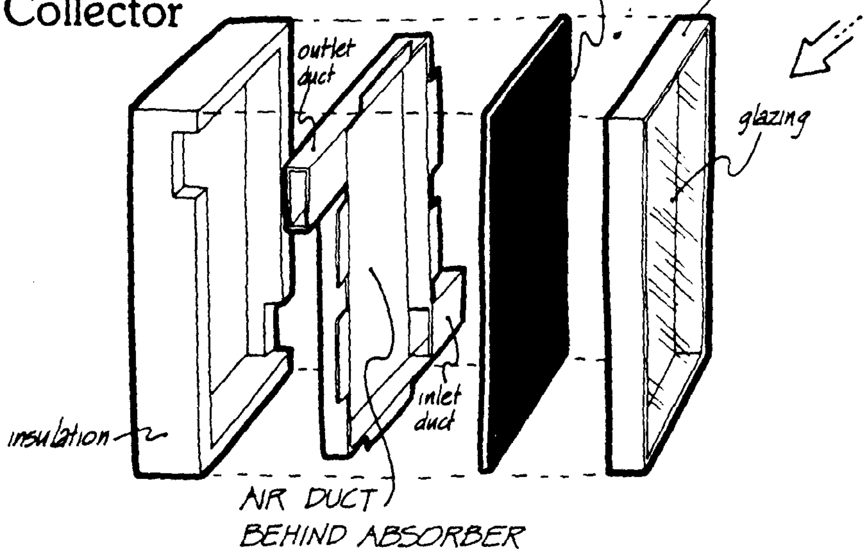
AIR-HEATING SOLAR SYSTEMS 17

So far we've only discussed *hydronic, or water-heating,* solar energy systems. It's also practical to let solar radiation heat *air* instead of water. An *air-heating* solar collector is very similar to *the* water-heating collectors we've already learned about. Air, instead of water, is forced past solar-heated surfaces.

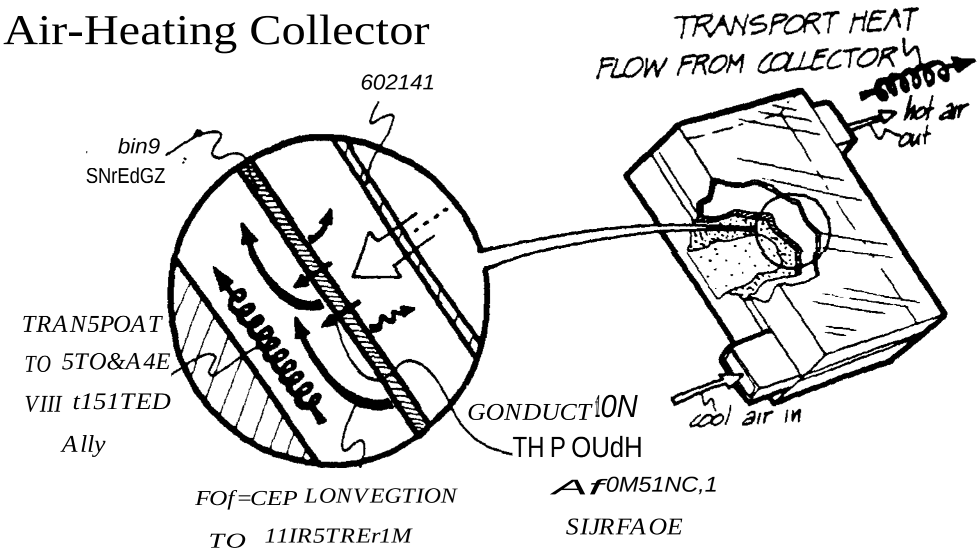
Most air-heating solar collectors are made with an absorber surface with air ducts instead of water ducts attached to the back side. As in a water-heating collector, glazing prevents heat loss from the black absorbing surface. An Inlet duct lets air be blown Into one side of the collector, and an outlet duct lets It flow out the other side. Insulation prevents heat loss from the sides and back of the air duct.

