moisture levels. In these, an interior air/vapor barrier should be added.

What about the rooftop vents? There are two types. One-way vents only let air out under pressure, but won't let air into the roof. Two-way vents allow airflow each way. These were developed originally to cure blistering, which was common in built-up roofs before the advent of glass felts. The blistering, however, has since been linked to voids left between the felt layers during the roofing process. It's not related to moisture trapped within the insulation—the space that the devices theoretically ventilate. The solutions seem to lie in improved roofing materials.

In roofs *with* vapor retarders, Tobiasson concedes the two-way vents may have a role to play in avoiding the creation of a vapor trap between the roofing membrane and the vapor retarder. Even in these, however, he thinks that the vents are unnecessary and may do more harm than good since they penetrate the roof surface—making potential leaks.

The second type of roof, shown in Figure 2, resembles a conventional cathedral ceiling. An airspace is left above the insulation and is vented around the perimeter of the roof with soffit vents. The problem is that

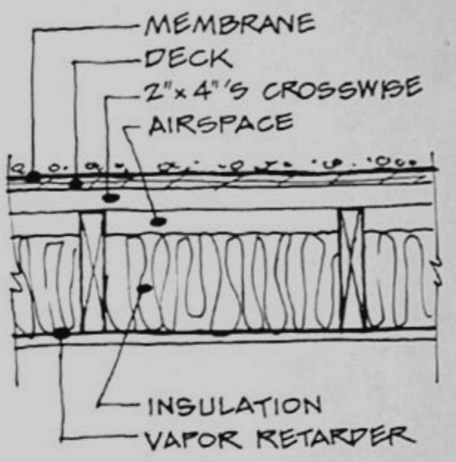

Figure 2. Flat woodframe roofs need a good air/vapor barrier and good ventilation. A ventilation plenum can be formed by laying 2x4's across the joists.

in roofs with very low slopes there is no chimney effect to drive air through the space. Ventilation here depends on wind pressures or temperature differences.

Of all roofs, this is the most prone to moisture problems. Anything that can promote air movement in the roof cavity helps. One approach, developed in Canada, is to create a full plenum, sometimes 2 or 3 feet high, above the insulation. The plenum is then vented, aided by a fan or cupola if necessary. A more moderate approach is to lay 2x4's across the tops of the ceiling joists under the roof sheathing. This interconnects the joist spaces and promotes better ventilation.

The real key with these roofs, though, is to keep moisture out of the ceiling. This is best achieved by using a continuous air/vapor barrier. Its most important job is to control airflow through ceiling penetrations, particularly in high-moisture areas. When problems occur, they are often over a kitchen or bathroom with a hole in the ceiling—such as a leaky fan housing. Electrical and plumbing penetrations also need careful sealing. Since today's tighter houses are prone to higher indoor humidities all over, the entire ceiling vapor barrier should be treated with great care. In commercial buildings, which usually have lower humidities, ceiling condensation problems are less common.

Another concern with flat roofs is how well they dry out if a leak or severe condensation does occur. One- and two-way breather vents have been shown to be of little use in drying out a wet roof. But full ventilation will provide some drying.

In winter, the wood in a roof will store a great deal of moisture. The next summer, it gives it up. This seasonal storage mechanism will handle moderate winter-time condensation with no difficulty. Wood has served us well in many old buildings as a winter moisture reservoir. As long as it isn't overloaded with water, and as long as it gets a chance to dry out seasonally, the wood will continue to do a good job indefinitely.