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Solar Radon Reduction System

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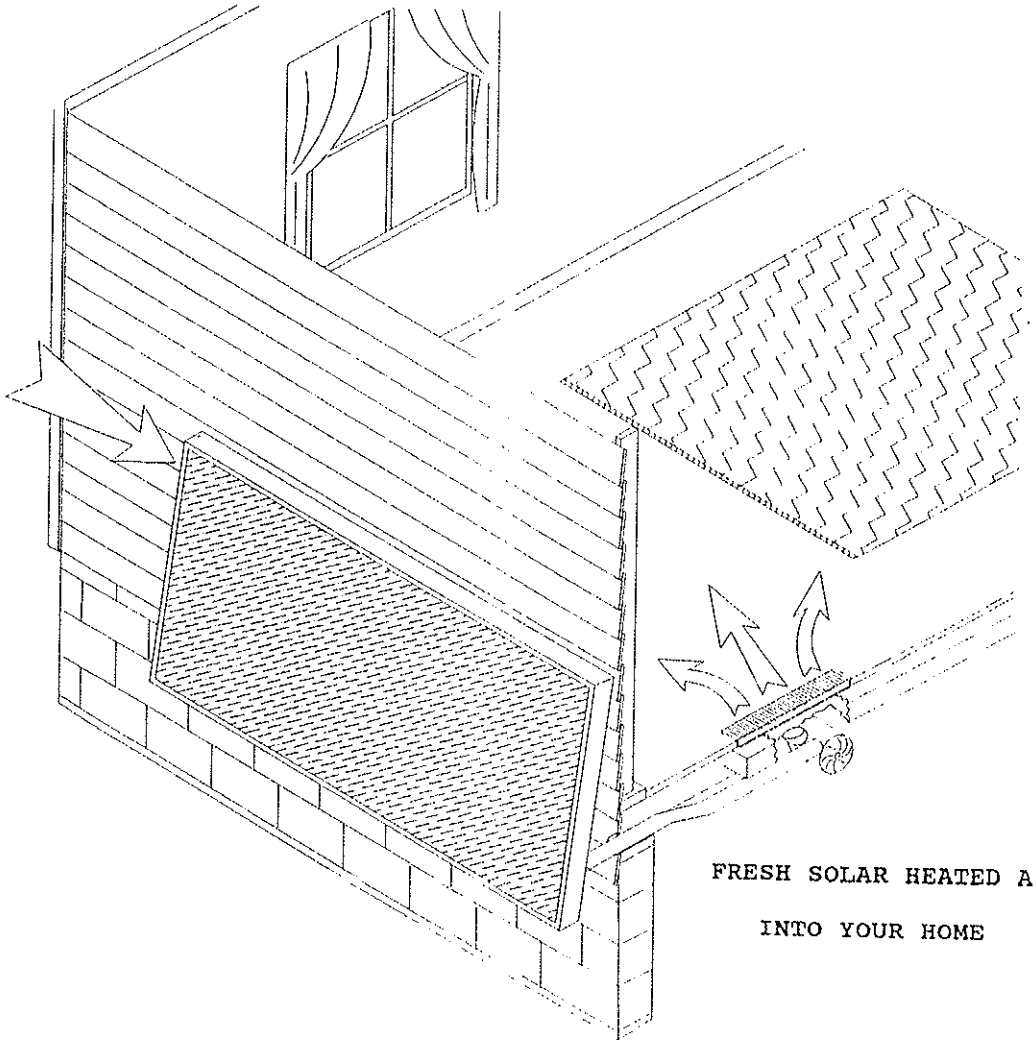
SOLAR RADON REDUCTION SYSTEM



IMPORTANT

The electrical circuits discussed, described, and illustrated in this manual should not be employed without careful consideration and evaluation of their suitability for any given application. No electrical circuit should be constructed without a thorough understanding of electricity, and its circuits. Basic carpentry and sheet metal skills are required. Explanations of elementary carpentry , sheetmetal and circuitry are beyond the scope of this manual and should be obtained from other sources. Due to the variances in construction techniques, building materials, and radon's unpredictability, other mitigation techniques may be required. After installing the Solar Radon Reduction System a follow-up radon test should be taken to assure that the radon level is below 4 picocuries per liter (pCi/L).
No warranty, either express or implied, including but not limited to any implied warranties of merchantability and fitness for a particular purpose, is made regarding this system and its effects. The primary purpose is to provide outdoor air to improve ventilation and reduce radon concentrations. In no event shall the authors or the publisher be liable to anyone for special, collateral, incidental, or consequential damages in connection with or rising out of the purchase or use of these materials, and the sole and exclusive liability, regardless of the form of action, shall not exceed the price of this manual.

