Pamco: One Man's Ultimate Standby Pump

by Kenneth D. Towl

Thomas Zompolas retired late in 1975 after thirty successful years running a machine shop. In 1978 he survived an IMC vacuum pump failure in his Cherokee 180 by flying needle, ball and "a strong local ADF signal." He was shaken, but after reading a 1979 article about a similar (and fatal) incident, Zompolas realized that his was neither an isolated nor unique experience. He turned his energies to making a safer vacuum system.

After looking at a variety of pump technologies, Zompolas decided that an electrically-driven backup was the most feasible approach. He'd looked at using manifold vacuum but discarded the idea for its lack of vacuum under full throttle (during climb or at altitude).

Treating the backup problem as a personal mission, Zompolas began researching gyro fundamentals and how they affected vacuum systems. As a result of his labors, he has earned FAA certification as well as United States patent 4,364,268 for the first totally automatic standby vacuum system. His creation is well worth a look.

The Pamco installation consists of three basic elements: a standard 211CC Airborne pump, a special DC electric motor, and a solid-state annunciator/control module. With nuts, bolts, mounts, relays, tubes and miscellaneous other bits and pieces, it will add about 12 pounds to your aircraft. Let's evaluate each element in turn.

The Pump

Airborne's 211CC is probably the world's most widely-used vacuum pump. Under test-stand conditions (surprisingly similar to electrical standby service) it can run well over 1,000 hours before normal wear makes it subject to failure. In fact, the carbon pump's unenviable reputation is largely due to its engine mounting where it is subject to such well-publicized demons as drive misalignment, reverse rotation, vibration, shock, acceleration and overspeed, high temperature, and contamination by foreign particles, moisture, fuel/oil vapors or solvents. Zompolas avoids these problems by pampering the 211CC with its very own, specialized drive system.

