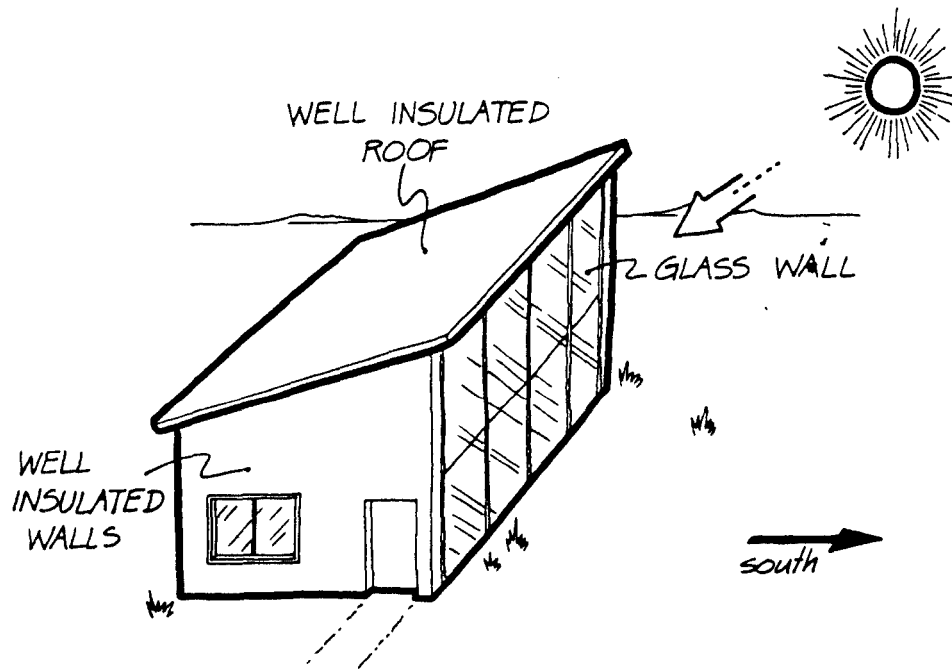


# A PASSIVE SYSTEM - DIRECT GAIN Z O

Passive solar heating systems are those which don't use pumps or fans to transport the solar heat. They are passive because all they use to operate is the sun's heat. Active systems, such as we've learned about so far, use active power-usually electricity-to operate.

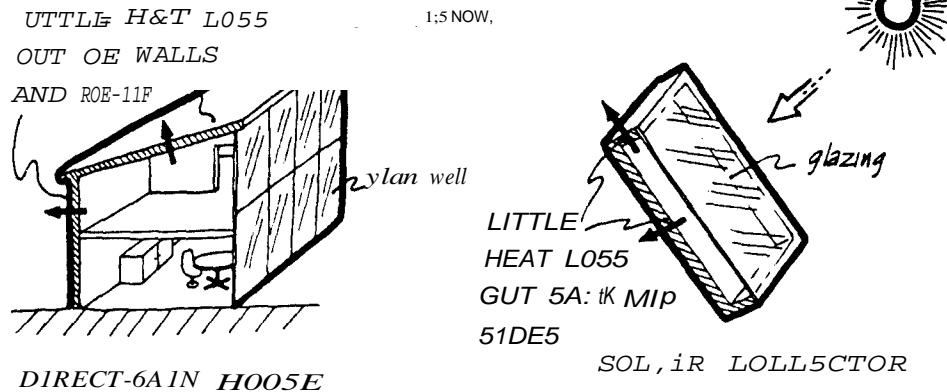
A *direct-gain* passive system is the simplest of passive solar heating systems. As with most passive systems, they are



A Direct-Gain Passive Solar House

used primarily for house heating. In a direct-gain system, the house itself becomes a huge solar collector. Imagine a house that had the entire south wall made of glass and had lots of insulation on the roof and other walls. Sunlight entering the south-facing wall would be absorbed by the floor, furniture, and inside walls. The heat would be trapped inside by the glass wall just as a solar collector's heat is trapped by glazing. Well-insulated roof and walls prevent heat loss out of the house just the way a collector's insulation prevents heat loss out of the back of the collector.

