ENGINE DYNAMIC BALANCE DEVICE

Bill Butters

Several years ago I saw an article in a magazine that described a device for testing an aircraft engine to evaluate its out of balance condition. Later, the Canard Pusher described how well this balancing technique worked for their aircraft, so I decided to try to balance my engine. This article describes how my home made system works and gives a general description of how to build your own vibration tester. The information presented here is enough for those people who have a working knowledge of circuits to be able to build their own but is not a detailed construction article.

If you've ever seen a tire balanced on a car using the spinning wheel and a strobe light, then you've seen how the system works on the airplane with a spinning propeller and a strobe light. On the aircraft a piezoelectric sensor is placed on the engine crankcase near the prop hub. If there is an imbalance in the hub/prop assembly the vibrations are transmitted into the crankcase and picked by the sensor. An amplifier circuit is attached to the sensor and the amplified output is sent to a strobe light that flashes to illuminate the prop hub. Most of this is obvious, of course, but how can the average pilot afford to own one of these for the few times it would be necessary to check an aircraft?

It's all done with standard parts and can be done easily. Here's how!

Sensor - This is a piezolectric crystal that converts mechanical pressure or vibration to electrical energy. There are numerous crystals (called transducers) on the market that are used in calibrated engineering applications, but the one that I used may already be sitting in your garage. It's your electric charcoal fire starter. Yep, it's that gadget that you point at the grill, press the trigger, and a big spark spits out the end. This gadget uses a piezoelectric crystal and a mechanical device to squeeze the crystal and thus force the high voltage pulse to appear at the business end.

I disassembled my lighter and removed the guts. The crystal was mounted in a small loose plastic cylinder so I repackaged the plastic into a sturdy aluminum housing suitable for mounting in an engine. From the crystal output I connected a small coaxial cable with a plug on the end. This plugs into the amplifier.

Amplifier - The mechanical vibrations that are caused by the engine are small compared to the mechanical squeezer that is used in the original application for the crystal. To overcome this an amplifier is needed to increase the signal level for the next stage. I used a common audio amplifier ,National LM380N, with an adjustment for sensitivity. The output of the amplifier is sent

to a small current pulse circuit. The current pulse is a short duration pulse that is used to simulate the current pulse that is seen on the spark plug wires of an automobile. The entire circuit, along with a nine volt battery, is housed in a small metal box 1.5"x1.5"x4" with a six inch loop of wire extending away form one side.

Strobe - This is the easy one. For the strobe I used an automobile timing light from Sears.

TESTING FOR VIBRATIONS

Setup - Attach the sensor to the crankcase split line close (within 8 inches or so) to the prop flange. This attachment must be secure and have a good mechanical mount to ensure that the engine vibrations are transmitted into the sensor. Snake the coaxial line back to the rear of the engine and connect it to the amplifier box. Connect the timing light to a 12 volt battery source for its power and then connect the light's spark plug clip to the loop of wire that extends out of the amplifier box. On the prop flange, prop, or spinner backing plate, using a high contrast grease pencil, mark at 90 degree intervals four unique marks. I use a square, a circle, a heavy line, etc. You'll find with experience what works best and what is easiest to see with the engine running.

Test - Start the engine and point the strobe at the marks that you have put on the hub area. If no flashes are visible from the timing light adjust the amplifier sensitivity until the light starts to flash. As on a car, this operation must be done in a subdued light so that you can see the marks as they are illuminated. Now, point the light at the prop area and observe the marks. If you see several of them and they are dancing around then reduce the sensitivity setting until one mark is predominate on the display. The location of this mark indicates the relative position of either the light or heavy part of the rotating mass. We don't know which it will be until after we change the mass to see what the result is.

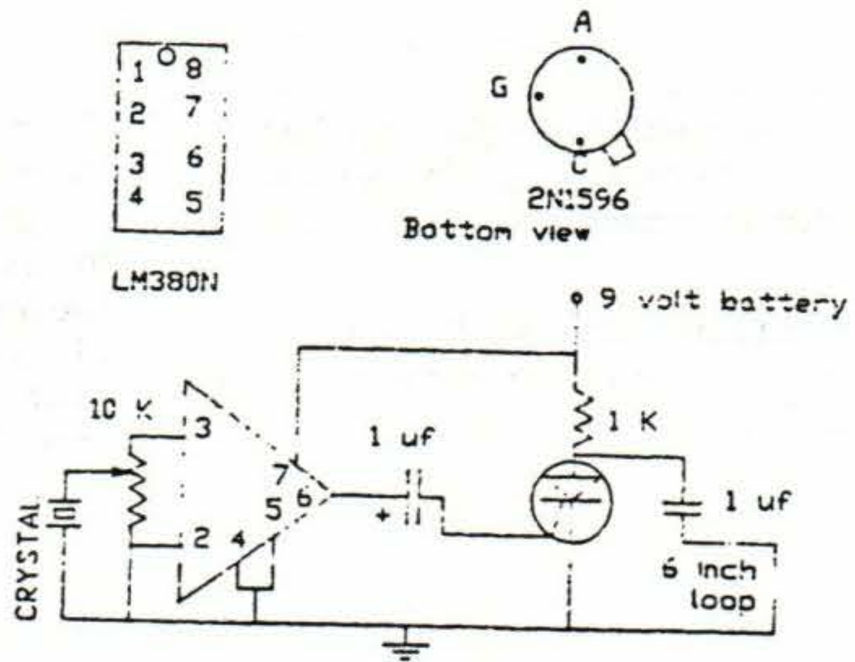
Stop the engine and position the prop so that the mark that you just saw is in the same relative position. Now put a washer (just one) under the spinner screw closest to the 12 o'clock position. Without changing the gain setting on the amplifier, start the engine and run the strobe test again.