The Motor

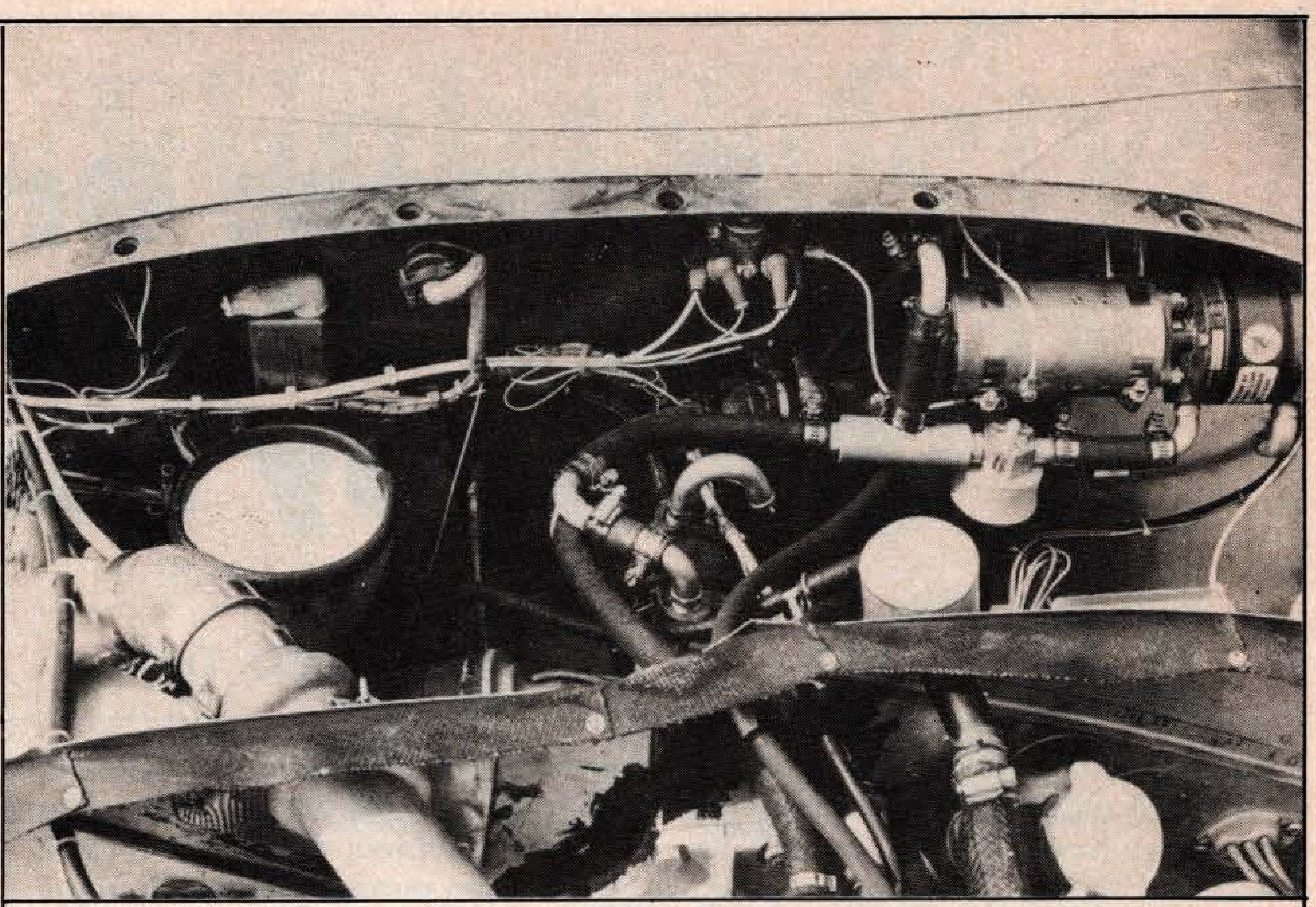
Pamco's motor was originally developed around a high-reliability computer unit. But industry demands on the maker and refinements Zompolas wanted led him to arrange manufacture with some local electrical service houses, people he says "have learned all there is to know about what can go wrong with an electric motor." With their input Pamco has developed a totally enclosed 4-pole, 4-brush series-wound 5-pound unit which accelerates gently up to around 2,000-plus rpm — ideal for a 211CC. It uses high-altitude copper graphite brushes, permanently lubricated, double shielded ball bearings, and has a minimum expected service life of over 500 hours — a long time in *emergency* mode.

The motor was designed to operate in temperatures from −57 to +172 degrees under RTCA (Radio Technical Commission for Aeronautics) test conditions as specified in DO-160A, "Environmental Conditions and Test Procedures for Airborne Equipment." Pamco's 28 VDC model is further spec'd to MIL-STD 8609B. The mechanically similar 14 VDC unit also meets 8609B, but that standard isn't formally applicable to 14-volt systems. RF interference is at or under specifications of MIL-STD-461B. In brief, it's a good little MIL-spec all-American-made motor. As of July, Zompolas hadn't yet received PMA (Parts Manufacturing Authority) approval for his motors from the FAA, but expects it without any difficulty.

