# Chapter 5

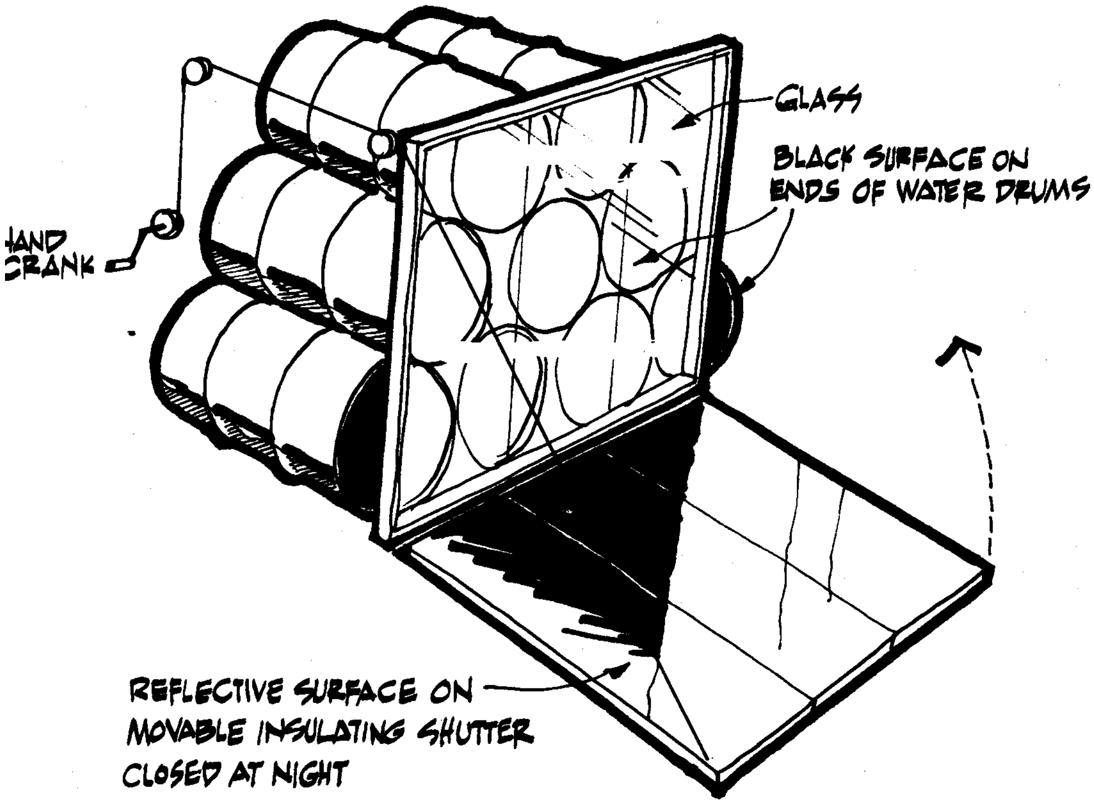
# Solar Walls

Solar windows let sunlight directly into the house. The heat is usually stored in a heavy floor or in interior walls. Thermal storage walls, as solar walls are often called, are exactly what their name implies- walls built primarily to store heat. The most effective place to build them is directly inside the windows, so that the sunlight strikes the wall instead of directly heating the house. The directly sun-heated wall gets much hotter, and thereby stores more energy, than thermal mass placed elsewhere.

These "solar walls" conduct heat from their solar hot side to their interior cooler side, where the heat then radiates to the house. But this process takes a while. In a well-insulated house, a normal number of windows in the south wall will admit enough sun to heat the house during the day. Thermal storage walls will then pick up where the windows leave off and provide heat until morning.

South-facing windows with an area of less than 10 percent of the floor area of the house are probably not large enough to provide enough heat during the day. If this is the case, vents could be added at both the base and the top of a solar wall. The wall can then provide heat to the house during the day just as solar chimneys do. Although the vents need be only 10 to 12 square inches for each lineal foot of wall, they can add cost and complication. Therefore, it is best not to use them unless heat is needed during daylight hours. Thermal storage walls with vents are normally called Trombe Walls, after Dr. Felix Trombe who, in the early 1960s, built several homes with this design in the French Pyrenees. [1]

1 Actually, the concept was originated and patented by E.1. Morse of Salem, Massachusetts, in the l880s. His walls, complete with top and bottom dampers, used slate covered by glass.

