BY DON LANCASTER

Understanding Pitot tubes.

Plus a GPS navigation update, picking a new microcontroller; new Internet directories, and more on the mystery band.

MAYBE IT'S BECAUSE I AM SITTING HERE ON A SAND DUNE WATCHING GILA MONSTERS IN THE MIDDLE OF THE UPPER SONORAN DESERT, BUT NOBODY HAS EVER ACCUSED ME OF BEING much of a boat person—at least not lately. I do know that the binnacle goes on the top and the barnacle goes on the bottom. Interchange those two and you end up with a serious breach of maritime etiquette. At any rate, one recent help-line caller wanted to find out if I knew anything about how boat speedometers operate.

Boat speedometers

Not having the faintest idea at the time, I muttered several things about gyros, strain gauges, differential thermistor temperature sensing, GPS, and sonic Doppler radar shifts. Most of which were wrong.

Let me review the normal ways of finding an answer to something I do not have the foggiest clue about: Ask some expert or visit a suitable place where I can find an answer. In this case, that would be a marina or a boating supply store. Read relevant magazines and trade journals, such as those on boating or on marine retailing, and even boating-supply catalogs. Then contact the manufacturers for useful literature. Most important, seek out relevant reference papers.

Another option is to search the Internet or a commercial online service. You can also try a surefire solution that lets you instantly find *any* answer to *any* technical question: Use the *Dialog Information Service* found at your local library or conveniently online at *GEnie*. If there's no real rush, try my ultimate ploy: let your subconscious work on the project for a few weeks until you stumble over an answer.

Sure enough, *Motorola* sent me a new *IC Sensor Device Data* manual. And right there on page 4-166 is application note AN1536 on, of all things, boat speedometers, including the full construction plans. There's also one magic word that tells us all about how boat speedometers work: *Pitot*.

That tells us that boat speedometers work exactly the same way that airplane speedometers operate. Only one uses a liquid, and the other a gas.

Pitot tubes were first developed by Henri Pitot, an eighteenth century French physicist. Figure 1 shows details. Create a smooth flowing and non-turbulent liquid or gas channel of constant diameter, such as a pipe. Measure the *differential* pressure between a radial and an axial port. The pressure difference should be nearly proportional to the *square* of the velocity, usually within five or ten percent.

The exact results depend on the density of the liquid or gas and the temperature. Figure 2 shows the curves for freshwater and saltwater boat speedometer pressures. The

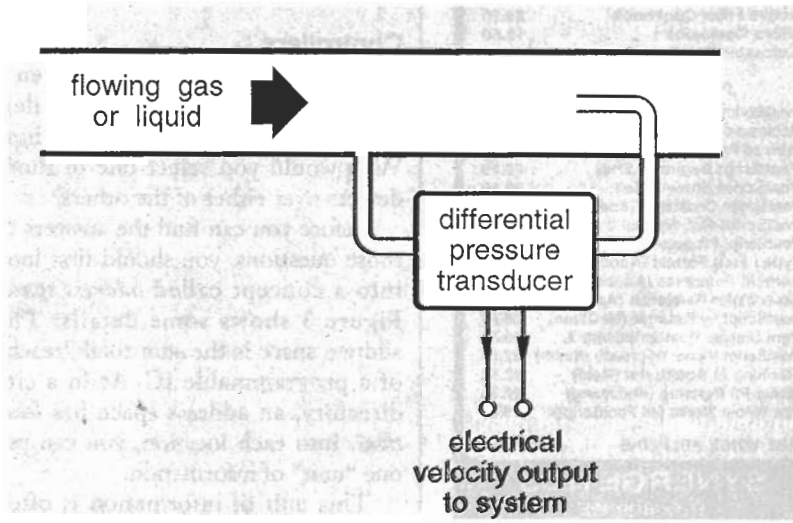

FIG. 1—A PITOT TUBE can be used to measure the velocity of a flowing liquid or gas. Uses include boat speedometers and fire hydrant testers.

speed will, of course, be that of the boat *relative* to the water current.

Motorola has a unique offset-canceling scheme which swaps the op-amps around and then cancels out the difference so that the speedometer can show absolute speed instead of realative speed. Other low cost pressure transducer sources are available from *Sensym*, *IC Sensors*, and *NovaSensor*.

Pitot tubes are not suitable for sailboats or other low-speed applications. Other techniques are required for ultra low velocities. Differential GPS is an obvious choice.

Ah, hindsight. After thinking about it for a while, it seems I do use a boat speedometer quite a bit after all. Except that its box is plainly labeled "Fire Hydrant Flow Tester." All fire hydrants must be tested twice each year. First to make certain they work at all, and second to verify a peak fire flow gallonage rate that can meet a given insurance rating class.

You hold this beast in the middle of an open hydrant stream and grab a reading. Then you look up the flow in a graph remarkably similar to the curves of Fig. 2.

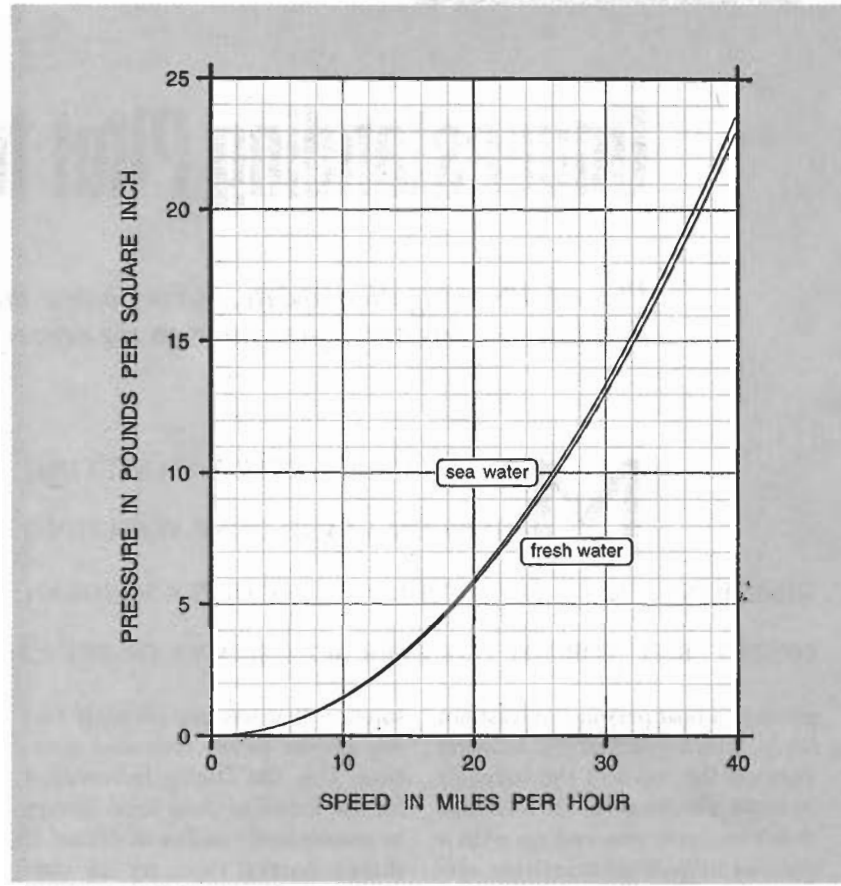

FIG. 2—PRESSURE VERSUS SPEED for flowing water at 60 degrees F.

I still don't have any information on commercial versions of boat speedometers. So, how about sending me some data sheets on them. There's a free *Incredible Secret Money Machine II* for your trouble.