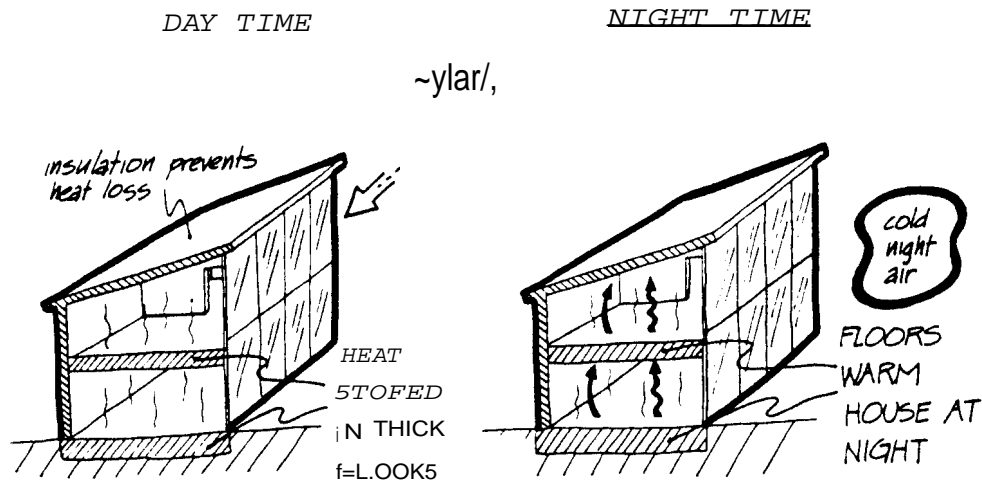
## A Direct-Gain House is Like a Solar Collector



The simple direct-gain house might not be very comfortable to live in. During the day it could get very hot inside—remember how hot your car gets after sitting all day in the sun with the windows shut. At night it could get cold, because little of the solar heat collected during the day would be available to heat the house at night. For some buildings these problems aren't crucial. A school, for example, needs heat only during the day, and windows can always be opened to keep the building from getting too hot. Homes and most other buildings, though, need heat at night as well as during the day.

Active solar heating systems need storage to hold solar heat until night, and so do passive systems. Storage can be added to the direct-gain system just described by constructing the floor and inside walls of material that stores heat. For example, the floors can be made of thick rock or concrete. When the sun strikes the floor, the rock heats up and remains warm until nighttime; as it slowly loses its heat, it keeps the house warm.