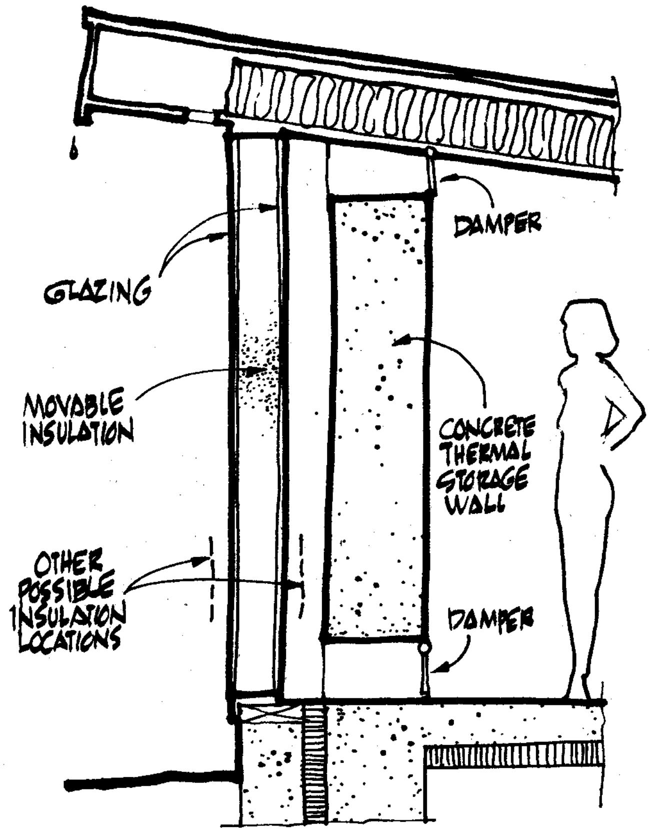



This water wall, called Drumwall™, was first developed by Steve Baer of Zomeworks Corporation. It consists of 55-gallon drums filled with water. Insulating panels hinged at the base of each wall cover the single layer of glass at night to reduce heat loss. With the panels open and lying flat on the ground, the aluminum surface reflects additional sunlight onto the drums. During the summer, the panels in the closed position shade the glass.

One type of thermal storage wall uses poured concrete, brick, adobe, stone, or solid (or filled) concrete blocks. Walls are usually one foot thick, but slightly thinner walls will do, and walls up to 18 inches thick will supply the most heat. Further thicknesses save no additional energy.

Containers of water are often used instead of concrete. They tend to be slightly more efficient than solid walls because they absorb the heat faster, due to convective currents of water inside the container as it is heated. This causes immediate mixing and quicker transfer of heat into the house than solid walls can provide. One-half cubic foot of water (about 4 gallons) per square foot of wall area is adequate, but unlike solid walls, the more water in the wall, the more energy it saves.

The main drawback of solarwalls is their heat loss to the outside. Double glazing (glass or any of the plastics) is



