

COMPASS DILEMMA

Pilots and avionics shops need to work together for efficient maintenance of magnetic compasses and gyros.

BY ED MAHER

Want to know how to make enemies at an instrument shop? Imagine the technician's frustration at finding nothing wrong when an electronic or other compass indicator is sent in for repair or replacement because it precesses or displays the wrong heading. Compound this when the shop returns it and the customer complains, "It still doesn't work!"

Over and over again, customers (technicians, pilots and kit builders) send directional gyros in for repair. The shop goes through the whole routine and finds the bearing race is worn, possibly enough to cause precessing. Cautiously, the shop consults the customer, saying, "There is no guarantee this will resolve your problem; there is a little reprecising, but it shouldn't be enough to cause the degree of error described. Do you still want to have it repaired?" The customer gives approval. The gyro is repaired, bench-checked and found to meet factory specs. It is sent back to the customer, reinstalled and *surprise!* The same squawk resurfaces.

Checking It Out

So what happened? The shop doing the troubleshooting calls the instrument shop and says, "It is still doing the same thing!" The shop asks if they checked it on an official compass rose or master compass. "Of course we have!" is the defensive answer. Again the shop expends several hours and finds nothing wrong. Finally, the plane is taxied to a compass rose and swung. Guess what: Both the wet compass and the gyro are found to point incorrectly.

Next problem: The customer doesn't want to pay for the repairs. After all, there wasn't anything wrong with the indicator; it was the wet compass all this time! But the instrument repair facility did exactly what it was asked to do: confirm a defect and complete a repair. In fact, the shop was instrumental in determining the cause and the solution. In many cases, the instrument shop has, for good will, not charged for such a repair, but this is too much to ask. The problem wasn't the shop's fault.

Placing blame is simple. The FBO, mechanic or the pilot should have immediately taken the plane to an FAA-designated compass rose and confirmed whether the gyro or the magnetic compass was at fault. But that didn't happen.

Example No. 2

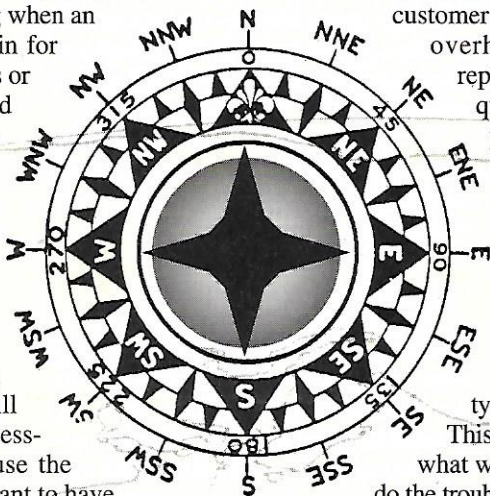
Another scenario plays out this way: The field shop or customer suspects a defective gyro and requests an overhauled unit from a repair depot. The replacement indicator is received, installed quickly and...Uh Oh, it doesn't work. The pilot angrily brings the plane back, complaining of the same problem and saying he isn't about to pay for the overhaul. Here's a slightly different story from the first, but the outcome is essentially the same. The field shop didn't do its homework and most likely will have to pay the price.

How do we reduce or eliminate this type of unnecessary and expensive squawk? This isn't a trick question. The answer is to do what was recommended by the instrument shop, do the troubleshooting in the right order, and swing the compass on a designated compass rose—one approved by the FAA.

The Right Way

To determine if wet or magnetic compass and directional gyro differences exist before ordering a new or overhauled indicator, the following list should be helpful. Before beginning this test, make sure the engine is running at an rpm that will allow the alternators or generator to come on line. The control yoke or stick must be held in normal flying attitude and all avionics should be on. Position of the yoke is important.

