause the Thermo-ply to buckle and later cause problems with the air flow through the collector.

If the collector is long enough to have center manifolds, snap a chalk line down the center line of the collector. Snap one line to each side of it, at a distance of the manifold pan width plus 3

inches. (If the manifold pan width plus 3 inches is greater than 24 inches, measure over an additional 1-1/2 in. for an additional stud.)

BLOCKING: The location of the collector vertically on the wall depends on the height of the glazing being used and the sill to header height of the wall. Looking at (3-W5), and the relationship between the top and bottom of the absorber plate to the manifold pan, the collector can move up or down on the wall. But the top and bottom rib of the absorber plate must be overlapped at least 5 in. over the manifold pans. If either full rib width is above or below the manifold pan, air will not be able to enter the space behind the rib, and this part of the collector will be wasted. The drawings show the vertical layout based on the bottom limit of the collector being the top of the shoe plate. This can be varied by moving the collector down on the wall (as long as continuous blocking is supplied across the top as a fastener base), or up on the wall (as long as continuous blocking is supplied across the bottom as a fastener base).

Lay out the locations of the top and bottom of the collector vertically on the wall, using the actual height of the collector found in the introduction. Snap a chalk line across the studs at these points. Snap another chalk line horizontally across the studs, 2-1/2 in. inside the top and bottom of the collector. These lines are the upper and lower boundaries of the collector sheathing and the absorber plate. There must be solid continuous blocking across the top of the collector (whether actual blocking, plates or headers), from a point 1-1/2 in. above, to a point 3-1/2 in. below, the top of the collector. There must also be solid continuous blocking across the bottom of the collector (whether actual blocking, plates or headers), from a point 3-1/4 in. above, to a point 3 in. below, the bottom of the collector (3-W1).

The line chalked 2-1/2 in. inside the bottom boundary will be the center-line of the lowest horizontal 2x6 nominal blocking, shown as the shoe plate on the drawings (2-W1). This blocking will be in a continuous straight line from one outer manifold stud to the other. Since the blocking will not be staggered, toe-nail the blocking at one end. Make sure the 1-1/2

in. face of the blocking is flush with the outer face of the studs. Fasten a 2x4 (nominal) continuous line of blocking below the 2x6 (nominal), with its 3-1/2 in. face flush with the outer face of the studs if there is no blocking there already.

Measure from the center-line of the 2x6 (nominal) blocking a distance equal to the "coverage" width of industrial sheet siding that will be used as the absorber plate. Fasten the center-line of a line of 2x4 (nominal) blocking here, with its 3-1/2 in. face flush with the outer face of the studs. Again, the blocking joints will not be staggered, so toe-nail one end. Do not fasten this blocking in the manifold bays. Continue this blocking up the face of the studs with the on-center distance equal to the width of the absorber plate sheets, until the top of the collector is reached. Block behind the top of the collector from a point 1-1/2 in. above it to a point 3-1/2 below it (3-W1).

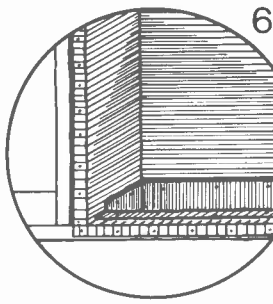
A slot must be cut (for the duct collars, Section 6.2) in the manifold bays through the bottom 2x6 (nominal) blocking and/or shoe plate. Cut the 2 in. wide slot, 2-1/2 in. back from the outer face of the studs, from manifold stud to manifold stud. Make the cut through the sub-floor as well (2, 3-W1). Fit 1 in. thick pieces of rigid fiberglass against the band joist below the manifold bays. This will lessen the heat loss from the duct connection. If the lowest piece of 2x6 (nominal) blocking is above the shoe plate, fit insulation between that blocking and the shoe plate.

If the wall is built on a slab, the duct collar entrance (4-W2) must be made through the inside surface of the wall rather than through the floor. The duct collar would be attached on one end to the back side of the manifold pan, and on the other to a duct that would run against the wall. The duct would have to be finished to match the finish of the living space, or insulated if it is in a utility space.

RETROFIT: Carefully cut slots in the plates within the manifold bays, 3/4 in. back from the front face of the studs. Be careful to leave 3/4 in. of shoe plate in front and in black of the slot. Carefully chisel away 3/4 in. of the band joist width

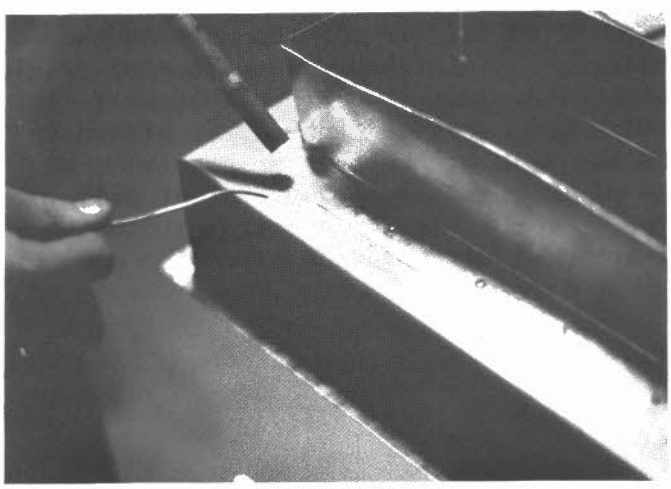
below the slot.

6.2 Manifold Pans



The purpose of the manifold pans is to distribute air the full height of the collector. The supply and return ducts are connected to the manifold pans. The air from the supply duct flows through the duct collar (4-W2) and fills the manifold pan, supplying the air to the full height of the collector. At the return manifold side, the hot air from behind the absorber plate will first fill the return manifold pan, and then be drawn away by the duct collar at the bottom of the pan. The duct collars must be connected to the manifold pans with an air-tight seal, or leakage will occur, and performance will be lost.

Prefabricate the manifold pans and duct collar inserts to the dimensions determined in Section 4.1. Have them made of 30 gauge galvanized sheet metal, with 1-1/2 in. nailing flanges. Overlap the horizontal corners over the vertical corners. Solder all joints and all overlaps.