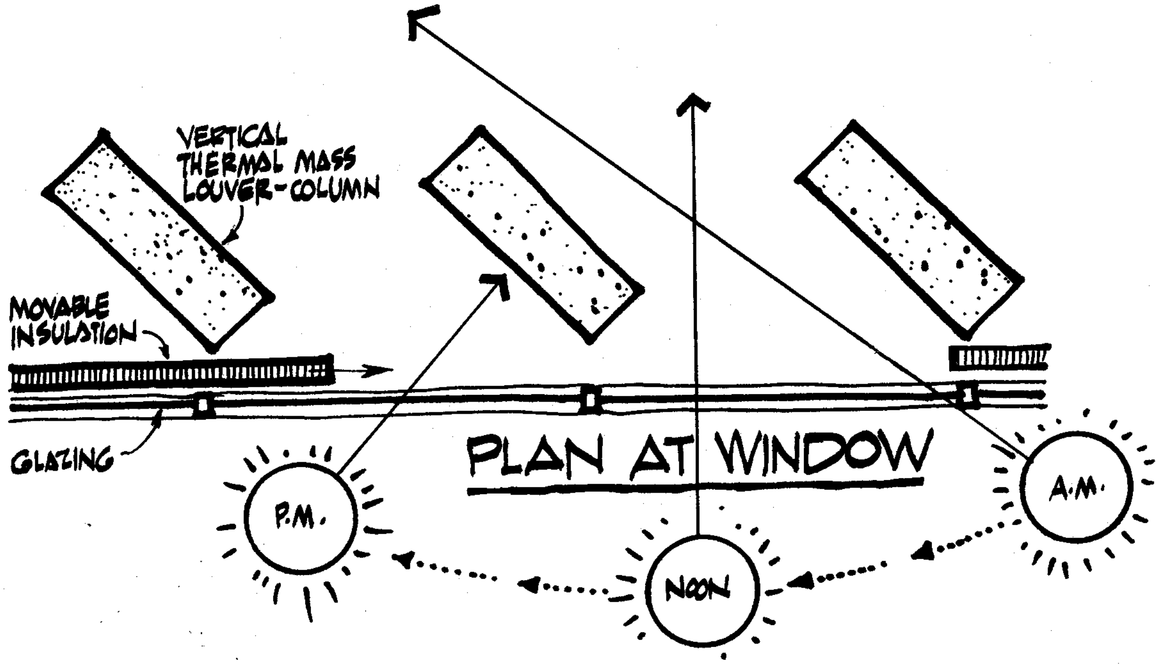

Movable insulation reduces heat loss from this concrete thermal storage wall. Hinged or sliding insulating shutters, reflective Mylar roller shades, and other forms of movable insulation can be used. However, it is usually a tricky challenge to design the movable insulation systems so that its operation is simple and convenient. Insulating values of R-4 to R-6 will do.

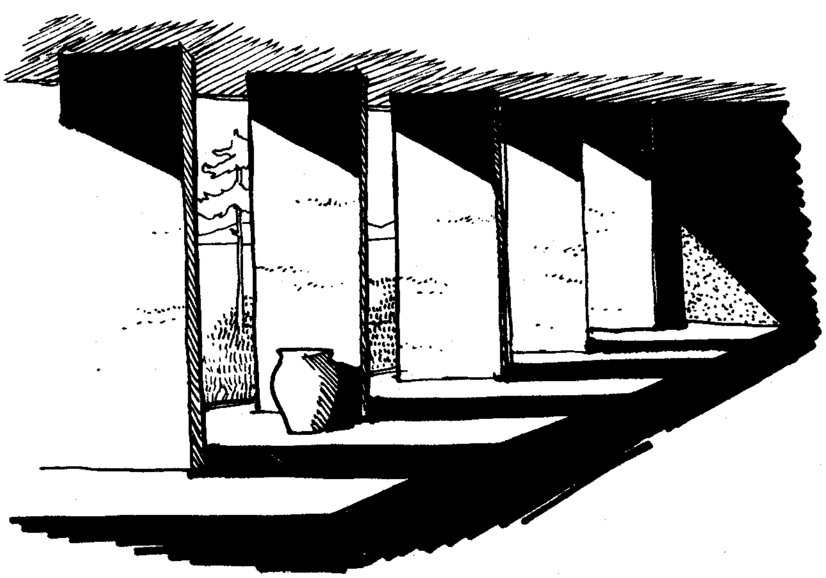
The economic value of movable insulation in passive systems increases as the climate becomes more severe. However, most concrete storage wall systems do not use movable insulation because of its relative inconvenience and expense. Triple glazing is being used increasingly as a suitable alternative in cold climates.