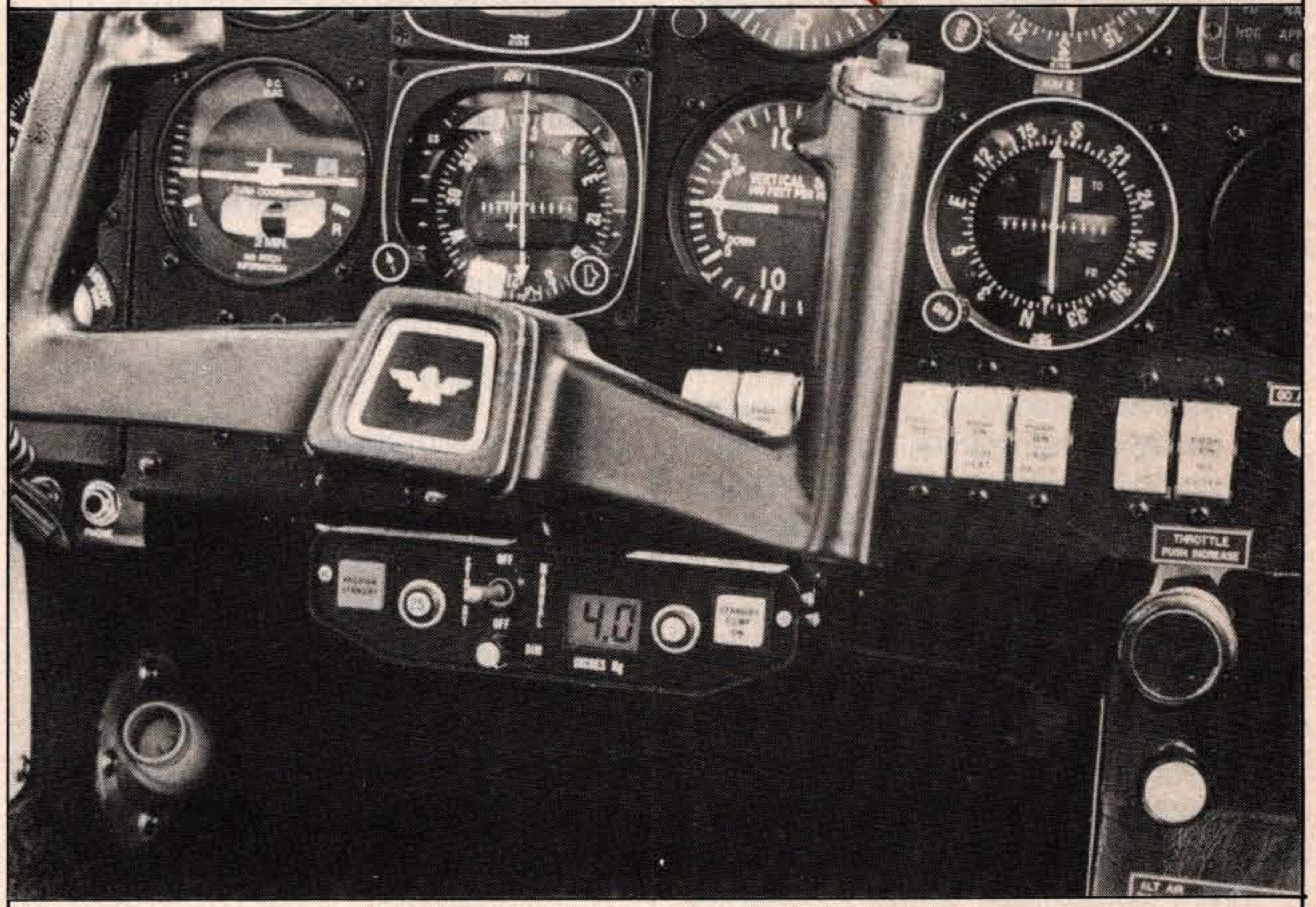
The real key to Pamco's standby is its patented, fully automatic activation system whose brains are in a compact annunciator/control module. In contrast to several competitors' units (or the economy-model Pamco) which must be manually switched on after a primary pump failure (or be left running constantly), you can switch an automatic Pamco to "Vacuum standby" and fly, confident that it will bring the backup pump on line whenever it's needed. Here's how it works.

The Unit in Action

Zompolas incorporated a pressure sensor in his control module which constantly monitors the aircraft's vacuum level. (Before being sealed at the factory, the unit can be internally switched to operate on pressure instead of vacuum, so Beechcraft fans can read "pressure" for "vacuum" just by ordering the right unit). If the sensor reads under 3.5 in. Hg, the standby unit kicks in and keeps running until system vacuum exceeds 4.6 in. Hg. You stay informed by adding the annunciator panel to your scan, checking the green "vacuum standby" and amber "standby pump on on" lights and accurate LCD digital vacuum indicator for changes. But once you have the system preflighted and switched to standby (see "Using the Pamco") you



If you can squeeze it into a turbocharged, intercooled Mooney 231, you can squeeze it anywhere. That being the philosophy, the Pamco's first home is shown above.