Soldering the Duct Collar to the Manifold Pan

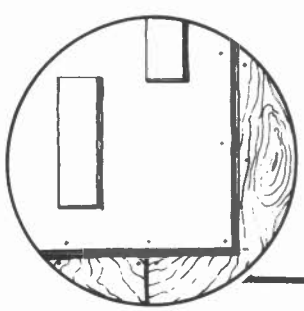
Decide which manifold will be closest to the storage rock bin. Make the return duct connection opening in that manifold pan, so that the duct run will be the shortest possible to storage. The duct connection opening and duct collar should be sized according to Section 4.1. If there are four manifolds, the return duct connection should be in the two inner manifold bays, and the supply duct connections in the two outer manifold bays.

Place the manifold pans into the manifold bays, with the nailing flanges over the studs. Fasten the pans with 1 in. galvanized roofing nails at 6 in. on center around the nailing flanges (3, 4-W2).

There are two ways to fasten the duct collar inserts to the manifold pans. One is to drop the inserts into the pans, and solder the insert to the pan. The other is to lay a 1/4 in. continuous bead of caulk around the duct connection openings inside the manifold pans, and drop the duct collar inserts into the openings (2, 3-R2). Fasten with #6x1/4 in. Phillips pan head sheet metal screws at 6 in. on center.

Cut two pieces of 3/4 in. thick rigid fiberglass insulation measured to fit behind each manifold pan. Cut them just big enough to fit snugly behind the pans and wedge them in place.

RETROFIT: If the room behind the collector is finished, the piece of 3/4 in. thick fiberglass insulation that will fit behind the manifold pan must be placed in the manifold bay before the pan is. Cut the piece just big enough that it will fit snugly in the bay. Wedge it into the back of the manifold bay, and place the manifold pan in front of it.



6.3 Sheathing

The air from the supply manifold pan flows through slots cut in the collector sheathing (1-W3). The air flows across the face of the collector, between the sheathing and the absorber plate. Therefore, the

seams between the sheathing must be air-tight, to keep the air from leaking through the back of the collector. For the same reason, the edge of the collector sheathing and the roof sheathing must be air-tight. This is accomplished with caulk, but also with support from studs and horizontal blocking. Caulk is also applied around the nailing flanges of the manifold pans, so that air cannot leak between the pans and the sheathing.

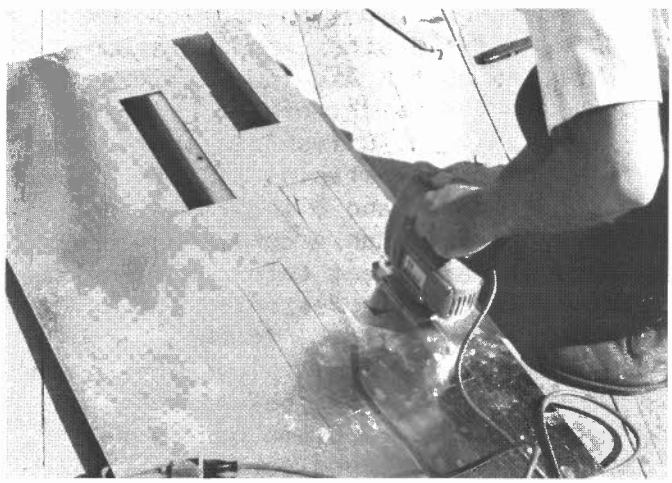
THERMO-PLY COLLECTOR SHEATHING: Thermo-ply super strength (Blue) sheathing, 1/8 in. foil-faced structural/insulative sheathing, is shown as the collector sheathing on the drawings. (See Appendix A.)

It is important that the four edges of the sheathing be supported be either blocking or the studs, horizontally and vertically. This is for structural reasons, and to minimize air leakage between the sheets of sheathing and the back of the collector.

The collector sheathing will run horizontally from the outside edge of one outer manifold stud to the outside edge of the other, and vertically from the center-line of the bottom 2x6 (nominal) to a point above it equal to the height of the glazing minus 1 inch. Fasten with 1 in. galvanized roofing nails or 7/16 in. crown divergent staples at 4 inches on center around the panel edges, and 8 inches on center at the intermediate supports. Run a continuous bead of caulk along the edge of each sheet before butting the edge of another against it. Begin fastening the sheets from the center-line of the collector. If the collector has center manifolds, cut manifold slots in the sheet to each side of the center stud, before mounting the sheets on the wall. Use a plumb bob to make sure that the sheets are being fastened vertically.

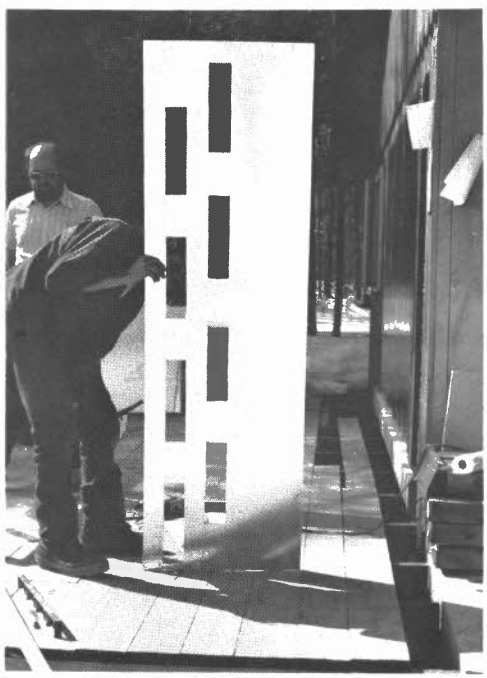
Cut the sheets so that the edges fall over the studs or over the blocking. Measure and cut the widths of the two end sheets, but cut the manifold slots in them before mounting on the wall. Apply a 1/4 in. continuous bead of urethane caulk around the edge of the manifold pan nailing flanges just before laying a sheet of Thermo-ply over them (3-A3). It is vital not to apply this caulk until you are ready to lay a sheet of sheathing over it. The caulk will harden quickly, especially on hot sunny days, and must be replaced if it skins over before the sheathing goes on. (See Appendix A for urethane caulk recommendations.)

MANIFOLD SLOTS: Cut manifold slots in those sheets of Thermo-ply that will lay over manifold pans. The slots are cut in the pattern called out so that every rib in the absorber plate will be fed air from the manifold pan. Measure in 3 in. from the outside of the sheet and snap a chalk line parallel to the side and running the length of the sheet. If the collector has center manifolds, cut manifold slots in the two sheets that will go over the manifolds, treating the side along the collector center-line as the "outside" of the sheet. Snap three more lines, parallel to the first and spaced 3 in. apart. Beginning at the center-line of the sheet and working first up and then down from it, mark the following lines between the pair of chalk lines closest to the edge of the sheet: 4-1/2 inches, 8 inches, 9 inches, 8 inches, 9 inches.