**adequate for cutting this down in most climates where winter is not too severe (less than 5000 degree days: Boston, New York, Kansas City, San Francisco). Triple glazing or movable insulation is required in colder climates.**

## Costs

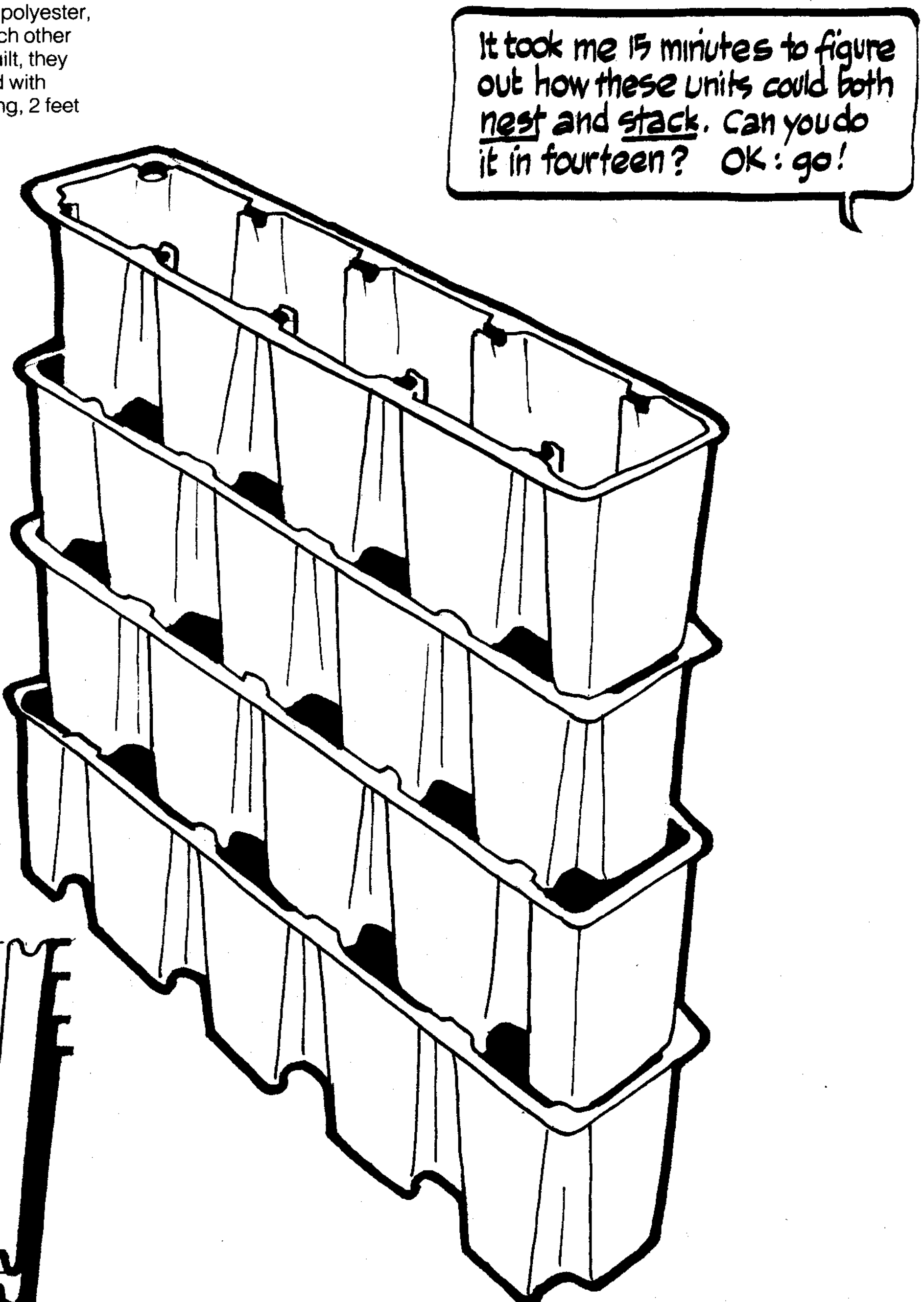
**Installation costs are affected by local construction practices, building codes, labor rates, and freight rates. Walls made of poured concrete and masonry block are less expensive in areas of the country where these materials are commonly used. The exterior glazing can be low in cost if an experienced subcontractor is available or if materials**