The control unit, mounted under the panel of a Mooney 231. Because the device comes on automatically, there is no critical need to keep the unit in the normal scan.

can largely keep your attention on the flight instruments where it belongs.

How High Can You Go?

The Pamco system should keep your gyros happy no matter how high you fly. Zompolas spent months working with the Milwaukee School of Engineering, Applied Technology Center to find out exactly what gyros need. His experiments have brought to light some interesting new information on aircraft gyro behavior at different altitudes and vacuum levels.

Zompolas first tested the airflow required by a variety of old and new gyros. He found little airflow change between new and in-for-overhaul gyros, *but differences exceeding 200% between gyros of different manufacturers.* By establishing a "worst-case" three-instrument setup (needing more airflow than any two known instruments), Zompolas showed that only 3 inches Hg. at sea level is necessary to maintain gyro performance to manufacturers' and TSOC5c standards.

No Need for 5 Inches?

But some might think the 5 inches traditionally maintained by vacuum regulators is needed to provide sufficient vaccum at altitude. Zompolas ignored this "common sense," and by depending on first-hand testing and observation, proved that as density altitude increases, gyros *will* maintain their RPM with much less vacuum than required at sea level. He showed, in fact, that gyros designed to turn at 29,000 rpm with 5 inches Hg. vacuum at sea level, given the same 5 inches at 30,000 feet spun at *over 49,000 rpm.* Zompolas reasoned that these extra rpm provide nothing but worn out gyro bearings, since gyros are designed to meet TSO standards at their sea level speeds. (Author's note: The higher vacuum does help bring gyros up to speed within an FAA-specified 5 minutes — see the "Instrument Flying Handbook.")

Indicated Vacuum

After exhaustive testing, Zompolas convinced the FAA that with as little as 2.5 inches vacuum at 30,000 feet, he could maintain the same gyro rpm as provided by 4 inches Hg. at sea level. Then he proved, at that altitude, that his motor/pump combination can do even better — holding 3.1 inches and maintaining gyro speeds equivalent to the sea-level 5 inches of vacuum. These tests, incidently, led the FAA to accept "Indicated Vacuum" as an appropriate method for determining gyro rpm.

The FAA agreed to let the Pamco controller switch on at 3.5 inches and to operate at a normal design speed giving 4 inches Hg. At that level gyro airflow is more than sufficient, and less electrical energy is used than the traditional 5 inch setting would require. By incorporating a test-proven placard showing the "Indicated Vacuum" required at different density altitudes (for gyro performance equivalent to 4 inches Hg at sea level), Pamco earned FAA certification for use at service ceilings up to 30,000 feet.

Using the Pamco System

"Normal Procedures" in the Pamco POH supplement give several ways to test the system before takeoff — in my mind a critical feature of a standby system. If you have enough battery power, before engine start you can switch to manual and check for a "standby pump on" light and approximately 4 in. Hg. vacuum. Switch off promptly to avoid battery drain — remember it takes up to 14 amps! After engine start, at idle rpm, you can again switch to manual and check activation.

The automatic standby mode can be checked during runup. With at least 4 in.Hg coming from the engine pump, switch to "standby." The "vacuum standby" light should come on, while the "standby pump on" light will be off. Now reduce power until the gage reads under 3.5 inches vacuum — after two seconds the "standby pump on" light should illuminate and you should see approximately 4 in. Hg on the gage. To check system cutoff increase engine rpm until the vacuum gage reads over 4.6 in.Hg. After approximately two seconds the system will deactivate, extinguishing the "standby pump on" light while leaving the "vacuum standby" light on so you know the unit is still on duty.