Cutting the Manifold Slots

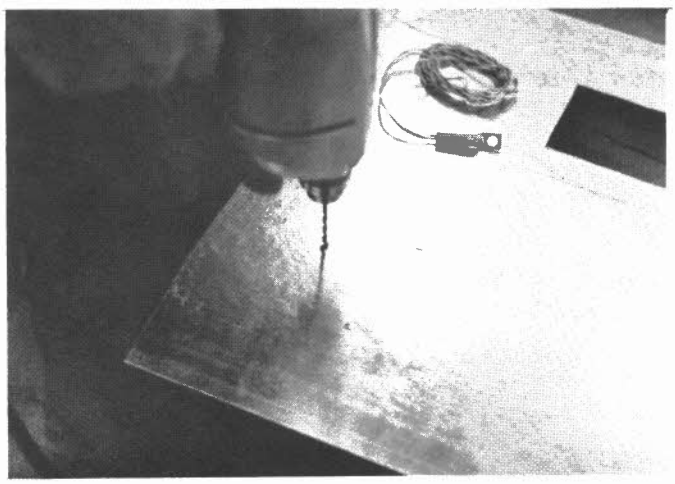
Beginning again at the center-line of the sheet and working first up and then down from it, mark the following lines between the pair of chalk lines furthest from the edge of the sheet: 4 inches, 9 inches, 8 inches, 9 inches, 8 inches. Mark one line 2 in. inside the top and bottom edge of the Thermo-ply (2-W3). With a sabre saw or utility knife, carefully cut out the rectangles that measure 3 in. by 9 inches, and the odd shaped rectangle at the top and the bottom of the inner set. repeat this process on the other end sheet of sheathing (and the center sheets, if there are center manifolds), and fasten them to the wall, as described in the section above (1, 3-W3).



Thermo-Ply Sheathing With Manifold Slots

In the sheet of Thermo-ply over the return manifold (the manifold closest to storage), drill one 1/8 in. diameter hole for every temperature sensor to be used (1-W3). These holes will be lined up with the inner manifold slots, beginning with the bottom slot, one hole per slot. They should be located horizontally at a distance in from the side of the collector (or from the collector center-line, if the center manifolds are

return manifolds) equal to the manifold pan plus 4 inches. These holes are for the wires from the temperature sensors that will be attached to the back of the absorber plate.



Drilling the Hole for the Temperature Sensor Wire

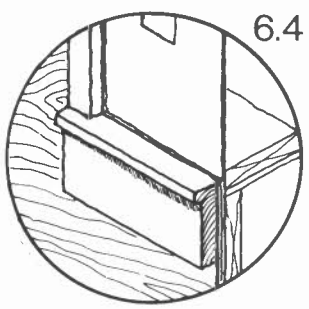
WALL SHEATHING: Sheathe the rest of the wall as usual, with 1/2 in. CDX plywood, caulking continuously between the edges of the collector sheathing and the wall sheathing (2-A14). Mark the center-line of the collector on the wall sheathing, 4 in. above and below the Thermo-ply perimeter. If the collector has inner manifold pans, snap a chalk line down the center-line of the collector between the two pairs of manifold slots.

RETROFIT: Sheathe the wall, as above, fastening the Thermo-ply to the existing wall sheathing. The Thermo-ply will run horizontally from the outside of one outer manifold stud to the other, and vertically

from the center-line of the bottom 2x6 (nominal) blocking (or shoe) to a point above it at a distance equal to the glazing height minus 1 inch (the two inside lines snapped horizontally on the sheathing). This will leave a 2 in. gap at each side, 2-1/2 in. at the top, and 2-1/2 in. at the bottom, between the Thermo-ply and the existing wall sheathing. Cut 1/2 in. CDX plywood to fill these gaps, caulking each side edge of the plywood as it goes in. Be sure each edge of the plywood is being supported by the studs or blocking.

Thermo-ply Sheathing and Manifold Slots in Place

6.4 Perimeter Blocking



The perimeter blocking not only sets the boundaries for the absorber plate to be fastened within, but is also the beginning of the framework of the glazing. It is vital that these pieces be plumb, horizontal, and square--and be fastened to the exact dimensions called for. Therefore, follow the sequence of laying out,

plumbing, leveling, and checking diagonals carefully. Check the dimensions several times to be sure they are correct. Any miscalculation now could mean the glass won't fit later.

TOP: Tack 1x2 (nominal) blocking across the top edge of the collector, with its bottom edge flush with the edge of the plywood. The blocking will run continuously from 2 in. outside one side of the Thermo-ply to 2 in. outside the other (1, 3-W4). Use a line level to make sure the blocking is horizontal.

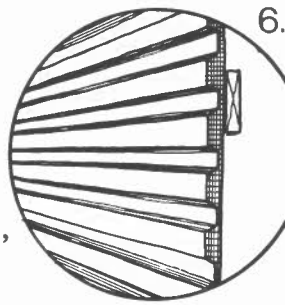
SIDES: Tack 3/4 in. x 2 in. (actual) blocking down the sides of the collector, with its side flush with the side edge of the plywood. The blocking will run continuously from the bottom edge of the top perimeter blocking to the bottom edge of the Thermo-ply (1, 2-W4). Use a plumb bob to be sure the blocking is vertical.

BOTTOM: Cut a 1/2 in. x 4-3/4 in. (actual) continuous rectangular section from a 2x6 (nominal) (3-W4). The resulting piece will run continuously from the outside edge of one side perimeter blocking to the outside edge of the other. Tack the piece across the bottom, with its top edge flush with the edge of the plywood. Use a line level to make sure the blocking is horizontal.

It is essential that these pieces are square with each other, so that the glass will fit later. Check the diagonals from the outside corners of the perimeter blocking. The bottom outside corners of the bottom shelf cut out of the bottom 2x6 (nominal) blocking will be considered the bottom outside corners of the diagonals (3-W4).

The vertical height from the bottom edge of the batten shelf to the top edge of the 1x2 (nominal) blocking should equal the glazing height plus 1/2 inch. Without this extra 1/2 in. space (1/4 in. allowed for above and below the glass), the glass might crack when it expands. The horizontal distance must be equal to the width of the collector, which takes into account the expansion spaces needed for the panels of glass. Therefore, the blocking must be fastened to the required dimensions, as well as have equal diagonals.