An Air-heating Solar Collector



After solar radiation passes through the glazing, it is absorbed by the black absorbing surface. Some heat is lost by natural convection and radiation from the absorbing surface, depending on how hot it gets-as in a water-heating solar collector. What is not lost flows by conduction through the absorbing surface to the air duct where it flows by forced convection into the airstream and is transported to storage.

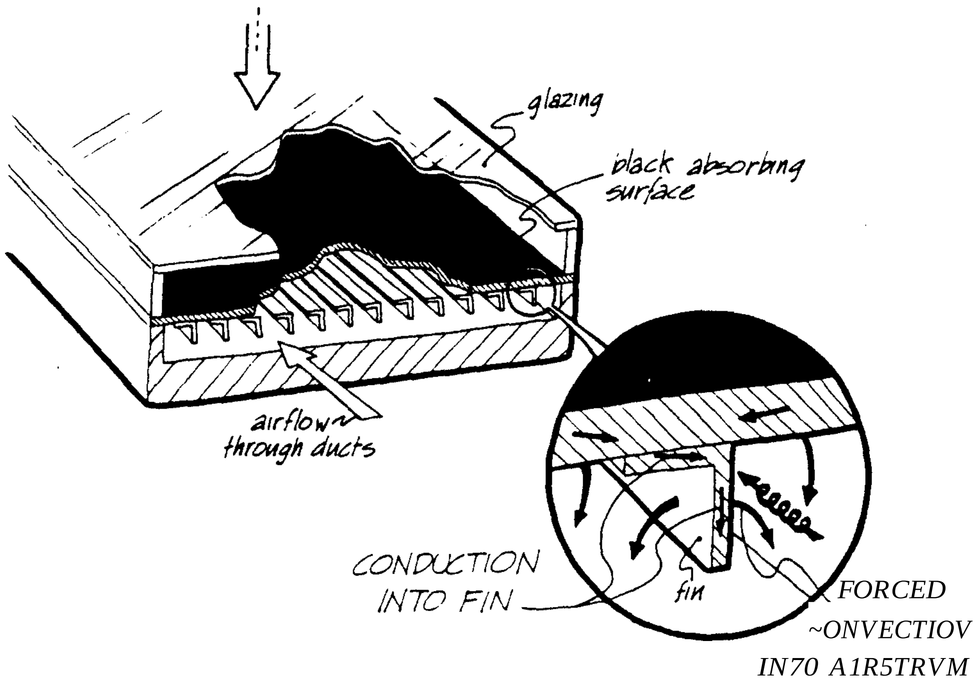
Heat Flow in an Air-Heating Collector



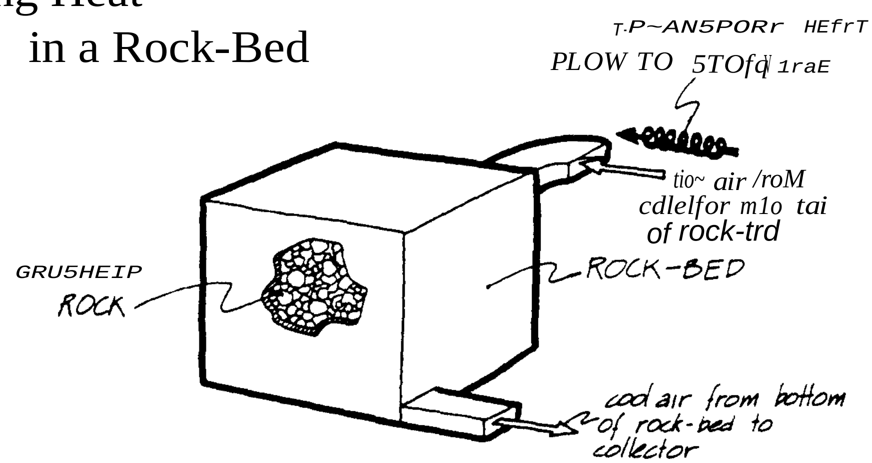
In air-heating solar collectors, lots of surface area must be exposed to the airstream. Often the back side of the absorbing surface has many fins, as do liquid-to-air heat exchangers and baseboard heaters. Heat conducted through the metal absorbing surface is conducted along the fins. With lots of fin surface exposed to the air in the ducts, solar heat can easily flow by convection into the airstream.