The automatic features makc emergency procedures simple. If you lose your engine-driven vacuum pump, the amber "standby pump on" will illuminate and you'll have gyro power. There are two actions required:

1. *Check the "Indicated Altitude"* placard to ensure you have sufficient vacuum for your density altitude — if you don't (with Pamco you probably will), you'll need to disconnect the autopilot from any vacuum-powered instruments, and descend to denser air, because IFR flight is prohibited without the placarded vacuum level.

2. *Then check your ammeter* for discharge conditions. The Pamco takes up to 14 amps at altitude, and this could easily put most well-equipped singles "over the top" electrically. You'll have to shed some electrical loads to keep your battery from discharging.

Finally, whether you run on manual or standby, do remember to turn it *off* before shutdown to avoid unnecessary battery drain.

Buying a Pamco

Okay, now you've decided your Turbo Gofast 6 needs a Pamco standby vacuum system. Congratulations, but there are a couple of snags. You can't put it in your aircraft without some creative FAA paperwork (unless you have a Mooney 231). As of July, Pamco held STCs only for the 231.

Zompolas says he has licked a number of production problems and expected availability of 50 manually-switched units (priced at $1,595) by August 1, 1985. Fifty automatic-model PAMCO's (at $2,195) should be available by early September. Installation is a straightforward matter of 3-5 hours, with most mounting work done from ahead of the firewall using expanding plusnuts. (Aircraft owners know that installation costs are exponential functions of the number of times your A&P goes upside-down under the panel.)

> **He found that 5 inches of vacuum at 30,000 feet produced 49,000 rpm.**

If you don't have a Mooney, Zompolas will even provide free installation (normally $100) if you'll fly into Wisconsin's Burlington Municipal Airport and give him a few days to earn an STC on your aircraft. With the wealth of test data he has accumulated, and after Pamco's successful installations on the tightly-cowled turboplus-intercooled Mooney 231, Zompolas feels that gaining additional STC's is only a matter of aircraft availability. He is now completing drawings which he feels will satisfy FAA requirements for the Mooney 201. Any Skylane or Comanche owners interested?

Is It Worth It?

Making a purchase decision on a vacuum standby is a little like deciding whether or not to get an emergency fire ladder for an upper story window. You don't really think you'll ever need it, and it can't save you from all emergencies you might have — but it might save your life. If you've read this far, you're concerned enough to consider buying some vacuum insurance. Is Pamco's right for you?

As a benchmark, I compare backups to the one addition that really offers redundancy: alternatively-powered flight instruments. I considered an electric attitude indicator (about $1,000 and 2-3 pounds) and either electric DG (another $1,000 and 2-3 pounds) or vertical dry-card compass ($200-350, 1.5 pounds). This installation takes panel space and requires some creative fitting, adds a constant 2+ amps to electrical load, and won't drive my autopilot if either the stock DG or vacuum pump goes down. It could require an unusual (or difficult) scan — but my chances of being without an attitude indicator or DG would be exponentially reduced. The system would work at any altitude I can reach and frees me from carbon-graphite pump foibles. But there's one bug — I'd have to notice the vacuum gage or vacuum annunciator light (stock on my Piper, easily fitted on other systems) to know when the primary gyros are without adequate air and hence unreliable.

In comparison, the automatic Pamco costs over $2,000 and chews up 12 pounds of load. The annunciator unit is easier to fit than two standby instruments. Pamco draws negligible current on standby, but may require shedding other loads in operation. It alerts you when the primary pump goes — and even better, keeps the gyros you're scanning in normal operation. And although it's no longer so important with the Pamco on board, there's a chance you can use the accurate LCD gage to get early warning of primary pump demise by recording the engine RPM it takes to show initial vacuum. (Once that starts to increase, the pump's remaining hours are probably numbered. Stay tuned for more research results.)

The system will maintain autopilot function through a pump failure — though not if the DG *itself* fails. Similarily, if the attitude indicator goes (and pneumatic gyro instruments do go) the Pamco can't help. But as far as making the carbon-graphite pump/pneumatic instrument system more reliable, the Pamco is hard to fault. It's the best solution one methodical, determined and creative entrepreneur could build. **IFR**™