6.5 Absorber Plate



The air from the supply manifold pan passes through the manifold slots in the Thermo-ply into the ribs of the absorber plate. It flows between the back surface of the plate's ribs and the face of the Thermo-ply, carrying away the heat from the two surfaces as it passes by. It then is pulled through the slots into the return manifold pan. The absorber plate is painted black to absorb more of the sun's light, and reflect less back to the outside.

It is very important that every edge of the absorber plate, including the overlaps, be air-tight. Leakage through the absorber plate can mean the difference between a good collector and a poor one. Therefore, be generous with the urethane caulk. And don't skimp on the screws. The number called for will help keep the aluminum's expansion to a minimum. The less the plate moves, the longer the seal of the caulk will hold.

Don't forget to attach the temperature sensors now, or to pass the wires through the Thermo-ply; it could save some costly (and embarrasing) tearing apart later. Identify which is which with a felt marker on the back of the Thermo-ply.

The absorber plate is made of 4 in. or 8 in. ribbed aluminum industrial siding sheets. If the collector is less than 16 ft. from inner supply manifold slot to inner return manifold slot, use 4 in. rib. If the collector is equal to or greater than 16 feet, use 8 in. rib. The 4 in. rib comes in 45-5/8 in. overall widths, which actually cover 48 inches.

Decide which sheet width will be used, and order it in the .032 in. thickness with the mill finish. Enough sheets will be needed to cover the collector vertically from the bottom to the top edge of the Thermo-ply (3-W5). The sheets will be as long as the horizontal distance from side to side of the Thermo-ply (2,W5). Use the following two equations to determine the number of sheets to order, and their length:

No. of sheets (round off to the next highest

whole number) = (collector height in inches - 5 in.) / 48 in. (for 8 in. rib) or 44 in. (for 4 in. rib)

Sheet width (round off to the next highest 6 in.)= (collector width in inches - 4 in.)

For example, if the collector were the same one used as the example in the introduction (15'-9½" wide x 8'-3½" high) and the 8 in. rib sheets were being used, the number of sheets ordered would be:

(99½"-5")/48" = 1.97 or 2 sheets.

If the 4 in. rib sheets were being use, the number of sheets ordered would be:

(99½"-5")/44" = 2.15 or 3 sheets.

Notice the amount of aluminum that would have to be wasted if the 4 in. rib sheet is used. Only 6-1/2 in. of the last sheet would be used, and the rest would be wasted.

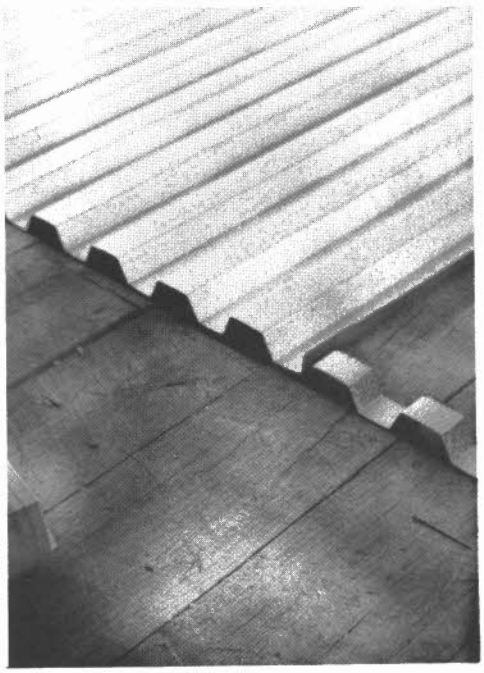
In either case, the actual sheet width would be:

(15'-9½" - 4") = 15'-5½" or 15'-6".

The sheets come in standard lengths up to 30 feet, in increments of 6 inches. If the collector is longer that 30 feet, divide the collector width in half and use two sheets to cover the width. The sheets will butt together at the center-line of the collector, between the two inner manifold pans.

At the ends of each sheet there will be a EPDM end closure strip. Order enough "inside" end closure strips by the linear foot to close off all the ends of the sheets. For example, if the collector is one sheet wide, order two times the height of the collector. If it is two sheets wide, order four times the height, because there will be two sets of EPDM end closure strips at the center-line of the collector.

The sheets of siding will be fastened with the rib running horizontally across the collector, and the 1-3/8 in. rib valley fastened against the Thermo-ply (3-W5).



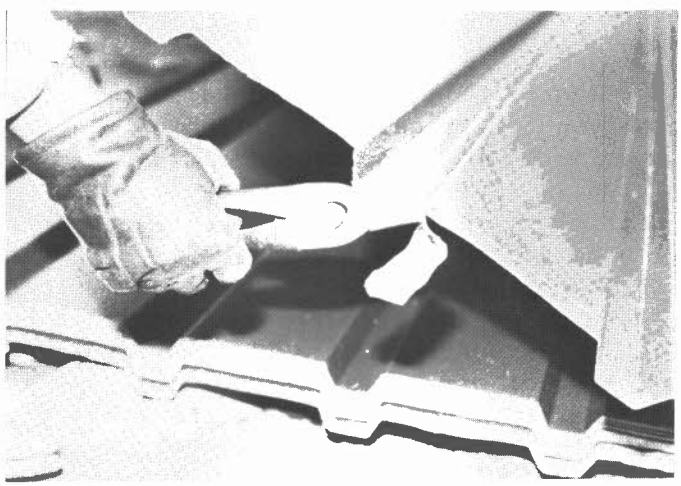
Aluminum Industrial Siding and EPDM End Closure Strips

The sheets will probably have to be cut both horizontally and vertically. Horizontal and vertical cuts can be made with a hand-held circular saw (using a carbide blade). Cuts across the rib can also be made with a pair of tin snips. Cuts along the rib or rib valley can be scored with a utility knife, and the siding is then bent back and forth until the metal breaks clean. When using the circular saw, wear eye and ear protection while cutting, as well as a respiration mask. Cutting the sheet may raise or bend the edge slightly. Remove the raised edges with a file or utility knife, and straighten the edge with a pair of pliers.

