



AEROSPACE™

Engineering Evaluation Report CH657.M.EER.001, Issue 2 Kelly Aerospace FAA-PMA Magneto

Date: July 14, 2022

Subject: Kelly Aerospace Magneto – Competitive Evaluation

Purpose: To evaluate the Kelly Aerospace magneto offering. The part numbers under evaluation are 4371, 4370 and 6351.

Scope: Three Kelly Aerospace magnetos were purchased through normal distribution for evaluation, as well as an impulse coupling as a spare part. Each magneto was tested against Champion's standard Acceptance Test Procedure (ATP) requirements. After ATP testing, the magnetos were also disassembled to take visual inventory of the condition of the parts. Once reassembled, the magnetos were tested on the Champion test bench to 500 hours, and if impulse-coupled, further tested on the impulse coupling test stand. Additionally, the Kelly impulse coupling was assembled to a brand new Champion Slick 4371 magneto per the Champion work instructions, and tested on the impulse coupling test stand to evaluate the impulse coupling individually.

Conclusions: The Kelly Aerospace magneto offering greatly underperforms when compared to the Champion Slick magneto under the test conditions described in this report. The Kelly magneto showed timing concerns, sparking performance issues and impulse coupling failures that indicate its reliability in flight falls well below the standard customers should expect from their ignition system.

Results – 4371 Magneto, Serial# J-K10113

Upon receipt of the first Kelly 4371, the unit was ATP tested per the Champion work instructions. This included spark testing at various RPM's and checking the E-gap setting of the magneto for timing. The Kelly 4371 was tested and passed the spark count and voltage at 135 RPM and 475 RPM, however the magneto failed the test at 1,000 RPM. While the voltage output was acceptable, the magneto sparked less than 100 times on 3 out of the 4 cylinders, compared to the Champion ATP requirement of 100 sparks on all 4 cylinders. As a result, the magneto was unable to complete the full ATP test. For the E-gap setting, Champion targets the engine-specified lag angle of 20° (as shown on the magneto's data plate), with a measurement range between 18 and 21°. The Kelly 4371 measured 26.3°, with a 26.9° degree lag angle.



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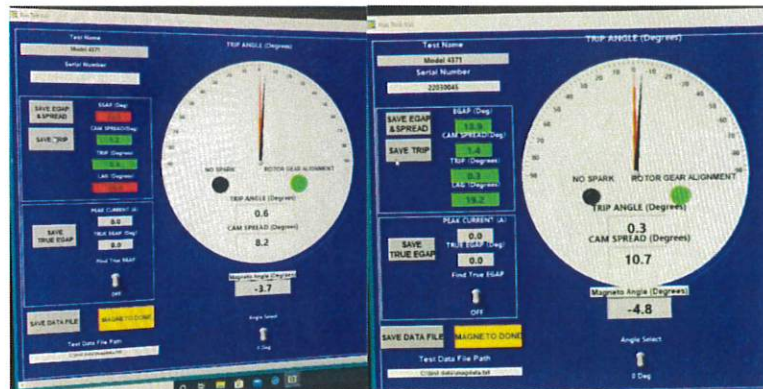
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The Kelly 4371 was then installed on the Champion bench test for endurance testing, where the magneto is run a maximum of 500 hours at 2,400 RPM. The magneto ran the entire 500 hours, however the magneto did not produce a spark on each cylinder the entire test. During several checks, the magneto was not consistently sparking on cylinder #1, and at times was also not consistently sparking on cylinders #3 and #4 as well. This performance is not unexpected when coupled with the ATP data and E-gap measurement. As mentioned previously, the magneto did not spark consistently on each cylinder above 475 RPM during ATP testing, and the E-gap, or the internal timing of the magneto, was off by more than 5° from the maximum of 21° allowed by Champion's synchroscope.

After 500 hours, the magneto was removed from the endurance test, and the ATP testing was performed again. This time, however, the magneto passed. The sparking consistency improved, and the E-gap was 18.9° with a lag angle of 19.2°.



Kelly 4371 E-Gap Evaluation: New (Left) and after 500 Hr Endurance Test (Right)

The explanation for this difference is the timing drift that occurs over the life of a magneto. The cam and spring are wear points, and as those surfaces wear the timing associated with their impact can and does change. However, the magneto is expected to measure within a range of approximately 2° from new to 500 hours of run time. This magneto drifted almost 8° in E-gap, and 7° in lag angle, which significantly affects the timing of the spark in the engine. This can lead to a rough-running engine and result in higher frequency inspections and timing adjustments by the end user, resulting in higher costs and more downtime.

Finally, the Kelly magneto was placed on the Champion impulse coupling test stand, which runs at 150 RPM to constantly engage/disengage the impulse coupling, simulating starting events. The impulse coupling failed in less than 1 hour, with the failure mode being a sheared pawl post. After failure, the unit was analyzed for any metallurgical defects that may have explained the failure. There were no defects in the metallurgical composition discovered during the analysis. However, the failure mode implies a material condition that is too brittle for the environment. For reference, the Champion impulse coupling lasts between 200-210 hours on the same test.



Results – 4370 Magneto, Serial# J-K10042

The second 4-cylinder Kelly magneto was a non-impulse-coupled 4370 magneto. The magneto was ATP tested on Champion's test bench, and passed both E-gap and final product ATP. The magneto was then put on the endurance bench test for 500 hours. The 4370 magneto passed the 500 hour test with no issues. After completion of the test, the magneto was tested on Champion's ATP test, where it passed all but the final run at 2705 RPM, failing due to missing 7 out of 100 sparks for a 93% spark rate. All other cylinders sparked 100%. This is the second of two magnetos tested that failed the ATP test either before or after running 500 hours.