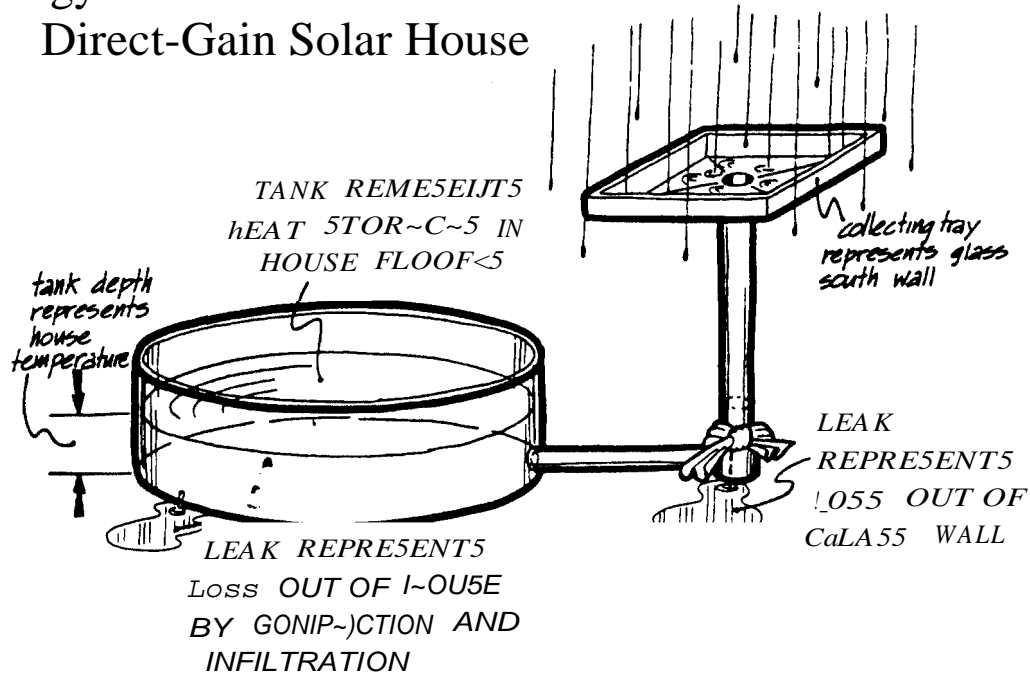
# Heat Storage in a Direct-Gain House



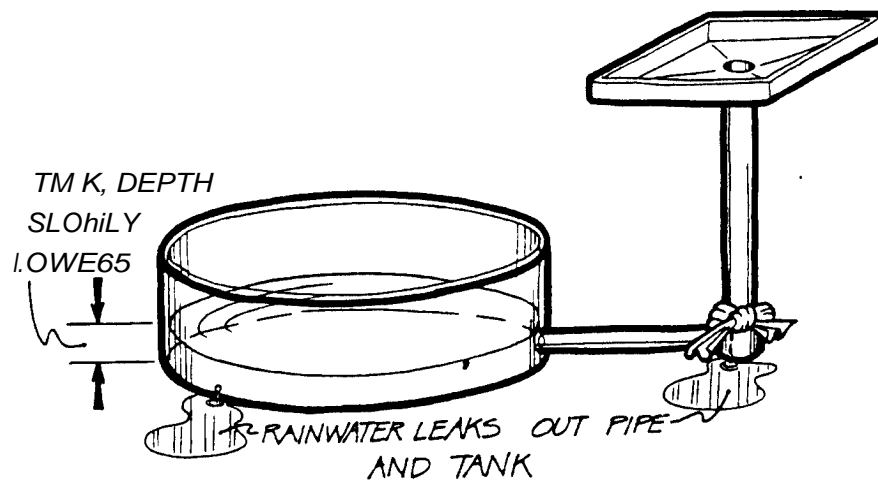
Sometimes drums of water are put inside a room to increase heat storage-water, remember, stores more heat than rock or concrete do. For best results, the water drums or thick rock floor should be in the direct sunlight, so that the storage is also the solar radiation absorber. The more heat storage there is in water drums and rock floors, the less tendency there is for a direct-gain house to overheat. A huge heat store will not get as hot after a day of absorbing solar heat, nor will it cool as quickly at night. The bigger the heat store, the less the temperature swing-the tendency to be too hot in the late afternoon and too cold in the morning.

The rainwater analogy to a direct-gain house is a collector tray directly attached to a large storage tank. The tank is large because the equivalent heat storage must be large to reduce temperature swing. The tank represents the heat stored in the house's floor or water drums; the water depth in the tank represents the house's temperature. A house loses heat to the outdoors; analogously, the tank must also have a leak. As before, the pipe on the collecting tray has a leak; it represents the heat leaking from the glass south wall on our direct-gain house. The rainwater tray collects the rain, filling the tank. When the rain stops, no rainwater flows down the pipe but water is still lost from both the pipe leak and the tank leak. The water level will slowly drop as the rainwater leaks out. It takes a long

## Analogy of a Direct-Gain Solar House



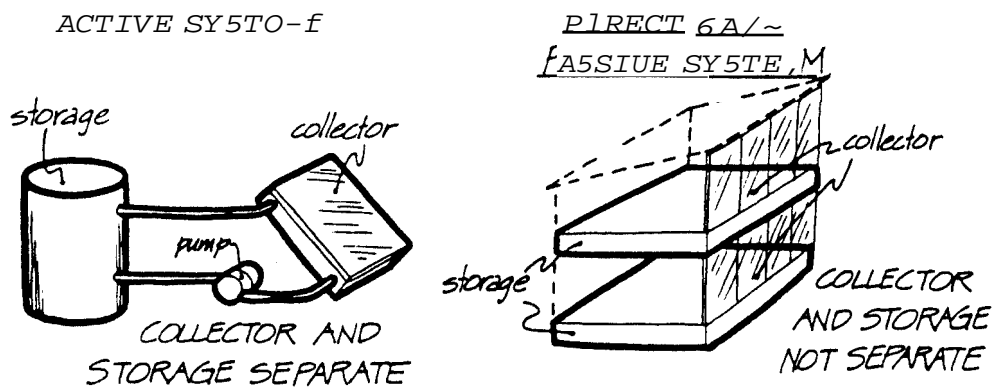
## Water Level in Large Tank Changes Little.



time to fill a large tank, so its depth doesn't rise very high; nor does a large tank drain quickly. The bigger the tank is, the less is the rise and fall of the water depth. Analogously, the bigger the heat storage is, the less the temperature swing is.