Cut the sheets to the length required to fit horizontally across the collector (e.g. 15'-5½"). Save a full piece of ribbed scrap, cut from the end of one sheet, to be used later. Cut off 3/8 in. from the bottom horizontal edge of the first sheet of siding, removing the curved portion and leaving 3/4 in. of flat metal before the rib begins. The top of the last

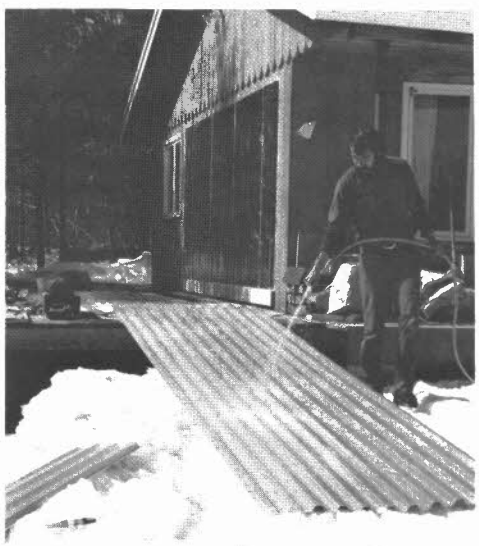
sheet will be cut after all the other sheets are in place on the wall and an actual measurement can be taken.

Cutting the Absorber Plate Along the Rib



Cutting the Absorber Plate Across the Rib

SHEET PREPARATION: To remove the thin film of oil that will be found on the sheets and prepare them for painting, sponge down the outside of the sheets with a solution of TSP powder (tri-sodium-phosphate) dissolved in water. Next, etch the sheets with muriatic acid according to manufacturer's instructions. The TSP powder and the muriatic acid are both available at hardware or building supply stores.



Washing the Absorber Plate

Using the scrap piece of siding as a guide, and a 1/4 in. continuous bead of urethane caulk as the "adhesive," lay out and stick the end closure strips

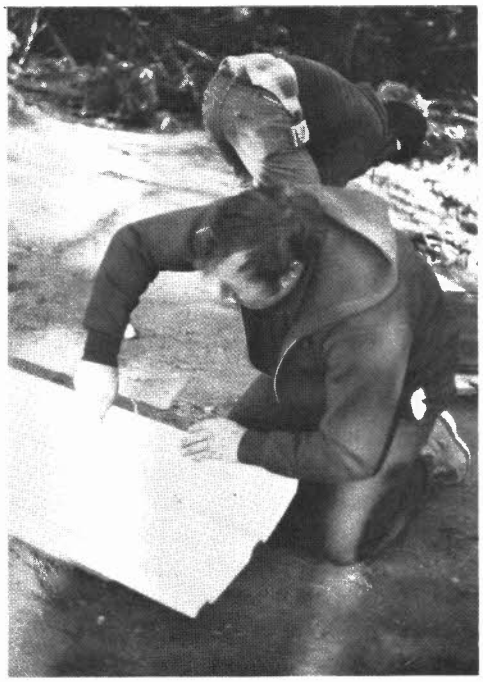
for the first sheet of ribbed siding to the wall (2-W5). The caulk must still be "wet" for it to act like a glue, so don't let it skin over before pushing the closure strips into it. Fit the ribs of the closure strip into the ribs in the scrap piece. Following the form of the siding will keep the closure strip from becoming stretched out as it is stuck in the caulk. Begin at the bottom perimeter seam between the Thermo-ply and the plywood, and line the strips up with the side seams of the Thermo-ply (or the center-line of the collector if there are two sheets per width of collector).

Laying out the EPDM End Closure Strips with a Scrap of Industrial Siding

If the collector has center manifolds, run one strip down each side of the collector center-line (the seam in the Thermo-ply). Do not let the caulk skin over before covering it with the strips. If it does, remove it and caulk again. (See Appendix A for urethane caulk recommendations.)

The temperature sensors will be located on the back of the sheets of siding located over the holes drilled in the Thermo-ply for the sensor wires. Before mounting those sheets on the wall, see TEMPERATURE SENSOR below.

Just before the first sheet is ready to be fastened to the wall, run a 1/4 in. continuous bead of caulk over the inside top edge of the EPDM end



Fastening the Temperature Sensor to the Back of the Rib

closure strips. Run the same size continuous bead across the bottom of the collector, along the bottom perimeter seam. Butt the bottom edge of the first

Caulking the EPDM End Closure Strip

sheet against the edge of the plywood at the perimeter of the collector, laying the sheet carefully over the end closure strips (3-W5). Make sure the end closure strips fit snugly into the ribs.

Fasten the sheet across the bottom edge, with #12x1-1/4 in. Phillips pan head aluminum or 18-8 stainless steel sheet metal screws at 6 in. on center. Fasten vertically through every rib valley at the ends of the sheet, and through every other rib valley at every stud. The studs can be found by noticing where the nails or staples are in the Thermo-ply. Do not fasten across the top of the sheet yet.

Lay out and caulk the EPDM end closure strips for the next sheet. Apply extra caulk where these strips butt against those already on the wall. Run a 1/4 in. continuous bead of caulk across the top edge of the overlap strip of the sheet already on the wall (at the top edge of the top rib valley) (3-R5). Place the bottom rib valley of the second sheet over it. Position the second sheet over the end closure strips. Wipe off any caulk that has been forced out before it skins over. Follow the same fastening schedule as on the first sheet. Continue this process for all sheets except the top sheet.

TEMPERATURE SENSORS: There are two temperature sensors that will be located near the return manifold pan. The first one is for controlling the normal operation of the collector. This sensor is mandatory. The second sensor, which operates the domestic hot water mode, should be mounted only if there is to be a DHW pre-heating system. It is likely that these sensors will be too thick to fit between the top of the rib of the absorber plate and the Thermo-ply. Therefore, they should be located over the manifold slots, allowing them to extend beyond the Thermo-ply if necessary. Attach each one to the back of a rib, located over each inner manifold slot that has a hole drilled next to it for the sensor wires (Section 6.3 and detail 1-W3). Each sensor should be fastened according to manufacturer's instructions. Attach wires to the sensors if they are not already attached. Check with the manufacturer for the type of wire, because some sensors require shielded wire. Fasten the bottom edge of the sheet to the wall. Tie a knot in each wire, and position it over its respective 1/8 in. diameter hole in the Thermo-ply (3-W5).

This will keep the wires from being pulled out of the sensors, after the wires are fed through the holes. Feed the wires through each hole, and then caulk the holes in the Thermo-ply and the absorber. Write with a felt marker on the back side of the Thermo-ply which sensor is which (e.g. "Tc" for normal winter operation and "Tchw" for DHW control). Finish attaching the absorber plate sheets.

Once the second to last sheet is on, measure from the bottom edge of the last rib valley to the top perimeter seam between the Thermo-ply and the plywood. This distance will be the width to cut the last sheet. If the top of the last sheet is cut across a rib valley, follow the lay-out of the end closure strips and the same fastening schedule as the other sheets. Run a 1/4 in. continuous bead of caulk along the bottom edge of the Thermo-ply. Lay the ribbed siding over it and fasten at 6 in. on center.

