LUCAS MAGNETOS

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THE MOST CURSED AND LEAST UNDERSTOOD PART OF A BRITISH MOTORCYCLE!

The primary advantage of a magneto is that it works independently of a battery. In fact you don't really don't even need a battery. Magnetos act as a generator and create their own low or primary voltage, then act as a spark coil and transform the low voltage into high voltage (around 20,000 volts). The faster they spin, the more voltage they put out.

Almost everybody has probably heard of the "reverse Polish logic" used in early LED calculators. I think Lucas engineers used reverse British logic in the design of the mag as it's designed backwards from conventional wisdom. Most mags, aircraft and tractor, have a stationary coil and a rotating magnet. Lucas, on the other hand, have a rotating coil and a stationery magnet (except for limited production SR series). The main advantage to this design is a smaller and more compact package.

Around fifteen years ago I got serious about

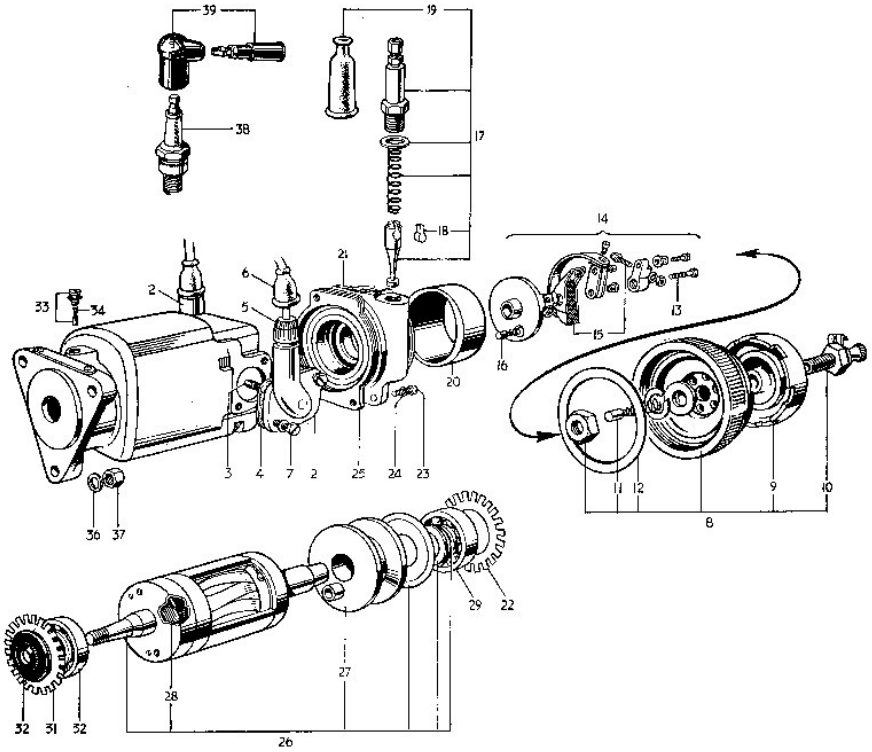

FIG. 35 MAGNETO WITH MANUAL CONTROL

working on Lucas magnetos out of necessity. After finishing the restoration on my Vincent, I found that I couldn't get the darn thing started. It would fire on one cylinder but not on the other. I would take out both plugs, kick the engine over, and both plugs would spark (more on this later). After doing the Phil Irving aerobic work out for several days I finally convinced myself of the obvious. There must be something wrong with the mag.

Vincent mags are a special problem due to the V-twin configuration. Magnetic fields have a north pole and a south pole, and they're 180 degrees apart. This works great for vertical twins such as Triumph because the magneto is supposed to fire every 180 degrees (or 360 degrees of crankshaft rotation). It is important to note that the points should open just as the magnetism induced in the armature is changing polarity and the magnetic field is collapsing. But this situation is complicated as the Vincent is a V-twin and only one plug (rear cyl.) gets an optimum spark. Because the second plug fires 25 degrees after the optimum point of field collapse the other (front cyl.) gets a mediocre spark. My mag had degraded to the point that one plug was getting a weak spark, and the other was getting a VERY weak spark.

Among other things, there are three main sources of problems with every Lucas mag in existence today-

(1) Leaky capacitor. This is the #1 cause for magneto failures. In the case of a magneto the capacitor stores voltage that is created by the collapsing magnetic field in the armature. In doing so, it also prevents the points from arcing or burning when they open. In order for a capacitor to do its job, it must be able to take on an electrical charge and hold it. A leaky capacitor cannot take a charge because the charge is dissipated as quickly as it accumulates. I can guarantee <u>every</u> British motorcycle powered by a magneto is either not delivering maximum spark and/or is on the verge of failing if the original Lucas capacitor has not been replaced. All capacitors made in that era were made with (waxed) paper dialectric, and they will degrade with age.

Lucas (and most other) capacitors made in the 50's & 60's used a paper dielectric. Remember back in the old days when you did a tune-up on your '57 Chev. (or was it a '65 MGB)? Any time you replaced the points, you automatically replaced the condenser.

I've tested NOS Lucas capacitors right off the shelf that are leaky. It's humorous seeing new Lucas capacitors advertised in catalogs at prices that approach $75 ea. Due to the above mentioned characteristics, an original Lucas capacitor is the <u>last</u> thing you want to use. So where is do you get one, Radio Shack? No. Due to the high pulse currents encountered with ignition circuits, special capacitors

must be used. (For engineers, the dV/dt rating should be >1500 and the DF <.05%) Capacitors obtained through commercial sources are usually metalized polyester and will fail.