1. Taxi the aircraft to an approved compass test site and turn on normally operated equipment.
2. With the plane stationary, turn on electrical systems and observe the effects of the magnetic compass before beginning the test. Record any errors or affected deviations.
3. Rotate the plane until it points north and set the directional gyro to magnetic compass heading.
4. Rotate the plane to east, then south, then west, referencing the directional gyro, and record the magnetic compass heading for each position.
5. Continue to rotate the plane on to north, referencing the directional gyro. The magnetic compass reading should be within 3° of the selected heading in No. 2.
6. If the magnetic compass and the directional gyro match within 3°, any errors on the other recorded headings are magnetic compass related and require swinging the compass. If an



SNOWLINE
WELDING AND FABRICATION
CUSTOM & PRODUCTION SPORTPLANE
PRODUCTS

RV-4 RV-6 RV-6A
STAINLESS STEEL
CROSSOVER EXHAUST SYSTEM
(THE COMPLETE ONE)

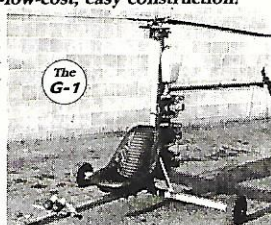
Cabin and Carb. Heat Muffs • Blow-Proof Exhaust Gaskets
Stainless Steel Attaching Hardware

Write or call for more information, or visit us at our new
expanded facility in Redmond, OR
2202 Airport Way • 97756
503-923-2545 / Fax 503-923-2447

Circle No. 148 on Reader Service Card

World's Tiniest **HOMEBUILT HELICOPTER**
Super-low-cost, easy construction!

This tiny marvel flies like the big ones, yet is the smallest and simplest piston-engine helicopter ever developed!



The G-1

- Carries one person
- Can be stored anywhere
- Powered by Go-Kart engines
- No license needed

Complete G-1 Construction Plans: Only \$24.95
(Add \$3 post. Foreign add \$6)

YOUR ORDER INCLUDES A HELICOPTER EXPERIMENTER BOOK & A HOMEBUILT HELICOPTER CATALOG

Catalog only: \$10

Order from:
VORTECH, Inc.
PO Box 511-KP
Fallston, MD 21047

1-800-583-6366

VAL COM 760 TSO VHF TRANSCEIVER



AMERICA'S BEST BUY - \$695.00

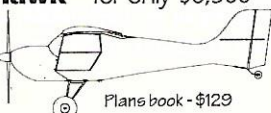
We carry all Morrow LORAN and GPS Systems - Call for competitive pricing

P.O. BOX 13025
SALEM, OR 97309

USA & CANADA 800-255-1511

Build the **MoHawk** for only \$6,500

STOL performance
2 seat - dual controls
folding wings
take off - 100'
550 lbs useful load



Plans book - \$129

TO ORDER CALL 1-800-785-HAWK

INFO PAK send \$5 - MoHawk Box 721 Ozark, MO 65721

Circle No. 161 on Reader Service Card

AVIATION BOOKS & VIDEOS
FOR HOMEBUILT AIRCRAFT ENTHUSIASTS

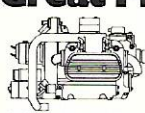
America's Finest Selection . . . plus Gadgets
To Order By Mail or Phone

FREE CATALOG 800-423-2708 TOLLFREE
"Serving Aeronautical Enthusiasts Since 1964"

AVIATION BOOK COMPANY
25133 Anza Dr. #E, Dept K, Santa Clarita CA 91355

Circle No. 112 on Reader Service Card

Great Plains Aircraft
supply company



VW-Based Engines & Components
Type 1 - 50 to 78 HP
Type 4 - 55 to 90 HP

18 Years of Development • Catalog \$3
Box 545 • Boystown NE 68010 • 402-493-6507

HOMEBUILT ROTORCRAFT



A MAGAZINE FOR THE ROTORCRAFT ENTHUSIAST
FEATURING EXCLUSIVE COVERAGE OF EXPERIMENTAL
GYROPLANES AND HELICOPTERS 12 MONTHLY ISSUES FOR
\$20.00 IN THE U.S., \$26.00 IN CANADA & MEXICO, \$34.00
OVERSEAS. SAMPLE COPY - \$2.50 (U.S. FUNDS ONLY) IF OUT
SIDE U.S. SEND INTERNATIONAL POSTAL MONEY ORDER.
MASTER CHARGE OR VISA ACCEPTED. CALL 1-505-298-9362

RFI PUBLISHING GROUP
SUITE 281KP 5555 ZUNI S.E., ALBUQUERQUE, NM 87108

Circle No. 130 on Reader Service Card

COMPASS

continued

error of more than 3° is present, overhaul of the directional gyro may be necessary.

Swinging It

Every aircraft has its own unique magnetic pattern. The structure, control yoke, radios, supports, ribs, stringers, engines, propeller, landing gear—everything can create magnetic influences.