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THE SOLAR RADON REDUCTION SYSTEM

INTRODUCTION

Homeowners trying to reduce their heating bills and conserve natural resources have combined insulation and weatherization to reduce the energy demands of their homes. By sealing our homes to prevent cold outdoor air from entering, we have reduced the amount of natural air changes in our homes. This has reduced the quality of the air we breathe in our homes. By tightening and sealing our homes, scientists have discovered that many houses are dangerously polluted by toxic chemicals and naturally occurring radon. The tightening of a home to conserve energy doesn't cause indoor pollution, but it can trap contaminates that would otherwise escape through cracks. Chemicals result from cleaning products, furnishings, cigarettes, building materials, and the earth. Improper ventilation concentrates the toxins and the harmful effects. The Environmental Protection Agency (EPA) ranks indoor air pollution as the number one environmental danger. What can you do to protect you and your family? Improve your ventilation by bringing outdoor air into your home. Proper ventilation is critical in keeping indoor air free of pollutants.

The Solar Radon Reduction System (SRRS) is designed to reduce the radon levels in homes and offices in an energy efficient manner. The SRRS reduces the amount of radon by introducing fresh, clean outdoor air into the home. This dilutes the amount of radon thereby lowering its concentration within the structure. The SRRS can also augment your heating system and reduce your heating bills. The SRRS can improve your homes ventilation and overall comfort level.

This manual will be your guide in installing the SRRS. It is a do-it-yourself guide that any handy person or contractor can follow. The SRRS is an EPA award-winning design and is a patented system.

SITE SELECTION

The solar heating system described in this manual is designed to be installed on a south facing wall, roof, or can be a freestanding unit. A previously installed solar heating system may be converted to the SRRS design. The site that you choose for your solar collector is one of the most important factors in the amount of solar heated air that you will receive. To find the best location for your solar collector you will need to look for the sunniest location possible. During the winter months, find areas on the site that receive the most sun during the hours of maximum solar radiation - 9:00 a.m. to 4:00 p.m. Avoid areas that could become shaded. It is a good idea to observe your preferred location throughout the heating season noting which area receives the most sunlight. Shading from most deciduous trees will have little effect on the amount of sunlight that you receive. Oak trees tend to retain their leaves throughout the winter and should be avoided.

Solar collectors should always face solar south. The easiest method to determine solar south (not magnetic south) is to consult your daily newspaper's listing on the times of sunrise and sunset. Compute the time that is exactly midway between them. This is referred to as solar noon. Place a stick or pole in the ground vertically. At solar noon the shadow cast by the pole will be true north. The exact opposite direction is solar south. **Fig.1** It is acceptable to be 30 degrees to either side of solar south; however an orientation of a few degrees to the west will increase the amount of solar heated air that can be collected.

Two other factors to consider will be the easiest location to cut into the perimeter joist and where you want the heat from the solar panel to discharge into the living space.

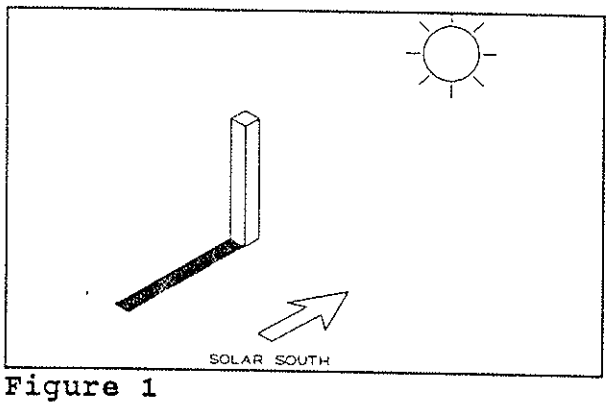


Figure 1

A Flat Plate Collector

The simplest type of solar collector to build is a flat plate collector. The flat plate collector is the most common type of collector and has been in use nearly one hundred years. The corrugated surface is painted black to absorb the sun's heat and the air flowing over the surface becomes heated. Existing solar collectors can be adapted to the SRRS design. Manufactured solar collectors can be expensive, however you can make own for next to nothing with a little ingenuity. Many materials needed to make a solar collector can be acquired for free by using scavenged or recycled materials from construction sites. Twenty percent of the material that goes to landfills is from construction or remodeling debris. For example, sheet glass can be scavenged from glass shops who will give away odd sized or used glass that would be appropriate for a solar collector. There are also hundreds of books and manuals on solar collector design and installation, most of which can adapted to the SRRS. This is a low cost design that can be installed for less than two hundred dollars with new material and equipment. The following solar flat plate collector design consists of a wood frame with a plywood backing, rigid foam insulation, a metal absorber plate, and a glass or plastic glazing.

Collectors can be built to any size that you wish. However it is easier to work with standard stock wood sizes. The best woods to use are higher grades such as kiln-dried redwood or cedar.

WARNING: PLEASE READ THE ENTIRE MANUAL BEFORE BEGINNING THE INSTALLATION PROCEDURE.