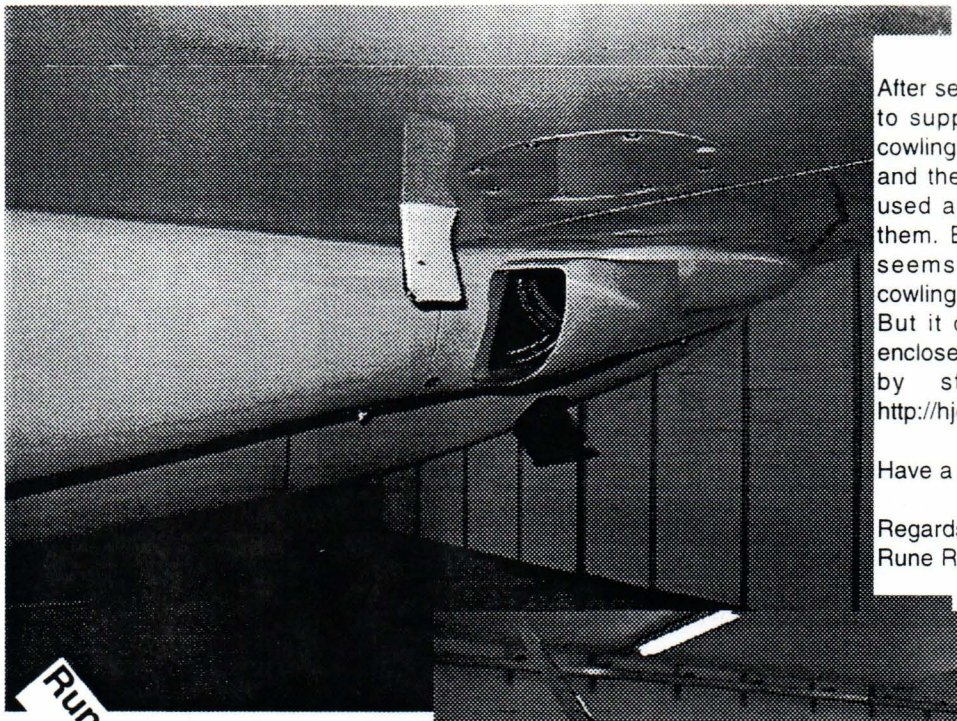
With the same gain setting, and with this second run, if you still see the same predominate pattern you can conclude that the washer was mounted on the wrong (heavy) side. Stop the engine, remove the washer, and mount it on the side 180 degrees from its original position.

Now you should see some results! If you've lived a good life and Murphy isn't a constant friend, the pattern of marks that you see should be more random. Remember that the gain was set for the out of balance condition so now that you're closer to balance you may have to change the gain to see the marks. Chase the balance with washers until you can't see any more benefits then go fly to see the difference in the noise and vibration.

If you want to measure the difference in noise and vibration use a Radio Shack audio dB meter for a before and after check.

If you want some experience at home with the strobe equipment, use a drill chuck key (the right angle type) and mount the key in your drill press. With the sensor fastened to the case of the drill press you can adjust the strobe's sensitivity to see six or more keys appearing motionless or reduce the sensitivity to see just one chuck key waving at you.





Rune Rostrup

After seen all articles from other builders, I want to supply the flyer with some pict from our cowling. We copied the Lancer cowling in front and the Berkut in rear. We only estimate and used a lot of time to figure out how to build them. But after doing lots of flight testing . it seems that we hit the "almost" ultimate cowlings, we still see things to modify on them. But it can be a idea for others to study. I enclose some pictures ,but there is more details by study pictures on this page: http://hjem.sol.no/rrostrup/

Have a safe flying 2002.

Regards
Rune Rostrup

Rune Rostrup's Defiant Details