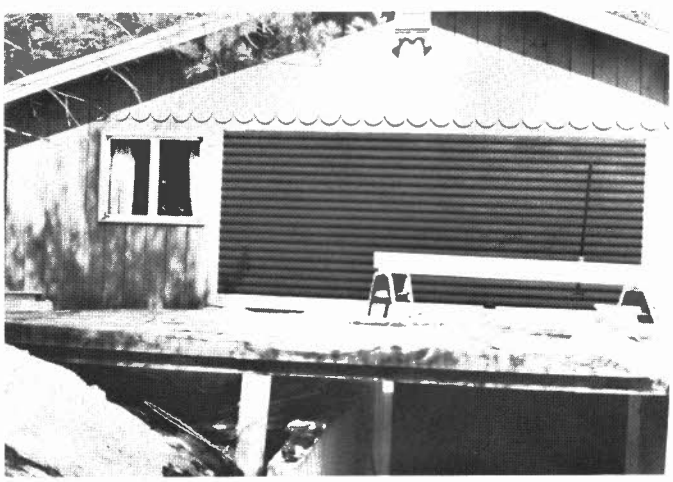
If the top edge of the last sheet is cut across a rib, follow the lay-out of the end closure strips and the same fastening schedule as the last sheets. Cut a continuous piece of 1 in. by 1 in. fir or spruce blocking. Run a 1/4 in. continuous bead of caulk along the top perimeter edge of the Thermo-ply. Lay the continuous blocking in the caulk, and butt its length against the side of the plywood edge, and against the end closure strips at each end. Caulk again along the top edge of the blocking and lay the edge of the last sheet over it. Fasten with #12x2-1/2 in. Phillips pan head aluminum or 18-8 stainless steel sheet metal screws at 6 in. on center.

Check the four corners of the collector. The end closure strips may raise the ends of the top and bottom edges slightly, which will cause leaks. If necessary, loosen the screws, add more caulk, then tighten and add more screws.

PRIMING AND PAINTING: Prime and paint the absorber plate with one coat of primer and one coat of paint. (See Appendix A for manufacturers recommendations.) Paint the inside surfaces of any wood exposed around the perimeter of the plate, with one coat also. Allow the paint to dry completely, a minimum of two full days. Standard enamel paints dry by solvent evaporation, a process that should be allowed to finish before the

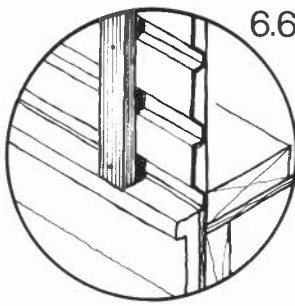
Painting the Absorber Plate

glazing goes on. If there is not enough time to allow for this, an epoxy based paint must be used. Once the absorber plate is painted, be careful not to scratch it. Precautions, such as srapping ladder legs with rags, should be taken. Touch up any scratches with paint, before the glazing is installed.



The Absorber Plate

6.6 Battens



The battens are those vertical members that the glazing system is attached to, so they must be securely fastened to the absorber plate or the side blocking. They must also be plumb, and exactly the distance apart called for, or the glass will not fit. Check the dimensions, plumb, and diagonals carefully. Then check them again.

Cut 1x3 (nominal) fir or spruce battens (1-W6) whose heights are equal to the glazing height minus 1 inch. Paint with two coats of flat black paint. (See Appendix A for paint recommendations.)

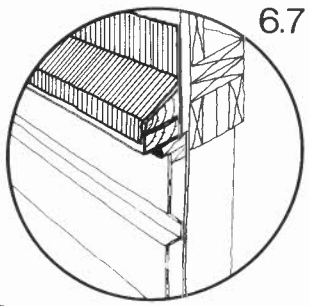
Tack the two outside battens down the sides of the collector first, lining up their outside edges with the outside edge of the perimeter blocking. Use a plumb bob to be sure the battens are vertical (2-W6). The outside to outside dimension should equal the collector width. Cut a piece of plywood with a horizontal dimension equal to the glazing height minus 1-3/4 inches, and a vertical dimension equal to the glazing width minus 1-3/4 inches. This is used as a guide to make sure the battens will be the correct distance from each other, so be sure the sides are square and the dimensions exact--especially at the corners.

Fasten the first vertical batten down the centerline of the collector. Check the diagonals to be sure it is square with the perimeter battens. Lay out the battens to each side, fastening down each batten as the plywood guide is run down between it and the one already fastened next to it. Fasten with #14x1-1/2 in. aluminum or 18-8 stainless steel Phillips flat head wood screws through every other rib. By the time the last one is layed out, the plywood guide should fit between this batten and the one preceeding it, and between this same batten and the one fastened to the perimeter blocking. Fasten the two outside battens with 3 in. drywall screws at 1'-0" on center.

Fastening the Center Batten

1x3 Fir or Spruce Battens

6.7 Glazing Preparation



The glazing preparation consists of several inportant parts. The first is weather-proofing the top and sides of the collector perimeter with blocking and flashing. The blocking, or cant set, across the top of the collector is sloped to allow for drainage. The second step is fabricating and attaching the sill, the piece of wood that will bear the weight of the glass. This sill is cut with channels that will allow condensation to escape from between the glazing and the absorber plate. The sill must be securely fastened, for each panel of glass can weigh from 72 pounds (34 in. x 76 in.) to 120 pounds (46 in. x 96 in.). Before it is fastened check and double check its position. The dimension from its top surface to the bottom surface of the cant set must equal the glass height plus 1/2 inch. Too small, and the glass might not fit, or worse it might crack later when it expands in the heat.

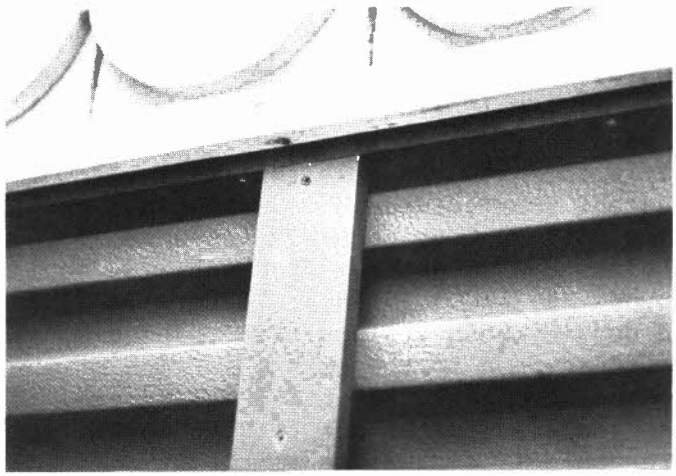
The smoke test is vital to the performance of the collector. The collector must be thoroughly checked for leaks. As will be seen on the first test, no matter how well the collector was caulked, there will still be spots that were missed. But don't get discouraged--the leaks are not difficult to seal. More than one test, however, will surely be needed to find and seal them all.