QUANTITY	MATERIALS
1	4'x 8' Sheet Plywood
2	12'x 1"x 4" Lumber
2	8'x 1"x 1" Lumber
2	8'x 1 1/8"x 1 1/8" outside corner molding (or 1 1/8" x 1 1/8" x 8' aluminum angle iron)
2	26" x 96" galvanized corrugated sheetmetal
1	4"x 14" screen
1	5" crimped starting collar
*	5" round sheetmetal(or insulated flex) pipe 5"x 60"
1	3/4" x 6" galvanized pipe nipple
1	1/8" x 1 1/2" x 4' slotted angle iron
1	2 1/4" x 12" floor diffuser
1	roll duct tape 2" x 60 yds.
1	4" x 5" sheetmetal reducer
1	Fasco fan motor - B75, 110volt, 3000rpm, 75cfm
1	thermostat 90° to 130° F
1	roll 12/2 NM-B with ground electric wire 250'
6	bag of 25 wire nuts
2	bag of 10 terminal connectors
1	male electrical plug
*	box of 20 wire staples
1	junction box
1	"SSU" fuseholder switch
1	3/4 locking nut
1	4'x 8' acrylic glazing
20	#8 hex head sheetmetal screws 1/2" long
32	#10 hex head sheetmetal screws 1/2" long
8	#12 woodscrews 2" long
20	#8 woodscrews 2"long (or 1lb 4D finnish nails)
1	tube silicone sealant
2	4'x 8' sheets Thermax insulation

* Quantities will vary with each application.

PROCEDURE

1. To build the frame cut the 1" x 4" side and end pieces for the collector frame to 46 1/2 inches and 8 ft lengths (2 each) to form all four sides. This will form a 4 ft. x 8 ft. outside dimension.
2. Screw the sides together using No. 12 x 2 inch wood screws to join the frame together. **Fig. 2**
3. Apply a high grade clear silicone sealant to the bottom edge of the frame to seal and hold the 4'x 8' sheet of plywood.
4. Install the 4 x 8 sheet of plywood to the frame. Secure with nails or wood screws. **Fig. 3**
5. Turn box over and cut the foam insulation to size starting with the sides so that the bottom piece fits securely.
6. Set the box in the location that you have in mind. Determine where the hole should be located at the edge of the panel that will allow the five inch round sheet metal pipe that connects to the solar panel to enter the house. The hole for the electrical wiring should also be determined at this time. It is a good idea to run the electrical wiring through the same joist space as the round pipe. The hole for wiring should be 3" inches to the left or right of the hole for the sheet metal round pipe. **Fig. 4**

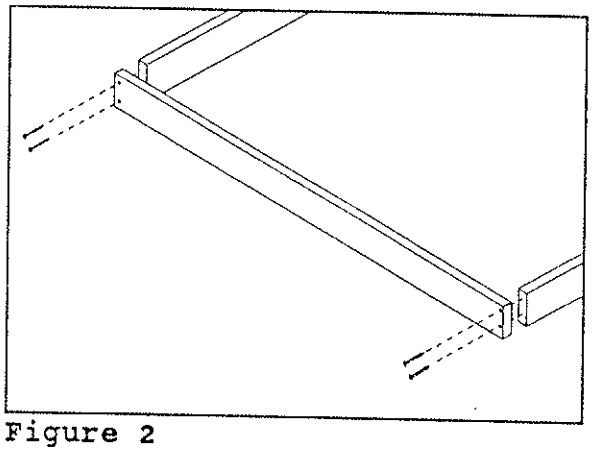


Figure 2

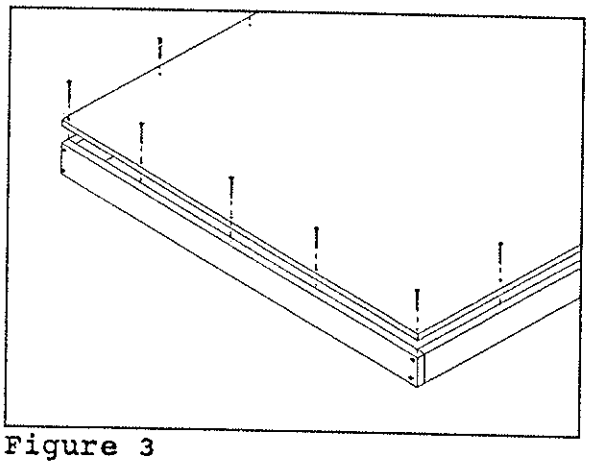


Figure 3

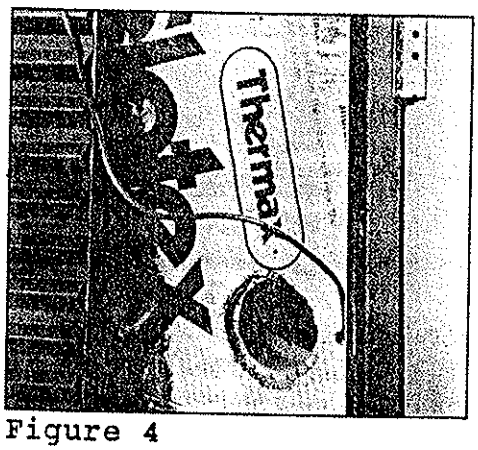


Figure 4

TIP: Be sure to inspect the inside the house so that you do not hit any electrical wiring or plumbing. The neatest looking installation will be cut through the perimeter joist, however some people prefer to hammer through the block foundation and cement up the hole around the duct pipe. Plan your work thoroughly and double check your measurements before you cut a hole or knock a hole in the foundation.

7. After you have found your location for the 5" inch sheet metal round pipe from the outside of the building hammer a 16D- 3 1/2 inch nail through the siding so that it protrudes into the inside of the house. Find the location of the nail from the inside of the house. Inspect the area around the nail to determine if there is enough clearance to cut a 6" inch hole. The nail should be in the center of the perimeter joist.