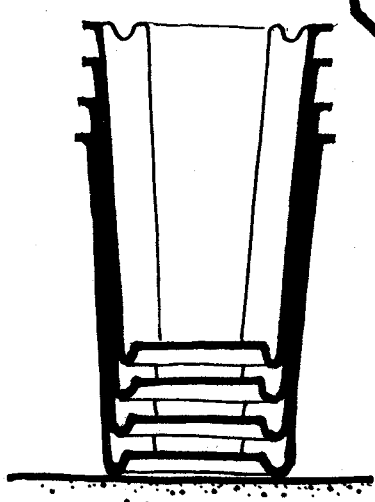


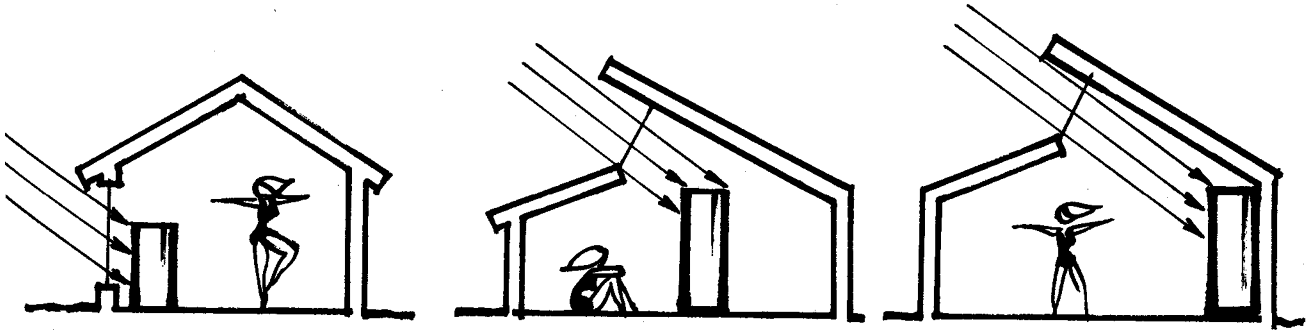



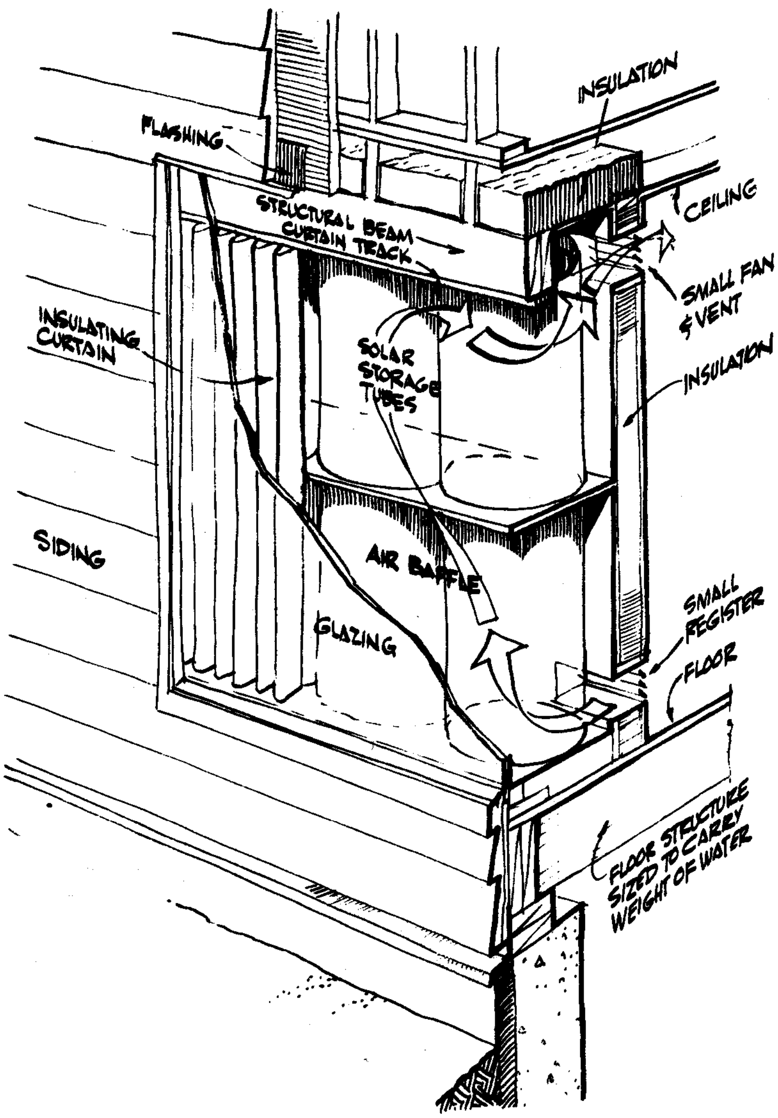
An alternative to the solid concrete wall are Vertical Solar Louvers, a set of rectangular columns oriented in the southeast-northwest direction. They admit morning light into the building and store much of the heat from the afternoon sun. The inside of the glass is accessible for cleaning, and movable insulation can be easily installed between the glazing and the columns. The columns do, however, use precious living space. This variation of a solar wall was first used by Jim Bier.

