An Engineering Approach To A Modern, Redundant Ignition System For Automobile Engines In Experimental Aircraft

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MYTH: Aircraft engines use dual ignition for safety reasons.
FACT: While some safety is realized due to redundancy one truth remains - aircraft engines use dual ignition to this day because they are based on 100 year old engine technology and will not make performance without the two plugs firing per cylinder. Aircraft engines have large displacement, long stroke, low RPM, low compression, and an induction system that rivals Briggs & Stratton designs for efficiency. Without dual spark plugs these engines would have no flame front propagation at all.

MYTH: Dual ignition is required by regulation on aviation engines.
FACT: No such regulation exists and if these engines would operate without any ignition system so much the better. One less possible failure item.

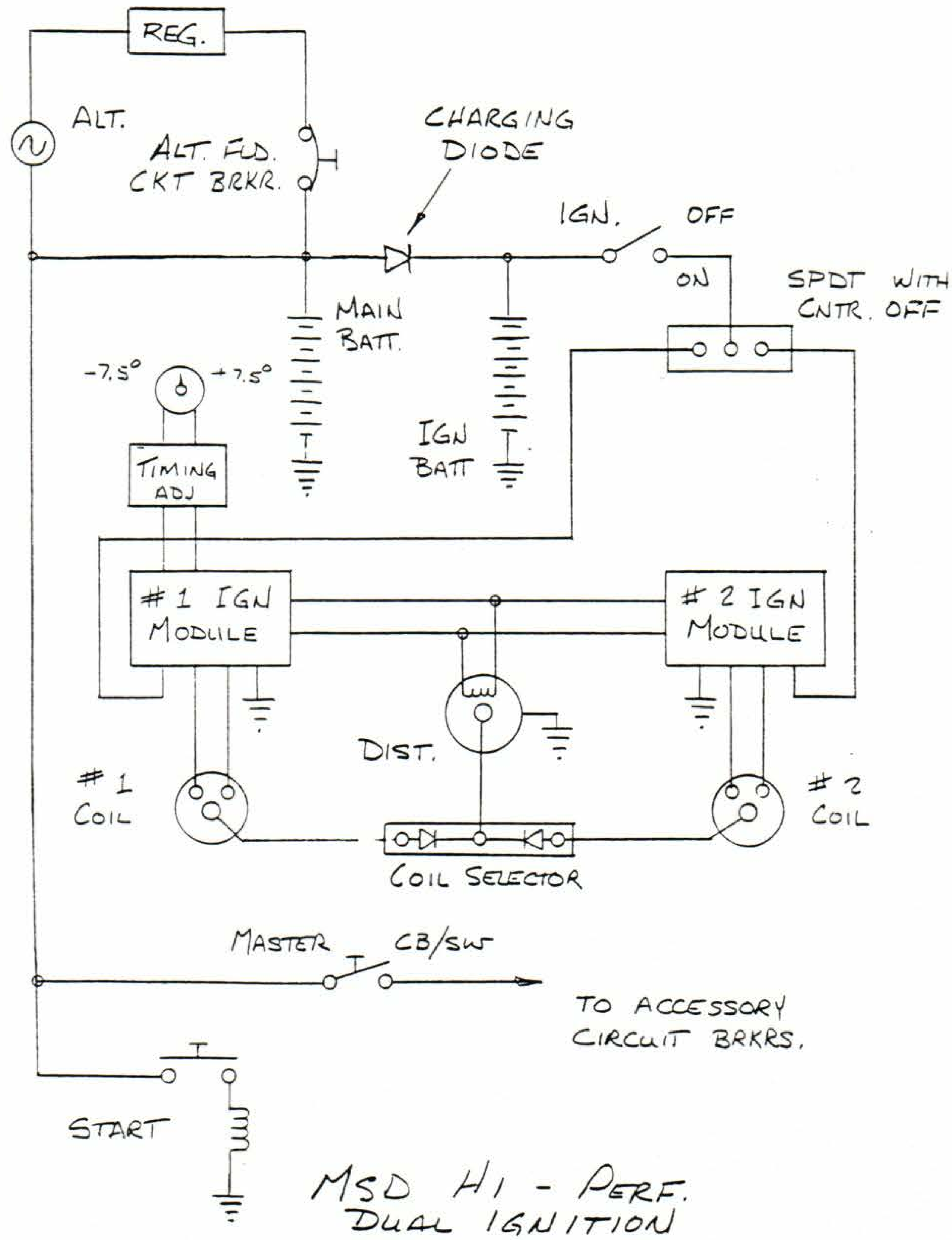
MYTH: Magnetos are used on aircraft engines because of their reliability.
FACT: These engines were certified with magnetos at the time when there was nothing else available; in fact, most aircraft during that time did not have an electrical system at all.

Magnetos have an operational life expectancy of about 1/5 that of modern electronic auto ignition systems. The one thing that magnetos do accomplish is that they do operate independently of the aircraft electrical system. Armed with these facts it becomes evident that if one could have the best of both worlds it would be a high energy ignition system as reliable as the modern electronic auto units and one which would operate independently of the vehicle electrical system.