The pre-shimmed glazing tape acts not only as a seal between the edge of the glass and the interior of the collector, but also as a cushion against wind pressure.

The glazing will be protected around the collector perimeter by a cant strip and blocking set across the top, and blocking down the sides. Across the bottom it is protected and supported by a sill. It is held out from the battens with pre-shimmed glazing tape (1-W7).

CANT STRIP: The cant strip and blocking set consists of two 2x3's (nominal), the top piece ripped across the long side with a side angle cut at a minimum of 4 in 12 (18.5^{o}). The blocking and cant strip extend to the outside edges of the side battens. Tack the first 2x3 (nominal) across the top of the perimeter blocking, with its 1-1/2 in. face against the plywood

sheathing. Tack the cant strip above the blocking with its 2-1/2 in. face flush with the 2-1/2 in. face of the blocking (3-W7).



The Cant Set

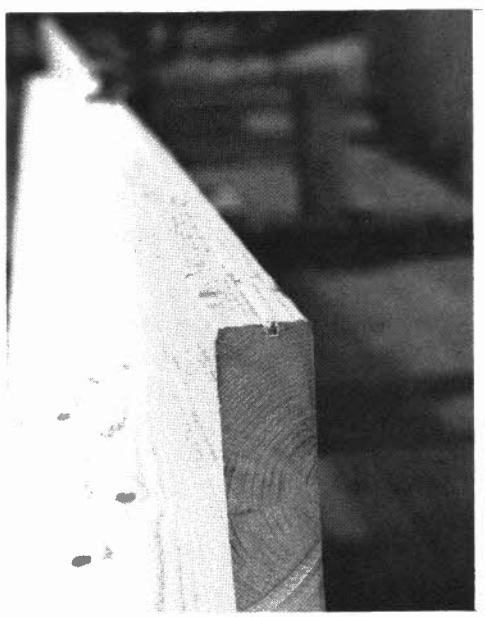
SIDE BLOCKING: Tack 1 in. x 1-3/4 in. (actual) continuous blocking down the sides of the collector with

The Side Blocking

the outside edges flush with the outer edges of the battens. The blocking will run from the underside of the cant strip set, and its height is equal to the height of the glazing plus 6 inches. The clear distance from inside to inside of this blocking must be equal to the collector width minus 2-1/2 in. to allow for glass expansion (2-W7).

SILL: The 2x6 (nominal) finish grade cedar sill will run horizontally across the bottom of the collector, from inside to inside of the side blocking. The top edge of the blocking will fit into the rectangular notch in the bottom perimeter blocking. Its top edge must be at a distance down from the cant strip set equal to the glazing height plus 1/2 inch (1-W7).

The sill should be prepared before mounting with 1/4 in. square condensation and drip channels set back 1/2 in. from its front face. Rout out the channels. Cut 1 in. deep by 1/2 in. wide vertical saw kerfs from the back of the sill at 1'-0" on center, beginning at the center-line of the sill (3-W7). The kerf shall be continuous from channel to channel.



The Sill

Tack the sill across the bottom of the collector, using a line level to be sure it is horizontal. Check the dimensions from the inside edge of the cant strip set to the inside edge of the sill, at several points. The clear distance must equal the glazing height plus 1/2 inch all the way across to allow for glass expansion. Check the diagonals also, as well as plumb and level lines.

Once the pieces are square, fasten them. Fasten the 2x3 (nominal) top blocking with 30d common nails at 1'-0" on center, and the cant strip with 10d common nails at the same spacing. Fasten the side blocking with 16d common nails at 1'-0" on center. Fasten the sill with 1/2 in. x 4 in. hexhead lag screws, countersunk, at 1'-0" on center. Do not fasten the lag screws through any of the weep slots.

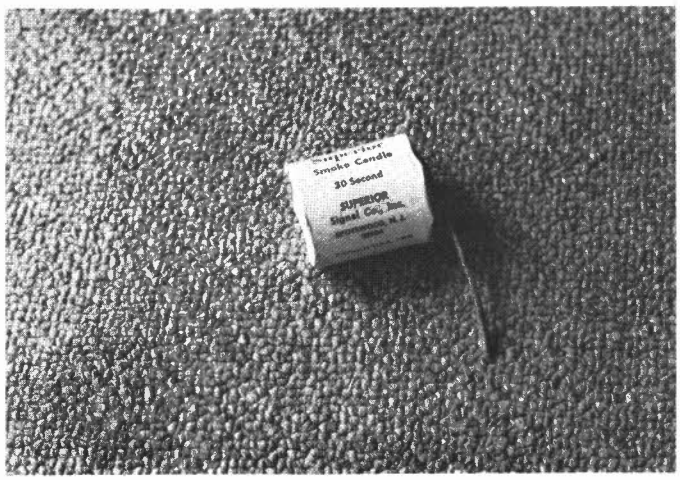
FLASHING: Bend 10 in. wide 0.019 in. aluminum flashing around the side blocking and onto the wall, beginning at the center-line of the side blocking. Start at a point 1-3/4 in. below the top of the sill, and carry the flashing up the side, bending over the end of the cant strip. Fasten with 1 in. galvanized roofing nails at 1'-0" on center.

Bend 10 in. wide 0.019 in. aluminum flashing around the cant strip and up the wall, beginning at the center-line of the 2x3 (nominal) blocking across the top of the collector. The flashing should be continuous from one side of the collector to the other. Bend the flashing over the wall with 1 in. galvanized roofing nails at 1'-0" on center.

SMOKE TEST: Before installing the glazing tape, or the glazing, it is necessary to check for leaks in the system. This is important, since even small leaks will reduce the efficiency of the collector dramatically. One method of checking for leaks is a smoke test. This can be done using a metal paint can and a smoke bomb. (See Appendix A for smoke bomb recommendations.) Follow manufacturer's warnings on the smoke bombs.