Modules of cast fiberglass-reinforced polyester, from One Design, Inc., nest inside each other during transport. After the house is built, they are stacked atop each other and filled with water. Each module is about 8 feet long, 2 feet high, and 16 to 20 inches wide.





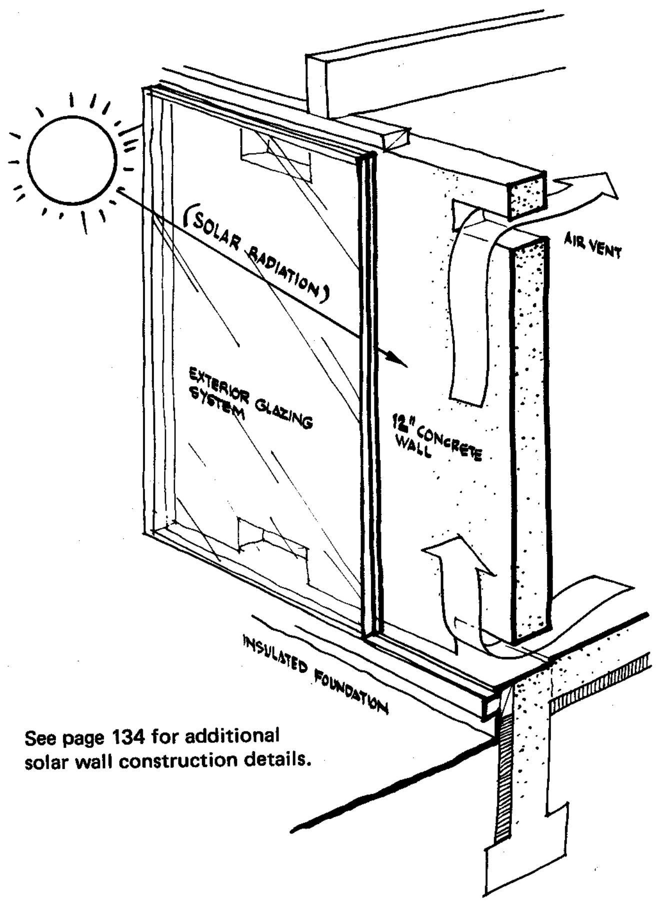



This thermal storage wall uses water-filled vertical tubes. To provide more control of heat flow into the house, a normal interior wall separates the water wall from the living space. A thermostatically-controlled fan circulates room air past the warm tubes. At night, an insulating thermal curtain is drawn across the glass. Corrugated, galvanized culverts and fiberglass-reinforced polyester tubes are the more commonly used cylinders.

can be obtained inexpensively through local suppliers. Total costs range from $5 to $20 per square foot of wall compared with $3 to $5 for conventional wood-framed walls without windows. Operating costs for solar walls are zero, and little or no maintenance is required.

## Construction

This example of a thermal storage wall has three layers of glazing. The inner layer is a very thin (.001 inch) clear plastic sheet, such as Teflon. The other two layers are glass. The outer one is double-strength glass and the inner is single. Alternatively, the two layers can be purchased as one unit of double glass.




See page 134 for additional solar wall construction details.

