To maintain the horizontal reference, which is necessary to assure accuracy, the entire assembly (card, magnets, and float) must hang below the pivot point. If it sits too high, the magnets will succumb to dip error, and the card will be excessively off the horizontal plane when flying in areas of high latitudes. On the other hand, if it is hung too low, it will be excessively pendulous, swinging easily during turns and acceleration. Even under the best of conditions, in the northern hemisphere the north-seeking end of the magnets will dip slightly; the opposite will be true in the southern hemisphere. To reduce the problems, the compass is filled with a liquid; this is known as compass damping.

Compass Fluid

Filling a compass with liquid sounds like a fairly simple thing. Actually, the requirements for this liquid are complex. To keep the size of the float to an absolute minimum, the liquid must have a high specific gravity. It must not get cloudy with age—very common for many liquids. Besides not being able to freeze or have a high vapor pressure, it must also maintain a relatively constant viscosity throughout the extreme temperature changes to assure continuous damping of rocking and rotational oscillation of the card.

The fluid used in a compass must be both nontoxic and flame resistant. Originally, alcohol was used, but eventually manufacturers went to both kerosene and trichlorethylene. Currently it is common to use either acid-free kerosene or silicone fluids because they not only have the dampening effect but also lubricate the pivot point. In some compasses, to prevent overswing during magnet alignment (remember fluid has very low friction), vanes are used as a sort of sea anchor. But when rolling out of a turn, momentum keeps the fluid turning in the compass, which tends to push the vanes (and the attached compass card) along with it. This phenomenon is very similar to the fluid in the middle ear, which leads to vertigo under the same situation. To reduce this problem of momentum, holes are drilled in the vanes to allow the fluid to pass through while leaving sufficient vane to damp overswing.

Some small compasses do not have liquid dampening. These are damped by magnetic eddy-current. To do this, the manufacturer uses the flux from the north-seeking end of the magnet. Because of the need for a higher than normal flux field, magnets with unusually high power-to-weight ratios are used. If doing away with the liquid sounds like a good idea, consider the consequences. The compass, which now has a greater flux field surrounding it, becomes highly susceptible to cockpit magnetic disturbances. Also, the heavier weight and lack of lubrication lead to early pivot point dulling and decreasing accuracy. The advantage of such a compass is that it is relatively inexpensive.

In the liquid-damped compass, the vane assembly is fitted carefully into a leakproof case with a clear window. Then the compass is filled with the liquid, making sure there are no air bubbles. Because liquid volume varies with temperature and virtually all liquids produce some gas over time, a flexible, perforated upper baffle is installed. The holes allow air to penetrate into an upper chamber, keeping the compass card chamber filled with liquid. In fact, the upper chamber is commonly filled with air to provide a variable pressure compensator conceptually similar to a hydraulic system accumulator nitrogen precharge. Some manufacturers put a diaphragm at the back of the compass,