Eventually all pre-70's Lucas capacitors become leaky. With time and age, the capacitor goes through a metamorphosis- first turning into a resistor, and finally into a conductor, i.e., dead short. That mag that worked great twenty years ago when the bike was parked now emits only a small spark. I've heard people say their mag will shock the crap out of you so it must be good. Wrong! House voltage (110 volts) will shock the crap out of you, and even kill you, but it certainly will NOT spark your spark plug.

But I must urge caution here. The condenser is located deep within the bowels of the armature, and to replace it is almost a surgical procedure. Careless handling will do some expensive damage to the slip ring, especially if the safety gap screws are not removed before the armature is removed. But that's only half the battle. Even if you did remember to remove the safety gap screws you will still get another chance to break the slip ring when you attempt to remove it from the armature. It's made of bakelite (plastic) and is VERY brittle. It's not unusual for it to become "glued" to the armature shaft due to corrosion of the brass. And there are usually other problems that must be attended to such as truing the slip ring and grounding surface in a lathe. So, unless you know what you are doing. or have a good stock of Lucas spares, it is better to trust someone who is more knowledgeable in this field. You can easily end up spending more by doing it yourself and still not have a really good mag.

(2) Loss of magnetism. The primary enemies of a permanent magnet are heat and shock (from vibes) and of course, age. I've tested the primary AC voltage in mags before and after magnetizing and have found an increase of around 10% to 20%. This means a comparable increase in secondary voltage. Not surprising considering most mags are around 35-50 years old.

(3) Armature failure- Either by breakdown of insulation, i.e. high voltage arcing to ground, or open secondary. The first sign of trouble is difficult starting when hot. The secondary insulation can be tested with a "megger" to check the insulation resistance. The armature should be stripped and primary hot and ground wires disconnected from the capacitor. Ideally it should be above 1000 megohms, and anything below 20 megohms indicates impending failure. Also, the secondary winding should be checked for continuity with an ohm meter. A resistance of around 5K ohms indicates a good winding.

I've seen mags taken off a running motorcycle that tested "open". (Starts okay when cold, but not when hot.) So why did the bike run?? The secondary is wound with a very fine wire about the thickness of a human hair. As a matter of fact, about one mile of it. If an open circuit develops in the secondary the high voltage can and will jump the gap, and the bike continues to run. Slowly but surely the ends of the fine wire melt and the gap gets bigger and bigger. This arcing inside the secondary will also leave a carbon track to assist the jumping of the spark. While the carbon track is not a perfect conductor, it's good enough to conduct the high voltage spark when the mag is cold. After it heats up, the bike misfires. Let it cool down and it will start okay. Then the cycle repeats itself.

But here's the bottom line. It's really false economy to use an old armature on a bike you are restoring or are going to ride any distance from home. The magnet wire used back then was insulated with a lacquer varnish. Magnet wire used today has a better polyurethane varnish insulation, and has a higher dielectric strength. Due to the high incidence of armature failures that I've found, I always recommend rewinding the armature. Or, don't ride your bike any farther from home than you would want to push it. And for the above reasons, I would certainly not trust an NOS armature.

Although highly unlikely, the pick-ups can be another problem area. One chap told me his bike was cutting out at high speed (5000+ rpm). Yeah, it was a little temperamental to start but seemed to run okay at cruising speed (3500 rpm). He was convinced his problem was carburetor so he overhauled them. No luck. He checked about everything he could think of, but still no luck. He sent me his mag and I put it on my test stand and ran it up to 1750 rpm. (Which simulates an engine cruising speed of 3400 rpm.) It seemed to be working okay, or at least had no obvious problems. After I overhauled and remagnetized it, I put it back on the test stand again at 1750 rpm. Presto, the problem was now obvious. The high voltage was arcing through the pickup to ground. Now that the mag was overhauled it was putting out enough voltage to jump through the pickup to ground at 1700 rpm. There was no obvious damage to the pickup that could be detected with the naked eye, but all it takes is a tiny pin hole. It's not unusual to find leakage points along the mold lines of the plastic pickups even at low speed.

High compression can be another problem with an old mag. The plug will fire when removed and the engine kicked over, but won't fire when put it back into the engine. Why? Because as the pressure is increased, higher voltage is required to jump the gap. Ergo, a magneto that might work on an engine with 7:1 compression might not work on an engine with 12:1 compression. The next step is to reduce the spark plug gap until the engine starts. I've been through the same scenario myself many years ago. First you reduce the gap to .015", and the bike starts. Then next year it's necessary to reduce it to .012" and it runs again. But how long can you keep reducing the plug gap? Another approach would be to use a plug with a small diameter center electrode such as Bosch platinum. A small diameter electrode will spark with a lower voltage, but will not give as hot a spark.

If you're old enough you might remember the Champion spark plug testing machines at your local filling station. Here is a good example of the relationship of plug voltage vs. chamber pressure. A spark plug was placed into the tester and a high voltage wire attached. You increased the air pressure to the spark chamber to see how much pressure was required to extinguish the spark. Back then, you didn't just replace your plugs at given mileage intervals. If a spark plug failed, you identify the ailing plug and replaced it. Why replace the rest of them if they are still working? Right? Eventually Champion finally got smart and stopped making plug testers as they surely affected plug sales.

To have a mag expertly overhauled is not cheap., but to replace Lucas parts that you screw up trying to DIY is not cheap either. If you don't have the special tools or expertise to do it yourself, trust it to someone who does.