TIP: An excellent reference point for determining an unobstructed joist is to measure from an outside water faucet on the inside of the house and transfer this measurement to the outside of the house before hammering a nail through the siding.

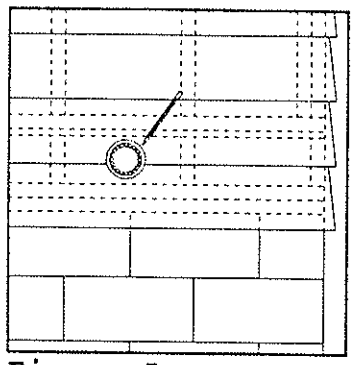


Figure 5

8. Center a five inch starting collar around the nail hole and trace the outside of the starting collar. **Fig. 5**
9. Measure 8" inches from the 16D nail to whichever side is nearest the outer edge of the solar collector and mark the hole for electrical wiring.
10. Remove nail and drill a pilot hole with a 1 1/4 inch wood bit or hole saw bit. Using the same bit, drill a hole for electrical wiring.
11. Using a reciprocating saw cut a round hole through the siding and the perimeter joist. Cut at least a 1/2 inch outside of the circle that you traced as a guide. Use a 6 inch blade or longer.
12. If you are mounting the solar collector flush to the house set the collector in position.

TIP: The collector or box can be raised or lowered to the exact position and held in place by setting it on top of a scissors jack or a hydraulic jack. The collector needs to be secured to prevent personal injury. Centering the collector under a window creates an attractive installation and allows the window sill to act as an extra hand. Raising the collector with the jack until the top of the collector is butted against the bottom of the window sill will hold the collector securely in place.

13. From the inside of the house trace both holes on the back of the box. This will mark the location for the next holes to be cut.

WARNING: The air intake to the collector should be at the opposite end from the air intake to the house. **Fig. 6**

14. Place the starting collar in the center of the hole that you just traced in instruction 13 and then trace the starting collar. This will provide the pattern for the next hole to be cut in the solar collector.

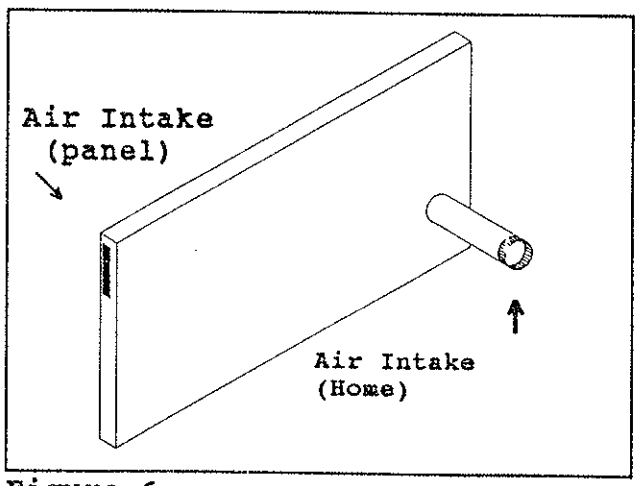


Figure 6

15. Drill a pilot hole in the center of the starting collar circle and a hole for the electrical wiring with the 1 1/4 inch wood bit through the back of the box.
16. Using a reciprocating saw cut a hole in the box for the starting collar. Use the pattern that you traced as a guide.
17. At the opposite end from the house air intake, measure and mark a two by twelve inch rectangle hole for the panel air intake.
18. Drill two pilot holes in opposite corners. Using a reciprocating saw cut the hole that you just traced.
19. Cut a screen to three by fourteen inches to cover the panel air intake. Secure the screen to the outside of the intake with No. 8 X 1/2 hex head sheet metal screws to prevent insects and animals from entering the collector.
20. Turn box face side up.
21. Then cut four 1 in. x 1 in. wood pieces to length so that they fit snugly cross the width of the box. Install these over the insulation. **Fig. 7**
22. Trim 5" off the 8' ends of the corrugated sheet metal using a skill saw with a 17 -21 teeth per inch metal blade.
23. Overlap the 2 pieces of absorber plate about 5" so that the absorber plate fits easily into the box.
24. Stand the box on it's side and trace the starting collar hole and electrical hole onto the back of the absorber plate.
25. Remove absorber plate from the box.