Figure 1 shows a system comprised of high quality, high performance, proven highly reliable components born of stock car, sprint car, drag strip heritage that will operate independently from the electrical system. This system uses a motorcycle battery dedicated to ignition only that is charged by but isolated from the aircraft electrical system by using a diode. In the event the aircraft electrical system voltage should drop to within .7 volt of that of the ignition battery, the diode will "cut off", thus isolating the two systems. The ignition will continue to operate independently for a length of time depending on the amp-hour rating of the ignition battery.

The only common pieces of hardware in the proposed system are the distributor and magnetic pick-up transducer, both of which have a very, very low failure rate compared to that of magnetos. When have you last heard of an electronic distributor quitting in an auto? As compared to magnetos? When failure does occur it is usually the ignition module that succumbs to vibration, heat, moisture, etc., and we have two of them in this system.

Other features of the system are: dual coils, dual ignition modules, an automatic coil selector, cockpit adjustable timing over a 15 degree range, plus the capability of selecting the back-up ignition system at any time (call it a



MSD HI - PERF.
DUAL IGNITION
FIG 1

"mag check", if you wish).

With this design, failure of an ignition module, coil, or entire electrical system means only that your pride and joy can continue on its merry way for several hours - just like a magneto ignition, totally independent of the electrical system.

Another feature I like is the built-in ability to isolate the complete battery/charging system from the aircraft wiring in case of a catastrophic failure or dead short. The master switch will isolate all accessories and the alternator field can be removed via an instrument panel mounted circuit breaker. Also, the ignition switch as wired will allow the engine to be cranked for maintenance purposes with no spark at the plugs. Don't forget to add a selector switch to your voltmeter circuit so both batteries can be monitored in flight.

Fixed timing magnetos have shortcomings in the area of total aircraft performance. Imagine the MPG possibilities when timing can be optimized at cruise as well as the fuel/air mixture. An additional benefit is the ability to retard the timing in the event that detonation occurs from low octane fuel or exceptionally high outside air temperature. This feature alone can save an engine as it only takes about 10 seconds of detonation at high power outputs to destroy an engine.

The ignition battery and the back-up ignition module are to be just that - back up - and should be flown only long enough to reach your destination or nearby airport so the primary system can be repaired.

COMPONENTS LIST

1. **Primary Battery Automotive, typical 12 v.**
2. **Ignition Battery Motorcycle, 10 ah minimum**
3. **Battery Isolator Std. Automotive**
4. **Ignition Switch Automotive single pole key type**
5. **Start Push Button Std. Automotive**
6. **Start Relay Std. Automotive**
7. **Master - Circuit Breaker Switch with current rating as required by accessories**
8. **Alternator Field Circuit Breaker push/pull style with current rating as required by alternator field**
9. **Ignition Select Switch - Std SPDT / 1 amp DC**
10. **Coil Selector - MSD P/N 8210 $38.00**
11. **Distributor - As required for engine. Distributor can be sent to MSD, El Paso, TX, and they will rebuild it and install magnetic pick-up and reluctor $65-$80**
12. **Coils - MSD P/N 8203 $40.00/ea**
13. **Ignition Modules P/N MSD 6200 $115.00/ea**
14. **Adjustable Timing Module (if desired) MSD P/N 8680 $109.00**

Mazda Rotary Powered Super Cuby

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Engine: 1985 RX-7 Mazda 12A with 25,000 miles with welded aluminum plate intake manifold. The fuel is fed by a 1962 GMC V/6 pickup carburetor chosen for its compactness. The exhaust header is welded steel tubing, doubled for the first few inches.

Reduction Drive: The belt reduction drive I came up with can be applied to most any automobile engine. Here are the basic steps: Save the existing bell housing, transmission, and clutch disk from the wrecked vehicle or from one matching the engine. Disassemble the transmission and save the front main shaft and enough of the tranny case to have the front bearing mount and bearing retainer. Saw off and discard the rest. Take the bearing to an auto parts or industrial supply store and buy a sealed bearing with the same dimensions.

Install drive sprocket on the transmission main shaft, bolt clutch disk to flywheel and assemble bell housing shaft and transmission front face to engine. Install two plates for mounting propeller drive shaft to bell housing and to transmission piece. Cut window in the bell housing for belt to pass through. Install propeller drive shaft with self aligning bearings and the driven pulley.

Cooling: The only problems I have encountered thus far has been in the area of cooling. This has been solved with a 15x31x1.5 inch aluminum coolant radiator from a GM car and a 4x8x12 oil cooler that was originally a Ford pickup air conditioning evaporator.

Pluses and Minuses: The advantage of this reduction system is that you have a lot of the machining work done for you by the auto maker. Everything except the driven shaft is in perfect alignment with the crankshaft (drilled, doweled, etc.) The main disadvantage is that this unit probably could be lighter. I have not made a weight analysis comparing this setup to commercial belt reduction units (Blanton, Meyers, etc.).

Flying Auto Power: The engine is in my Super Cuby airplane built from Wag-Aero plans and a set of used wings from an early Piper PA-18 (no flaps). I now have over 20 hours on it and have had absolutely no problems with the drive unit. The installation is extremely smooth and so quiet that you can hear the electric fuel pump when idling, using a Swiss muffler as per Tony Bengelis' book.

With a 80 inch diameter, 50 inch pitch wood propeller I get 90 miles per hour indicated at 5500 engine RPM (2060 at the prop). I am still experimenting with props and am in the process of building an 84x48 next. Climb rate has not