Results – 6351 Magneto, Serial# K-K01327



The 6-cylinder Kelly magneto tested was an impulse-coupled 6351 model. The magneto was ATP tested on Champion's test bench, where it passed both E-gap and final product ATP. The magneto was then put on the endurance bench test for 500 hours.

However, after approximately 18 hours, the magneto no longer sparked when operating at 2700RPM. The magneto was rotating, but there was no output at the spark gaps for any of the 6 cylinders. The test was stopped and the magneto removed for evaluation.

The magneto was tested again on Champion's ATP test, where it failed after only 18 hours of runtime. At 135 RPM, the impulse coupling engagement failed to produce enough voltage at any of the 6 spark plugs to spark and pass the test. Cylinder 5 did not spark at all during the test. Since the magneto failed the test on the first run, the testing was not carried out for the remainder of the program. This is most likely due to a failed coil unable to transmit the proper voltage through the system for a spark at the spark plug.

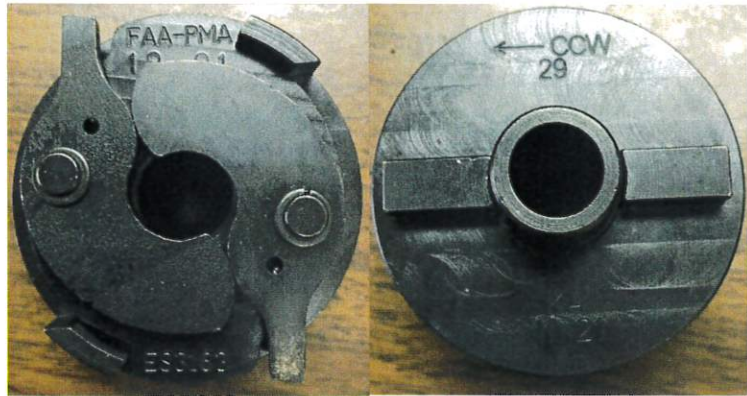
After testing with the 6351 was complete, the impulse coupling was removed for an additional test of the Kelly impulse coupling on the Champion test. The coupling was installed on a Champion magneto, and the coupling lasted approximately 50-55 hours on the test stand. The failure mode, in this case, was the outer shell and internal spring breaking catastrophically. This is the second impulse coupling to fail the Champion test. While Champion's test is aggressive, as mentioned previously the Champion offering lasts between 200-210 hours on this test. This is also the second Kelly impulse coupling to damage the pawl post, increasing the level of concern surrounding the metallurgy and reliability of the design.





Results – Kelly Impulse Coupling Installed on Slick Magneto

A Kelly Aerospace Impulse Coupling (right) was ordered separately as a spare part, and installed on a Slick 4371 magneto for testing and evaluation. The impulse coupling tester ran at 150 RPM, engaging the impulse coupling properly. However, after approximately 34 hours, the impulse coupling failed due to the stop plate lobes breaking off, as shown below.



This test is aggressive, and the failure mode shown above is typical for this test. As mentioned earlier for reference, the Champion impulse coupling reaches approximately 200 – 210 hours on this test. Referencing back, this was the third part of (3) to not pass the Champion test, with structural failures of the impulse coupling hub as the failure mode on both.



Overall Assessment

Based on the testing performed across (3) different magnetos of both 4-cyl and 6-cyl configurations, the Kelly Aerospace PMA magneto does not perform as well as the Champion Slick magneto, and does not show the reliability customers expect from a Slick Magneto. Two out of Three (2/3) brand new Kelly magnetos failed the Acceptance Test at Champion out of the box.

Only one of the three (1/3) Kelly magnetos showed a significant internal timing issue with the drift observed in the 4371, however the spark consistency of the 4370 could be indicative of a timing concern in that magneto as well.

The 6351 performance on the endurance test was disconcerting due to the suddenness of failure after such a short time. This indicates a problem with the coil in the magneto and if on an engine, would cause sudden power loss from that magneto after a very short amount of time.

Arguably as concerning as any issue observed is the impulse coupling reliability. Champion's test is designed to constantly cycle the impulse coupling, as a normally operating coupling only operates for a maximum of a few seconds per flight, and therefore the number of hours does not correlate directly to flight hours. However, a structural failure of the hub, whether it is a failure of the post or the typical failure of the stop plate lobes, can result in foreign object debris (FOD) in the accessory case. When all three couplings' performance and the metallurgical compositions are considered, it is believed that the surface hardness of the hub is such that the part is brittle and susceptible to cracking, and therefore breaking. Considering that each coupling failed after only a brief run time, the failures could presumably occur well before the 500 hour inspection requirement and therefore subject the engine to an opportunity for significant damage.

Overall, while the Kelly Aerospace magneto has the same appearance as and similar paint job to a Champion Slick Magneto, the testing performed clearly shows the Kelly product cannot be expected to replicate the quality and performance of the proven Champion Slick Magneto product line.



REVISIONS

<u>ISSUE NUMBER</u>	<u>PARAGRAPH</u>	<u>DATE</u>	<u>APPROVED</u>
1	Original issue	8 July 2022	TLJ
2	Scope: Changed “ATP” to “Acceptance Test Procedure (ATP)” and reworded for clarity	14 July 2022	TLJ

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