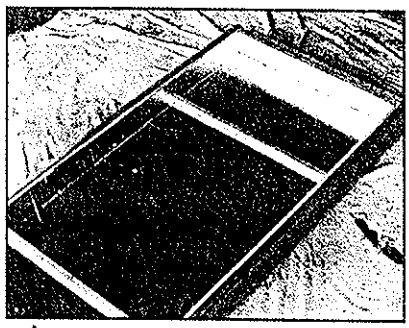


Figure 7

26. Drill a 3/4 inch hole in the circle on the absorber plate and a hole for the electrical wiring.
27. Using a skill saw with a 17-21 teeth per inch metal saw blade or a grit saw blade cut a hole for the starting collar to fit into.
28. Install a 3/4 inch by 6 inch galvanized pipe in the hole for the electrical wiring and secure with a electrical locking nut curved side down. The pipe nipple is used to comply with electrical codes.
29. Install a starting collar in the absorber. Turn down holding tabs.
30. Install a two foot 5 in. round pipe to the starting collar and secure with No. 8 by 1/2 inch hex head sheet metal screws.
31. Place the box on saw horses or chairs collector side up.
32. Paint outside of the wood box the color of your choice and allow time to dry.
33. The galvanized corrugated sheet metal needs to be etched so that the paint that is applied will adhere to the surface of the metal. With galvanized corrugated sheet metal, etch the metal using a commercially available galvanized metal primer or by pouring vinegar over the surface to be painted.
34. Paint surface with Rust Oleum's

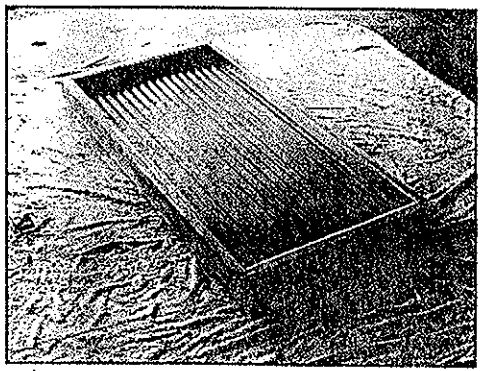


Figure 8

Flat Black, or equivalent. Allow time to dry.
35. Install the absorber plate in the box. Screw absorber plate to the snug fitting 1" x 1" with No. 8 x 1 1/2 in. wood screws. **Fig. 8**
36. Mount fan thermostat on the absorber surface in the upper half near the house air intake and secure with No. 8 by 1/2 in. Hex head sheet metal screws. **Fig. 9**

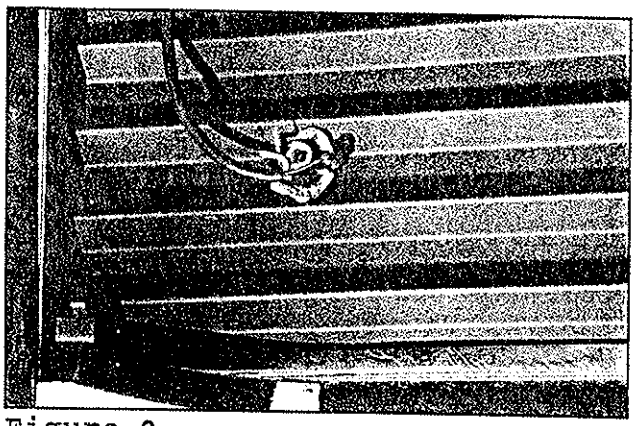
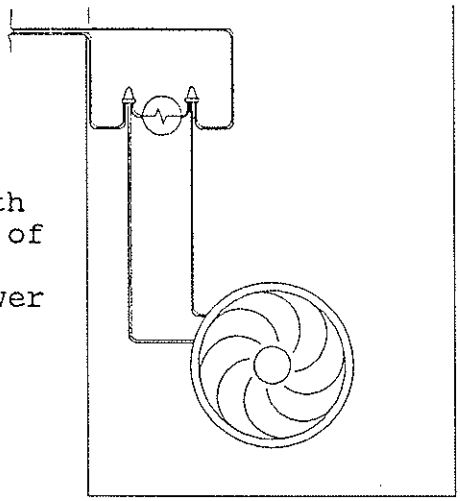


Figure 9

TIP: Estimate the number of feet of wiring that will be needed to connect the solar panel thermostat to the ventilation fan and cut wire to the approximate length leaving a couple extra feet for any miscalculations.
WARNING: All electrical wiring should comply with local codes and standards. Never work with live electrical circuits.
37. Use No. 12-2 with ground electrical wire. Connect the yellow receptacle terminals for No. 12 wires to the bare copper portion of the insulated wires, (crimp securely), and install on thermostat. Secure ground wire to absorber plate with No. 8 1/2 inch sheet metal screws. **Fig. 9**
38. Run wire through the holes and pipe nipple.
39. Cut 1/8" X 1" 1/2 X 1" 1/2 x 4 foot slotted angle iron into one foot pieces.
TIP: A reciprocating saw with a metal blade is an easy method to cut angle iron.
WARNING: The angle iron should be secured in a vise to prevent injury.
40. Set the solar collector into position. Slide the electrical and round pipe through the holes in the perimeter joist using the jack to hold the collector in position.
41. Determine the best location for the slotted angle iron to secure the solar collector. Mark the locations using the holes in the slotted iron as a template. Drill 1/4 inch pilot holes for the wood screws. Attach the slotted angle iron to the siding using No. 12 x 2 inch wood flathead screws.
42. Drill 1/4 inch pilot holes into the solar collector to secure the collector to the slotted angle iron with No. 12 x 3/4 inch wood screws. Another option would be to drill through the wood frame and secure with two inch x 3/4 inch nuts, bolts, and washers.
43. Remove Jack.
44. Cut 1 1/8 " x 1 1/8" x 8' aluminum angle iron or outside corner molding to form a frame to hold the glazing.
45. Attach the adhesive foam rubber to the outside edge of the solar collector. Place acrylic glazing into opening. Secure the glazing with the aluminum angle iron and secure the aluminum angle iron with No. 10 x 1 inch flathead wood screws.
46. Finish painting the collector.