Storage for an air-heating system is a *rockbed-a* closed container of crushed rocks, each about the size of an egg. As the hot air flows through the crevices in the rockbed, it gives up Its heat to the rocks. The rocks heat up and the air cools. If much smaller rocks are used, it's hard for the air to flow through the crevices; if much larger rocks are used, they don't heat up thoroughly. Heat in the rockbed *stratifies;* the rocks higher up are hotter than those near the bottom of the bed. Air coming from the bottom of the rockbed Is cooler than the solar-heated air entering the top.

Fins Improve Air-Heating Collectors



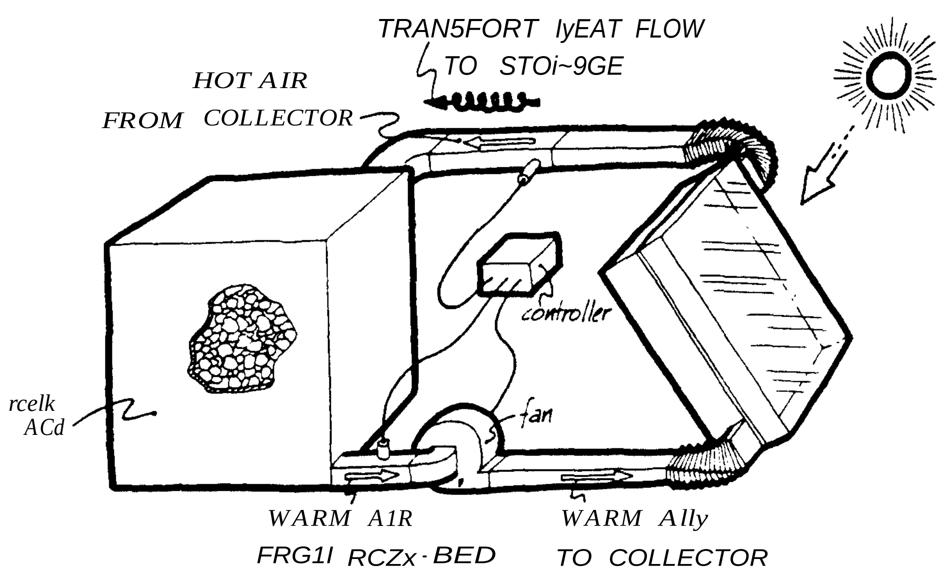
Storing Heat in a Rock-Bed



Functionally, the air-heating system works almost exactly the same as a water-heating system does. Solar heat Is transmitted through the glazing and is absorbed by the black absorbing surface. The heat Is conducted from the absorber surface and convected by air flowing through air ducts. Similarly, In a hydronic system, heat is also conducted from the absorber surface but is convected by water pumped through tubes. In both types of collector, heat is lost from the absorbing surface by means of radiation and convection, depending on how hot the surface gets. The heat that isn't lost is transported to storage by either air or water. As in a water-heating system, storage increases in temperature as heat is added. Cooler air (rather than cooler water) is blown (rather than pumped) back to the collector. Efficiency-the fraction of the incoming solar radiation going to storage-still depends on the collector temperature: a hot collector gives low efficiency and a cool collector gives high efficiency.

As in a water-heating system, a controller detects when the temperature of the air leaving the solar collector is hotter than the air entering it. The controller turns on the fan when heat can be extracted from the sun, and it turns It off at night or on cloudy days when no useful solar heat is available.