When we learned about active systems, we learned that the controller serves an important function in preventing night-time heat loss. The solar collectors in an active system are separated from the storage. Only the heat transfer medium (air or water) moves heat from the collectors to the storage. When the controller turns off the fan or pump, no heat can be transported from storage back to the collector. In a direct-gain system, though, the collector and storage aren't separated. The solar collector is the heat storage (the thick concrete floors).

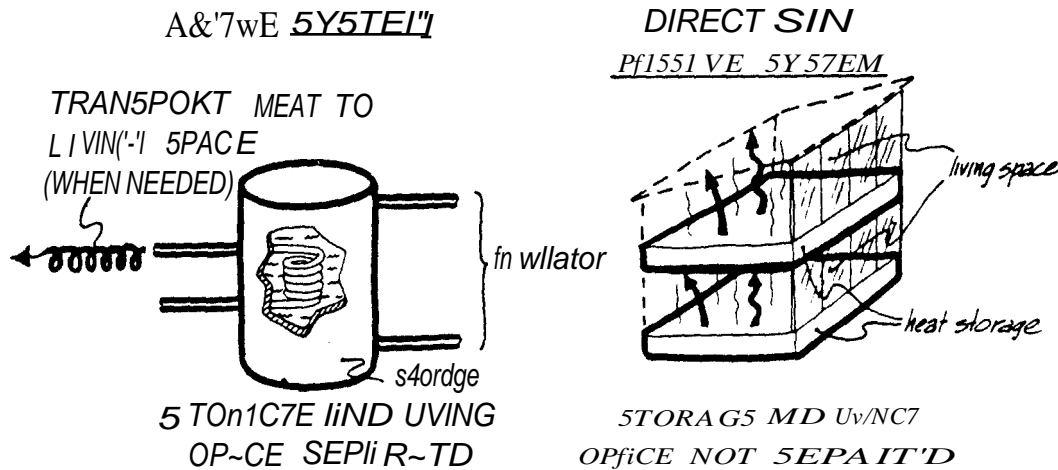
## Collector and Storage are Separated in an Active System



Unless the collector and the storage are separated, heat can leak from storage out the collector's glazing. Remember, in Chapter 8 we found that windows leak ten times the amount of heat of a well-insulated wall. An entire south wall of glass, then, represents a big heat loss. Even though the glass wall admits solar radiation during the day that heats the thick floor, at night the same glass wall loses much of the stored heat to the outdoors.

Not only do active solar heating systems have their heat storage separated from their collectors, but their storage is also separated from the living space. Stored heat can be used *when required*: a heat exchanger can extract solar heat from a water storage tank in a water-heating system, and in an air-heating system a distribution fan can blow solar-heated air from a rockbed. More important, when heat isn't needed, it can remain in storage. But in a direct-gain passive house, the heat storage isn't separated from the living space. If the floor of your direct-gain house gets too hot or too cold, so do you.

## Storage and Living Space are Separated in an Active System



As we look at other types of passive solar heating besides the direct-gain system, we'll think of them as having either a *diode function* or a *control function*. Diode is a term borrowed from electronics, and it refers to a device that lets electric current flow in only one direction. Thus, the diode function of a passive solar heating system lets heat flow in only one direction—into the house but not out of it. The control function, on the other hand, lets stored heat be controlled—distributing it to the living space when and where it's needed.

Active systems accomplish the diode function by separating the solar collectors from the storage. The two are thermally linked only when it's advantageous: when the collector is hotter than the storage. An active system accomplishes the control function by separating the storage from the living space. The two are thermally linked only when it's advantageous: when the living space gets too cold.

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