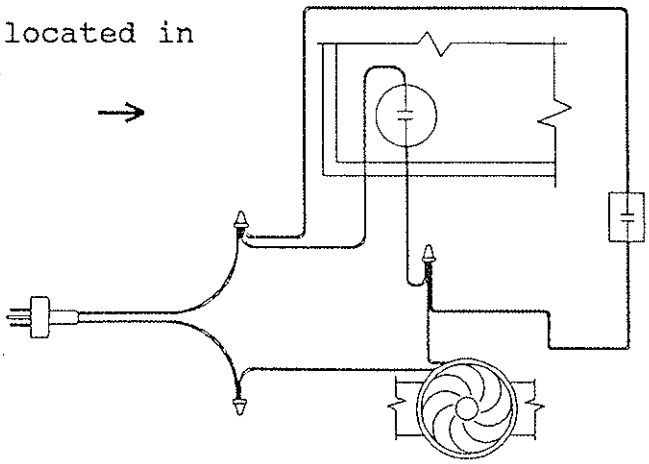
TIP: The SRRS system is designed to ventilate your home by bringing in outdoor air into the house. This can be accomplished in up to five different methods using the same design.
Methods:
1. Solar panel operation.
2. By inducing draft from forced air furnace operation.
3. By solar panel blower and furnace operation.
4. By wiring the solar panel blower to operate whenever the furnace fan motor operates.
5. The use of a ventilation control or by a constant radon monitor that will activate the ventilation system when an unacceptable radon level or other pollutant is registered.
TIP: You will need to determine at this time which is the best approach for your home. If you have a forced air furnace install the ventilation fan to the return air duct so that it will discharge into the living area that you want.
WARNING: Check local mechanical ventilation codes.
If you do not have a forced air system or local code prohibits a ventilation fan in the return air, install the ventilation fan so that it discharges directly into the area that you want to heat or ventilate.
47. To determined the area that you want the SRRS to discharge air into you have two options. Remove the return air grill and punch a hole through the return air sheet metal panning to mark the exact location of the ventilation fan, or cut a new hole for a 2 1/4 x 12 inch floor diffuser above the return air sheet metal panning.
48. After marking the location for the fan, hold the fan in position and trace around the outside to the discharge throat, and the 4 mounting holes of the blower flange.
49. Drill four 1/4 holes into the sheet metal at the locations of the mounting holes that you traced.
50. Mark a hole for the fan to discharge into on to the sheet metal.
51. Make a hole in the center of this pattern.
52. Enlarge the hole to insert the skill saw with a sheet metal blade or cut with aviation snipes so that the discharge of the fan will protrude into the return air panning or duct.
53. Place the fan over the hole and secure the fan flanged throat using the holes drilled at operation #49 with No. 10 x 3/4 hex head sheet metal screws.
54. Install the necessary 5 inch round pipe from solar panel to the fan intake. Insulate and secure to the fan.
TIP: Try to avoid elbows or turns in piping which could reduce air flow.
55. Support the piping every two feet or as required to secure piping.
56. Run electrical wiring to fan motor as required by local codes.
57. Mount junction box near the fan motor so that the motor leads will enter the junction box.
TIP: It is recommended that the electrical system be wired to a Fused Switch Box (SSU) so that the system may be unplugged or switched off depending upon need or season. Check Local Codes.
58. Install a power cord to the junction box so that the system may be unplugged.

Electrical Wiring Diagram



Relay wired in parallel with blower motor (coil voltage of the relay must be the same voltage as the furnace blower motor)

Furnace Blower Motor



Thermostat located in solar panel

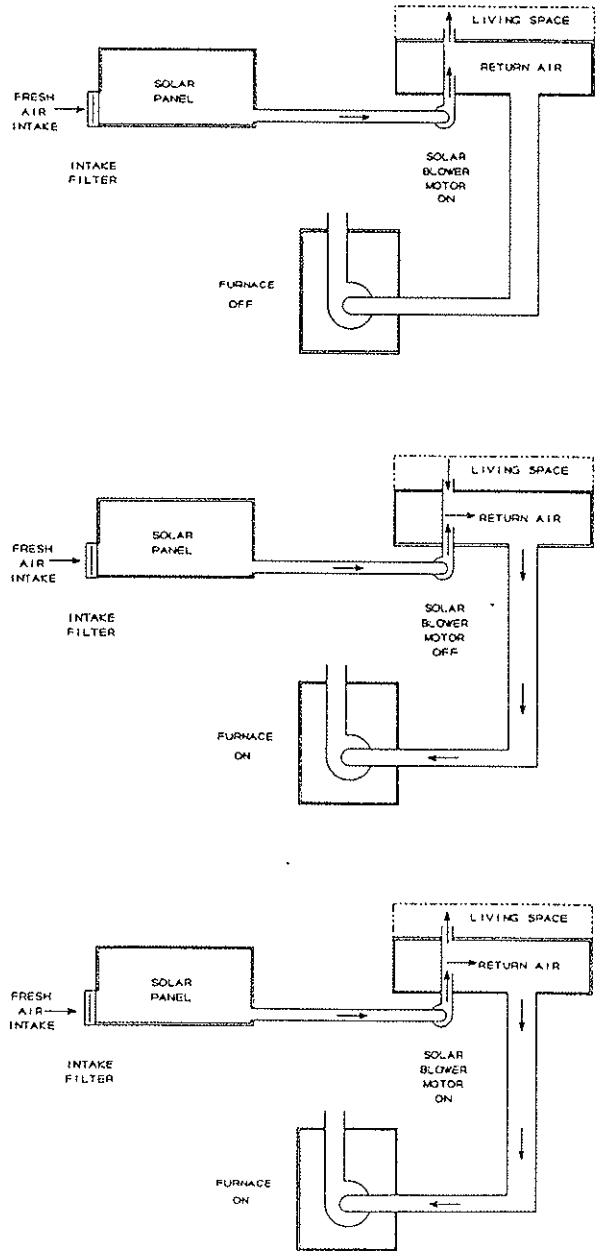
Relay contacts (Normally Open) located in furnace compartment.