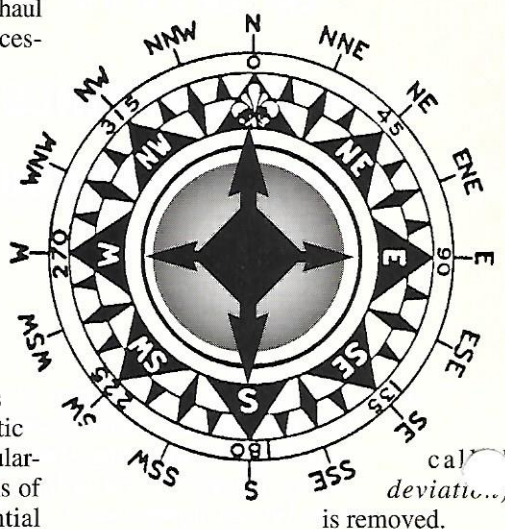
The wet compass is not especially easy to adjust (swing). This is especially true when exact magnetic headings aren't known—and particularly when contending with big chunks of steel, aluminum and other influential structure or electrical circuits.

The wet compass consists of a sensing element (bar magnets) attached to a floating device. To restrict sudden changes in motion caused by the aircraft, the entire assembly is submerged in a fluid similar to the consistency of kerosene.

A replacement for the time-honored *wet compass* is the vertical-card magnetic compass. It uses a massive magnet that is mounted on a shaft supported by jeweled bearings held in a vertical housing. As the plane rotates through the cardinal headings, an azimuth card, connected through gears to the fixed magnetic sensor, rotates to display the magnetic heading. This unit is less susceptible to exterior magnetic fields, but more prone to airframe vibration; installation or maintenance crews should closely observe the original factory mounting system.

If the procedure in the list above indicates that your problem is the inaccurate wet (magnetic) compass, swing (adjust) the compass using this list. Set up the same conditions mentioned above, including use of an approved compass rose. Before beginning calibration, select a nonmagnetic screwdriver—brass or stainless steel—for making these adjustments:

1. Point the plane north on the compass rose. Adjust the N-S screw until the card reads exactly north.
2. Rotate the plane to east, adjust the E-W screw to remove all errors and to read exactly E.
3. Continue to rotate the aircraft until it points south. Note the deviation, then adjust screw until *half* of the error (it's



4. Rotate the plane until pointing west and note the deviation. Remove half of the error.

5. Again rotate the plane until it is back to north. Is the error the same as it was when pointed south? It should be, but some very small readjustments may be necessary to average the error readings.

6. Rotate the plane to east. Does the compass display the same deviation as your earlier west notation? If not, some minor adjustments may be necessary.

7. After completing these steps, again rotate the plane through the cardinals, but also stop at 30° increments to confirm accuracy of your calibration and to list the indicated magnetic headings on the compass correction card.

Follow-on Checks

As the plane is swung to set the wet compass, also check the slaved compass; the flux valve or compass amplifier may need to be adjusted. When power is applied to the directional gyro system, the compass card will slave around to the heading determined by the position of the flux valve installed in the aircraft. Any ground test must be conducted away from obstructions. The plane should be placed on one of cardinal headings on the compass rose and indicated heading recorded. Rotate the airplane to the other three directions. Cycling through all four main headings before making any adjustments will indicate the overall error.

Add the errors up algebraically and divide by four. The result is the error index. While sitting on a cardinal heading, using a magnetically inert screwdriver, loosen the three screws securing

the flux valve in place and rotate it to cancel out the index error. If the error is positive, the valve is to be rotated counter clockwise, resulting in a minus reading on the valve's flange. Recheck the readings at all compass headings; all error readings should be within at least 2°. If not, a compensator may be needed to remove any excessive error. The remaining error could be due to the airframe's inherent magnetic field. Make sure that the mounting screws or surrounding clamps and their screws and nuts are nonmagnetic.

Gyro Problems

1. The list identifies gyro problems and the resulting indications.

1. The number one cause of gyro failures is dirty filters, either at the indicator or inline. Look for an excessively high vacuum indication.

2. Vacuum pump failure. The vacuum should indicate 3.5 inches or higher, but not more than 5 inches of mercury on the vacuum gauge. Put on a test vacuum gauge and look for poor regulation, high or low vacuum and the possibility of a faulty aircraft vacuum gauge failure.