An Air-Heating Solar Energy System



All in all, air-heating systems function much the way water-heating systems do. In fact, the systems are so similar that the rainwater analogy can represent both. However, al though they are functionally similar, there are important differences in the design of the two types of systems.

One way solar air-heating collectors differ from water-heating ones is in temperature rise. Temperature rise is the difference between how hot the air is going into the collector and how hot it is coming out. Since air doesn't transport heat as well as water does, air flowing through a collector tends to heat up more. If the same amount of air and water were flowing into their respective collectors at the same temperature, the air would come out hotter than the water. If the air comes out hotter, then the average collector temperature would be hotter too-and a hot collector means low efficiency.

Fortunately, air-heating systems don't have low efficiency, since the air blowing into them is cooler. Because of the stratified effect mentioned earlier, air flowing into the collector comes from the rockbed fairly cool. Cool air entering the solar collector tends to lower the collector's temperature and to improve efficiency. The improvement due to the cool inlet of air from the rockbed offsets the reduced efficiency of a big temperature rise through the collector: the air starts off cooler but gets hotter. The net effect is that an air-heating system is just as efficient as a water-heating system.

What are the advantages and disadvantages of using an air-heating system? Generally, air systems are best for house heating, while hydronic systems can be used for house heating, hot-water heating, and pool heating. Although it is possible to make an air-heating hot-water heater or pool heater (using an air-to-liquid heat exchanger), it is usually too costly to be practical.

For house heating, an air-heating system won't spring a leak and ruin your rug as a water-heating system might do. Leaks In hydronic systems can be caused by corrosion,of metal

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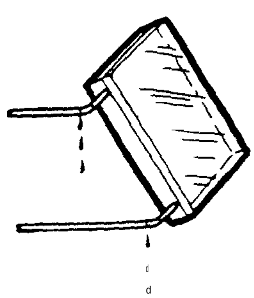

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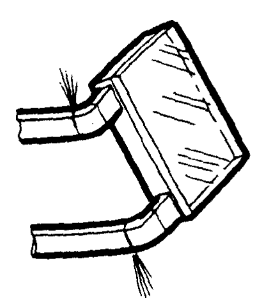

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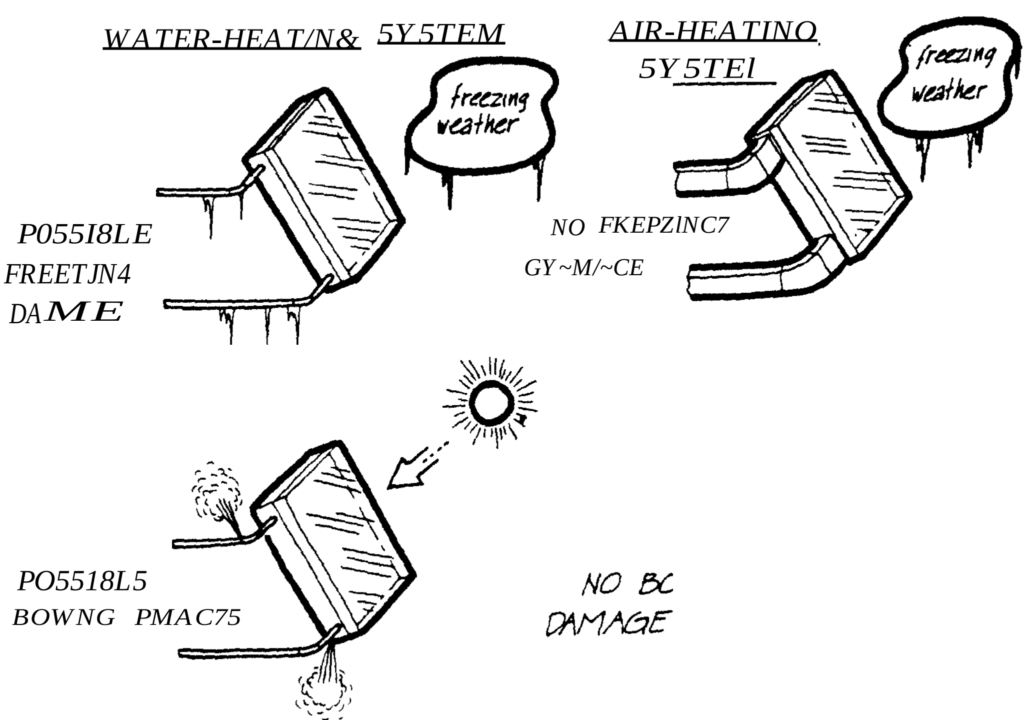
collectors and pipes or by freezing, as we'll see later. Leaks In air-heating systems won't ruin your rug, but they can mean a big loss in efficiency. Unless air leaks in ducts and collectors are carefully sealed, heat can easily leak away. If there are air leaks, they are very hard to detect.