Blower Motor for heated air from solar panel

Figure 10

59. Connect ground wires to the junction box.
60. Wire hot lead from the power source to the lead going to the thermostat in the solar panel. The other wire from the solar panel will be the hot lead to the fan that will start the fan motor operation, depending on the temperature of the collector. The other wire from the fan motor will be the neutral wire. It will be connected to white insulated wire coming from the power source.
TIP: If the system is to be wired to a continuous radon controller wire the controller in parallel with the thermostat so that either the thermostat or the radon controller can start the ventilation fan. Another method is to wire a relay in parallel with the furnace fan motor so when the furnace fan starts the relay for the solar panel blower will be energized. **Fig. 10 - 13**
61. Plug in electrical cord. Turn on the switch to begin SRRS operation.

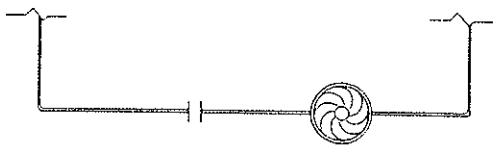
SRRS MODES OF OPERATION



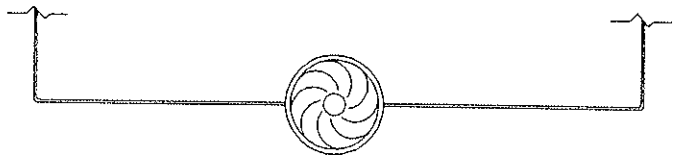
Electrical Wiring Schematics

Wiring for a Basic SRRS

The most energy efficient method of SRRS operation. When the thermostat reaches 110 degrees the electrical contacts close starting the solar blower motor. The solar blower motor draws fresh air from the outdoors through the solar panel and discharges the solar heated air into the house.



Thermostat Contacts - Solar Blower Motor



FBM
Furnace Blower Motor

Figure 11

SRRS With Furnace Blower Relay

This method of Solar blower motor control is used for buildings requiring more ventilation.
C-1 is the contacts of the thermostat located in the solar panel. C-2 is the contacts of relay R-1 located in the furnace compartment.
SBM is the Solar Blower Motor.
FBM is the Furnace Blower Motor.
The Solar Blower Motor will operate as it did in Figure 11, as well as operate whenever the furnace motor is running. Both motors will run on a call for space heating or by selecting the continuous fan setting on the thermostat, whenever extra ventilation is required.