3. Damaged bearings or pivot points caused by previously dropped gyro or excessive vibration. Faulty gyro operation may be obvious.

4. Exceeding operating limits and/or internal gyro failure may cause the compass card to spin in one direction.

Generally speaking, attitude and directional gyros won't require aggressive maintenance except for filter changes unless some form of failure occurs that can be attributed to these discrepancies. Severe and expensive failures such as that from internal wear usually occur after 1000 hours or more.

Wrapup

We have covered quite a bit, but don't lose sight of why this article was written, which is to encourage thorough troubleshooting before tasking an avionics shop to fix a gyro or compass problem. These steps will keep cost and frustration to a minimum.

KP

Ed Maher is an avionics manager and consultant in San Diego.

COZY MARK IV



A bonanza of performanceat a Cozy price!

This beautiful, 220 mph, stall-resistant, 4-place family airplane costs much less to build and operate than so called pre-fabs. For only \$13,000 of parts and materials, plus engine and avionics, first time builders can build the Cozy Mark IV from our plans and construction manual, using the same EZ-build, moldless, composite construction technique & aerodynamics developed by Burt Rutan, and well-proven by countless EZ builders in the last 17 years. Send \$10 for our information kit and/or \$500 (\$535 overseas) for plans and construction manuals to:

Co-Z Dev. Corp., 2046 No. 63rd Place, Mesa, AZ 85215 (602) 981-6401

GROUND ADJUSTABLE PROPELLERS

For Ultralites and Home Builts
The Original Manufacturer of Ground Adjustable
Propellers for Ultralites Since 1980.
Blade Lengths 20" to 72". Blades Laminated 1/16"
#1 Hard Maple. 2,3,4 Blade. 125 hp maximum.
Quality and Craftsmanship Unequaled. Expert consultants.
PRECISION PROPELLERS, INC.
P.O. Box 1392 • Vernal, Utah 84078
801-789-3699 • Fax 801-789-6059

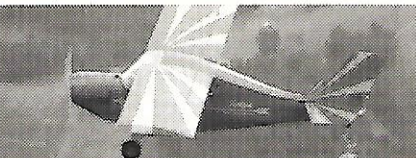
Circle No. 140 on Reader Service Card

FLYING CARS & ROADABLE AIRCRAFT

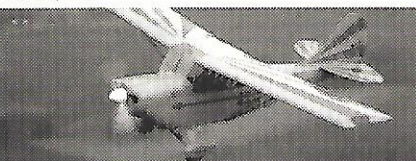
A magazine for the enthusiast and experimenter featuring exclusive coverage of all roadable aircraft and flying cars, both homebuilt and production.
6 issues/year, \$15.00 in the U.S., \$21.00 foreign. Sample copy \$3.00, \$4.00 foreign. U.S. funds only.
ROADABLE AIRCRAFT MAGAZINE
338 8th Ave S, Dept K4, EDMONDS WA 98020-3412

Circle No. 143 on Reader Service Card

Horizon 1 2-place tandem EXP, all wood construction, quick fold wings. Complete air frame kits \$5,200. Plans \$275.



Horizon 2 2-place tandem EXP, quick fold wings, slotted flaps & ailerons. Complete air frame kits \$6,800. Plans \$350.



Celebrity—The very best all around 2-place EXP biplane. Absolute best buy available. Complete airframe kits \$6,900. Factory demos available.



Fisher Aero Corp.

7118 State Route 335
Portsmouth, OH 45662
(614) 820-2219

Information Packets Available
\$8.00 within US \$10.00 Overseas

You can afford to buy a kitplane

... after you've checked out our



- ☐ Free Builders School ☐ Payload ☐ Super Cub Performance
- ☐ Comfort ☐ Aircraft Quality Components
- ☐ Choice of Lycoming or Continental engine mount
- ☐ Think *MOUNTAIN EAGLE*, think full-sized aircraft

You can afford a *MOUNTAIN EAGLE*
from Montana Coyote - 3302 Airport Rd. - Helena, MT 59601

\$17,995 FOB Helena, MT for complete kit - less engine, instruments, accessories, prop and finish paint

406-449-3556 406-449-3570 FAX

Info Pack \$15 Video \$25

Visit our Booth at Arlington & Oshkosh this Summer

Circle No. 137 on Reader Service Card