It is helpful at this point to have the supply and return ducts attached to the duct collars, to check for leaks at the connections.

Seal off the duct connections to one manifold



Smoke Bomb

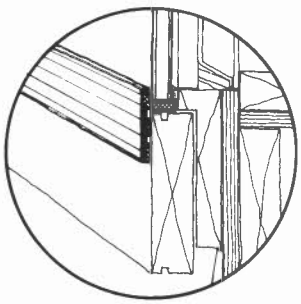
or duct using polyethylene film (or cardboard) and duct tape. Leave a hole at the other manifold duct to put the paint can through. Place the smoke bomb in the paint can, ignite it, and place it into the duct.

It will not be unusual for the collector to leak slightly around the edges of the absorber plate and at the overlaps, and these leaks must be completely sealed. Adding extra clear silicone caulk and more screws at these seams will help stop the leaks. Paint over any new screws and touch up any scratches.

Also check the back of the collector for leaks at the manifolds, ducts or those made by any fasteners that punctured the Thermo-ply. Caulk all leaks with silicone caulk.

Several tests may be required before all the leaks are sealed.

GLAZING TAPE: Just before glazing each 'bay' with an insulated glass panel, run 1/8 in. by 1/2 in. pre-shimmed glazing tape vertically down the inside edges of the front face of the battens, horizontally across the bottom edges of the front face of the top perimeter blocking, and the top edge of the front face of the batten shelf (2, 3-W7).



6.8 Glazing and Finishing

The insulated glass panels allow the sun's light to pass through and hit the absorber plate, but slow the transfer of the resulting heat back to the outside. The glass must be able to expand and contract freely with the extreme temperature changes. Therefore, the 1/4 in. gap allowed around each panel is vital to the survival of the glass. Each panel of glass rests on two setting blocks. These blocks support both pieces of glass, but allow them each to move independently with the expansion and contraction. The inner layer of glass will move much more than the outer, because it is experiencing higher temperatures. This is the reason why insulating glass panels with metal or glass fused edges cannot be used.

The aluminum clamping bars with built-in gaskets provide support along with an almost caulk-free, weather proof seal. The only place caulk is needed is at the intersections of the clamping bars, where water could leak in under the bars and rot the wood.

GLAZING: The rest of the glazing process involves mounting insulated glass panels to the collector with the CY/RO Universal Glazing System. (See Appendix A.) The total CY/RO U.G.S. consists of a lower EPDM gasket, an aluminum clamping bar and two upper EPDM gaskets. The lower gasket has been replaced on the wall collector by pre-shimmed glazing tape (Section 6.7). Therefore, do not order the lower gasket (4-W8).

Cut two sections of the clamping bar 1 in. longer than the width of the collector (from outside edge to outside edge of the side blocking) for the top and bottom. Miter the corners so that the outside length of the bars equals the width of the collector. Cut two sections of the clamping bar, 1 in. longer than the height of the collector (equal to the glazing panel height in inches plus 3-1/2 in.), for the two sides of the collector. Miter the corners so that the outside height of the bars equals the height of the collector. Cut the rest of the vertical clamping bars, to be placed over the battens, the height of the collector minus 5 in. (1-W8).

If the collector is wider than 25 feet, the horizontal bars may have to be done in pieces. The clamping bar only comes in stock sizes of 25 foot lengths. Try to keep the splices to a minimum.

Pre-drill the clamping bars at 8 in. on center along the center-line of the bars, with holes no more than 1/2 in. from the ends. Feed the upper gaskets into the channels extruded into the under side of the bars. Run the gaskets continuously through any splices of the clamping bars.

Line up the bottom horizontal clamping bar along the sill, with its top edge 3/4 in. above the top edge of the sill. Fasten with #12x2 in. aluminum or 18-8 stainless steel Phillips pan head sheet metal screws, with neoprene washers. Fasten all the screws part way, leaving enough room to set the glass on the sill without disturbing the glazing tape. Repeat this process up one side of the collector, lining up the inside edge 3/4 in. to the inside of the inner face of the perimeter blocking.

SETTING BLOCKS: Each panel of glass will be centered between vertical strips of glazing tape. Place two 1/4 in. x 1 in. neoprene (70-90 Shore-A-Durometer) setting blocks on the sill at the quarter points of each of the bays (1,3-W8). The setting blocks are available from local glazing dealers.

GLAZING: Special precautions must be taken when handling large panes of insulating glass. If a unit is leaned against a vertical support, provide one support under both panes of glass to keep them from sliding apart. Take care not to damage the edges, and do not pivot the glass panels on their corners. The glazing recommended in Appendix A comes with a stencil in one corner. This stencil should be glazed to the inside bottom left hand corner when installed. Clean the inside of the glass thoroughly before pressing the glass into place against the tape.

In the corner framed by the two clamping bars in place, carefully slide the first panel of glass underneath the two glazing bars on the wall. Center the glass inside the boundaries set by the clamping bar and the batten, lining up the free edge with the edge of the

glazing tape nearest the center-line of the batten. (The glass must be 3/8 in. from the center-line of the batten.) Tighten the screws on the two clamping bars already in place. Center the next vertical clamping bar over the next batten, covering the free edges of the glass. Partially fasten the screws. Do not fasten the top clamping bar at this time.

Center the next panel of glass in the same way. Fasten the screws across the bottom of the glass, and up the batten between the two panels. Partially fasten the next vertical clamping bar to the batten. Continue this process across the collector until the last vertical clamping bar is fully fastened. Fasten the top horizontal batten across the collector, overlapping the clamping bar 1/2 in. over the glass.

Caulk all the intersections of the clamping bars: horizontal and vertical joints, splices and mitered corners. (See Appendix A for silicone caulk recommendations.) This caulk will keep water from leaking through the intersections and under the clamping bars.

INTERIOR FINISHING: Cut rigid fiberglass insulation the width and length necessary to fit behind the manifold pans, from manifold stud to manifold stud, and from top to bottom blocking. Make the insulation as thick as will fit, without protruding beyond the studs. Locate the sensor wires that were fed through the Thermo-ply. Attach more wire (shielded wire if manufacturer calls for it), and run to the air handling control panel (see Figure 8.15 and 8.16 or 8.23 and 8.26). It is important to tag the wires so that they don't become confused with each other. Insulate between the other studs with full depth fiberglass batt insulation. Staple a 6 mil polyethylene vapor barrier to the studs, overlapping the sheets 6 inches and taping the upper edges down. Finish the interior surface as desired.