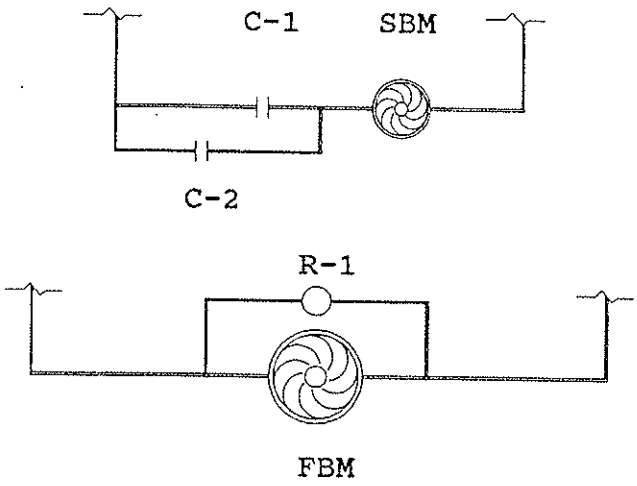
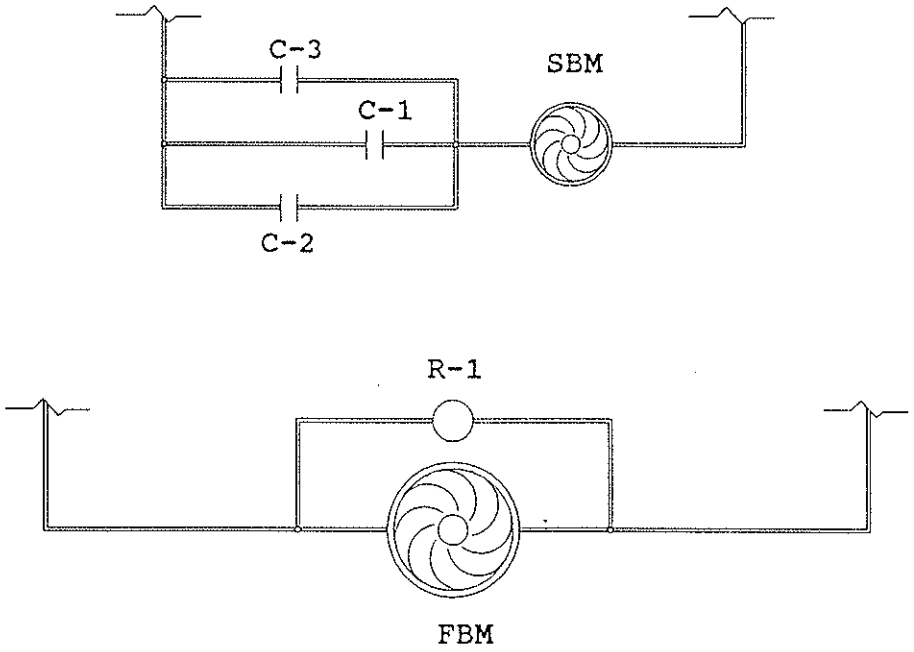


Figure 12

SRRS With Continuous Radon Monitor

This method of operation is used with a continuous radon monitor. The monitor will turn on the solar blower motor when a radon level above 4 pCi/L is registered and switch off the solar blower motor when the radon level has fallen to 3.5 pCi/L (or other predetermined levels). The solar blower motor will continue to function as it did in figures 11 & 12. C-1 represents the thermostat contacts. C-2 represents the Normally Open contacts of Relay R-1. And C-3 is the Normally Open contacts of the continuous radon monitor. When C-3 is closed the solar blower motor will operate drawing fresh clean outdoor air into the building.

WARNING: Wiring should conform to Continuous Radon Monitors Manufactures recommendations.



If your Radon level is above 10 pCi/L you should consider hiring a professional radon mitigator. Professional Radon mitigators have passed the EPA Radon Contractor Proficiency Program.

This is a homemade solar collector. The materials used were debris recycled from a home improvement project. The glazing is recycled from two sliding glass doors. The fresh outdoor air is drawn into the house through the insulated duct on the left end of the panel.

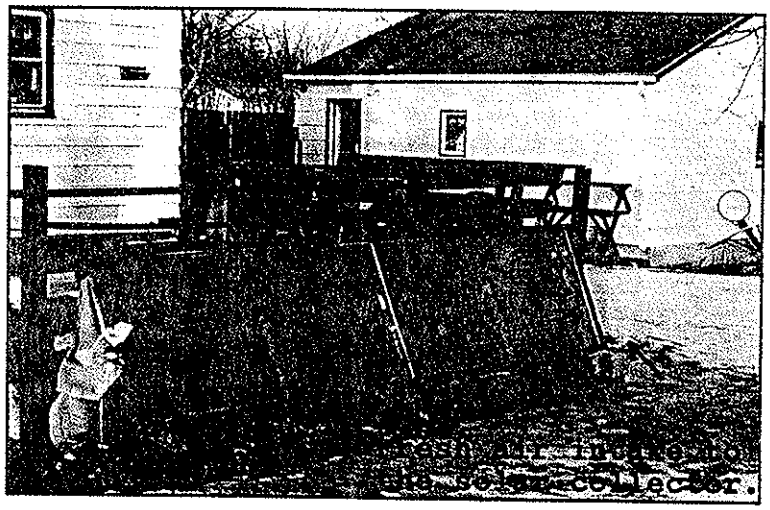


Figure 14

This is an angled wall mounted solar collector. The outdoor air is drawn from the top left corner into the solar collector. The solar heated air is than drawn into the house from the top right corner.

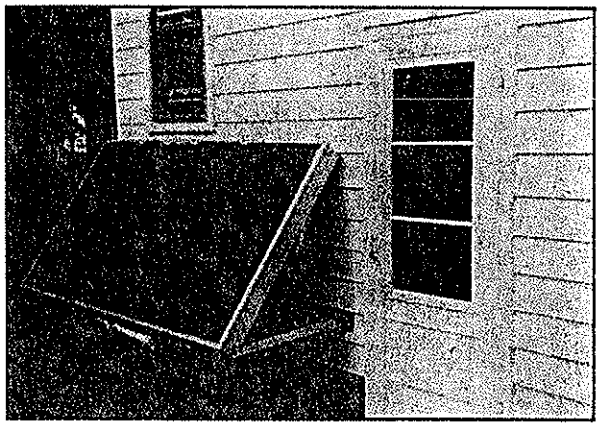


Figure 15

This is an example of a flush mounted solar collector design. The outdoor air intake is on the upper left hand side. The air intake to the house is on the lower right hand side.

Figure 16