Mount the entire glazing system one or two inches away from the wall. If the wall has vents, mount the glazing 3 to 4 inches away to allow for adequate air flow. Be sure to provide for the removal of cobwebs from the air space, and for cleaning and replacement of all glazing components. If you use aluminum, rather than wood, for framing and mounting the glass, place wood or other insulating material between the aluminum and the warm wall as a thermal separator. The glazing should extend above and below the face of the storage wall and be fully exposed to the sun. Glazing must be airtight and water resistant; it is the Weather skin of the building.

The wall itself is of concrete, 12 inches thick, and of any height or width. It is either poured-in-place concrete, solid concrete block masonry, or concrete block filled with cement mortar. Use regular stone aggregate in the concrete (about 140 pounds per cubic foot). Lightweight aggregates should not be used, since they do not store as much heat. Unless the wall has to do structural work as well (such as supporting another wall or the roof), the concrete mix can be a relatively inexpensive one. When, as in many cases, the wall also supports the roof, reinforcing steel and structural anchors can be added without altering the wall's solar performance. In general, treat the juncture between the inner storage wall and the foundation floors, adjacent side walls, and roof as normal construction. However, make sure that house heat cannot easily escape through masonry or metal that is exposed to the weather. For example, foundations directly below glazed thermal storage walls should be doubly well-insulated from the ground.

If you install vents in the wall, use backdraft dampers to prevent reverse air circulation at night. (There are no commercial suppliers of these dampers, so see the previous chapter on solar chimneys for an example of one you can build.) Place the vents as close to the floor and ceiling as possible. Openings may be finished with decorative grills or registers. Such grills will keep inquisitive cats and tossed apple cores out of the airway, too!

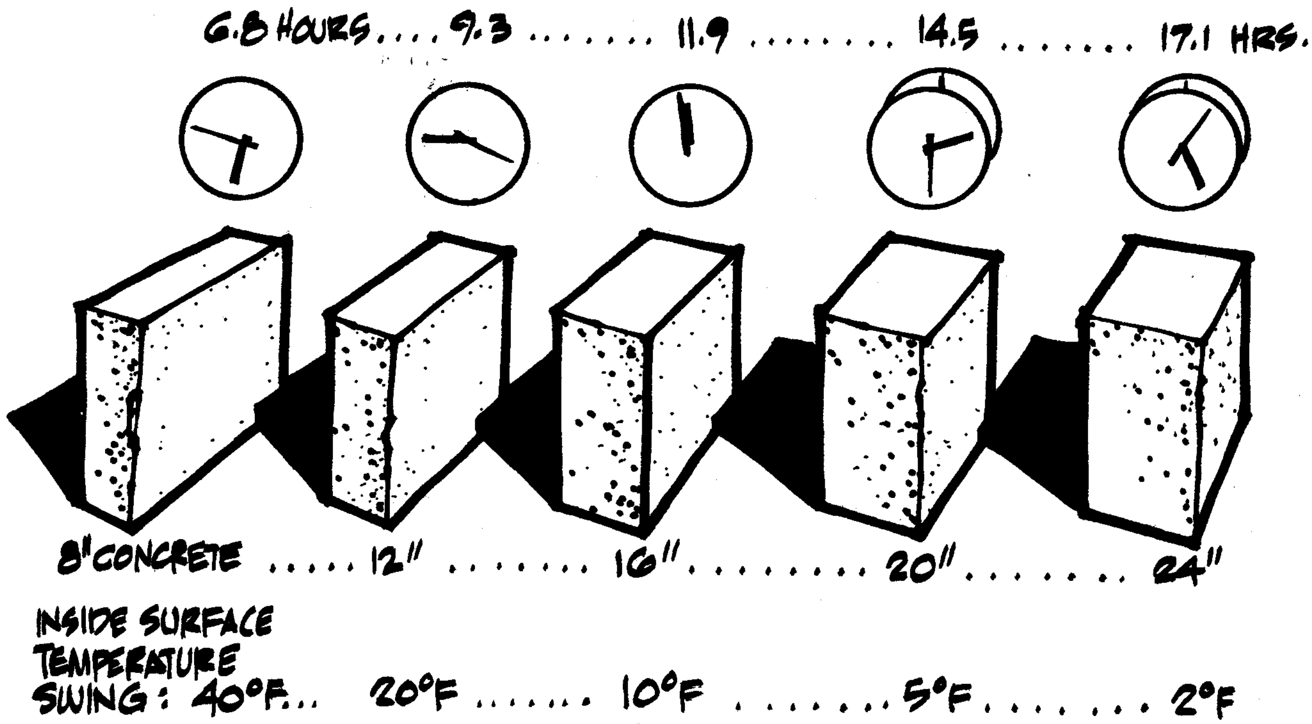
Any interior finish must not prevent heat from radiating to the room. Just seal and paint the wall any color, or sandblast or brush the surface to expose the stone aggregate. A plastic skim coat or plaster can be used. Sheet