But the greatest advantage of an air-heating system Is that no freezing or boiling precautions must be taken. Water In a hydronic system can freeze, rupturing a solar collector's water carrying passages. Since almost everywhere In the United States except Hawaii, southern California, and southern Florida have occasional freezing weather, hydronic systems must have some type of freeze protection. Antifreeze Is often added to the water as protection against freezing, or *drain-down* systems can be Installed to drain the water from the collector at night to prevent It from freezing.

Water can also boil in a hydronic solar collector If It gets too hot. It probably won't boil while the pump Is running, since the water pumped through the collector keeps It relatively cool. But if the pump breaks down or the electricity goes out, the collector can get very hot. Stagnation temperatures of 300° F and

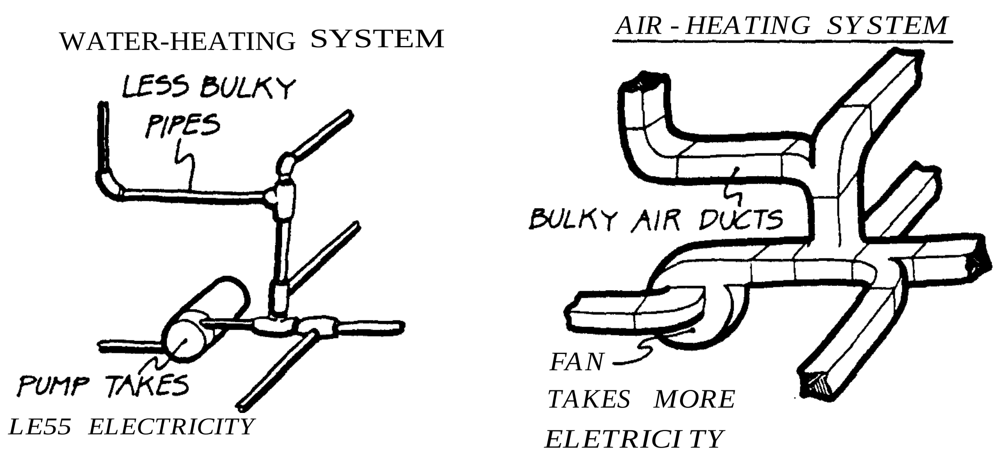
Some Advantages of Air-Heating Systems



higher can occur on a bright, sunny day. To prevent the collector water from boiling, chemicals like glycol can be added, or the system can be set up to drain the collector automatically If the pump stops working. In any event, freezing and boiling precautions can add expense and complication to a solar heating system that an air-heating system doesn't entail.

What about the disadvantages of air-heating systems? There are some. First, an alr-heating system tends to use more electricity driving Its fans than a hydronic system does driving its pumps. Second, the ducts needed to transport the heat from the solar collector to the storage tank and then from storage to the rest of the house can be much bulkier than the piping In a hydronic system. Also, the bulky ducts are generally more expensive to install than are the pipes.

Some Disadvantages of Air-Heating Systems



Now that we've looked at solar energy systems that use pumps or fans to transport heat from collector to storage, let's look at some systems that are truly solar powered.