### The Heating Effect

Heat loss through solar walls, even after days of cloudy weather, is not much worse than through conventional walls. The overall U-value of solar walls is 0.23. Due to their solar gains, they are net energy producers. (They are also *neat* heat producers.)

The temperatures of the heat supplied by solar walls is generally more moderate than that supplied by conventional heating systems. The lower temperatures tend to be more comfortable and less drying. Vented solar walls provide air at the ceiling level at 90°F to 100°F at air flows of approximately one cubic foot per minute per square foot of wall area.

The interior surface of a twelve-inch-thick wall reaches its warmest temperature in the early evening and then coasts from there by releasing stored heat. Temperatures range from 65° to 85° over the course of a day. The interior surface of a 24-inch wall peaks in temperature about 8 hours later. It doesn't get nearly as warm as thinner walls, but it provides heat more evenly for a longer period of time.



materials, such as wood or hardwood paneling, should not be used. Use gypsum board only if excellent continuous contact between the board and the wall can be obtained-a difficult if not impossible task. Remember that many architects and interior designers regard natural concrete as an acceptable and attractive interior surface material.

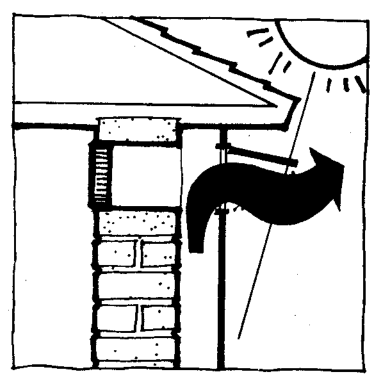
Cleanse the solar (outer) surface of the wall with a masonry cleaner, prior to painting with virtually any dull finish paint. Although dark brown and dark green have been used, flat black paint is preferred for maximum heat absorption.

**Summer Shading**

A solar wall will supply a small amount of heat through the summer and have an effect on cooling bills. Shading the wall, with an overhang, an awning, or a tree, is the most effective method to reduce its exposure to direct sunlight. A cloth or canvas draped over the wall is also effective.

Some people choose to place vents in the framing at the top of the wall. The vents are open during the summer, permitting the heat from the wall to escape to the outside. Their primary shortcoming is that they are prone to leakage during the winter. This air leak can have a significant effect on the performance of the wall during the winter.

The earlier illustration of water drums has a movable insulating shutter that lies flat in front of the wall. In addition to its functions as a solar reflector and heat insulator during the winter, it can act as a shading device during the summer when it is in the vertical closed position.



## Converting Your Existing Home

Solar walls are more difficult to add to an existing home than are solar windows, solar chimneys, and solar roofs. Uninsulated brick, stone, adobe, or block walls are candidates for conversion if they are unshaded during the winter and if they are oriented in a southerly direction (within *30°* east or west of due south). Solid walls are more effective than walls that have air spaces, as is often found in brick walls comprised of two layers. If possible, the inner surface of the wall should be cleaned of conventional interior finish materials. Openings for vents are usually very difficult to make in walls that are candidates for conversion to solar walls. If, however, your windows are not large enough to supply all the heat you need during the day, and if heat is more important during the day than during the night (as for example, in an office building or a school), install vents of the sizes and in the proportions described earlier in this chapter for new walls. Paint the wall, and then cover it with the glazing system appropriate to your climate. For unvented walls, cover the wall first with an inexpensive sheet of plastic to bake the solvents out of the paint. When the plastic is coated with a thin film, remove the plastic and proceed with the installation of the permanent glazing system.