

CONTINENTAL® IGNITION SYSTEMS



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Continental Motors, Inc.

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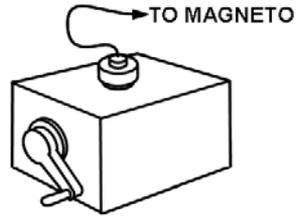
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DISCLAIMER

Information contained in this document is for reference only, not representative of any particular Continental Motors ignition system. Consult the appropriate ignition system service manual for application-specific magneto service and troubleshooting instructions.

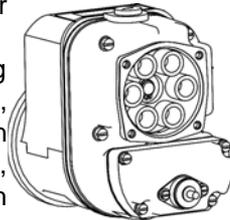
A. Introduction

An early engine starting aid was the hand-cranked “booster magneto” many folks working in the aviation industry may never have heard of one. It connected to the aircraft magneto circuit during a hand-prop start. By turning the crank handle at the same time as the propeller, a stream of high voltage was emitted into the distributor section of the magneto. While the booster magneto was functional, it required at least two people to start the engine. Impulse couplings and vibrator type starting “booster” circuits replaced the function of the external booster magneto.



BOOSTER MAGNETO

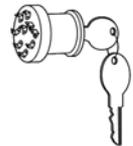
The vibrator (shower-of-sparks) starting booster circuit, widely used on aircraft engines, is supplied with certain Continental



MAGNETO



VIBRATOR



SWITCH

Motors S-200, S-1200 and D-3200 series ignition systems.

B. About Impulse Couplings

Impulse couplings have been used for many years on internal combustion engines. The purpose of the impulse coupling is:

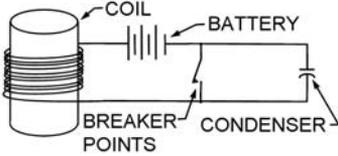
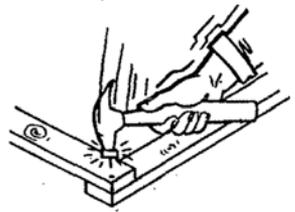
1. To “SNAP” the magneto through its firing position at a faster than normal rate of speed, to produce a strong spark even at slower engine cranking speeds.
2. To postpone or delay the “SNAP” until the piston nears top center in the cylinder so ignition is retarded, or delayed to prevent a “kickback.”

When the engine starts, the impulse feature disengages, and the impulse coupling functions as a plain drive member as long as the engine is running. Impulse coupling flyweights may become magnetized, which prevents the stop-pins from engaging properly. When this occurs, the impulse coupling must be serviced (degaussed). Cold weather may also prevent the impulse couplings from engaging when congealed oil dampens the flyweight's “snap” function.

Impulse couplings produce only one spark for each cylinder firing cycle. Under certain starting conditions, a "Shower of Sparks" ignition may be more desirable.

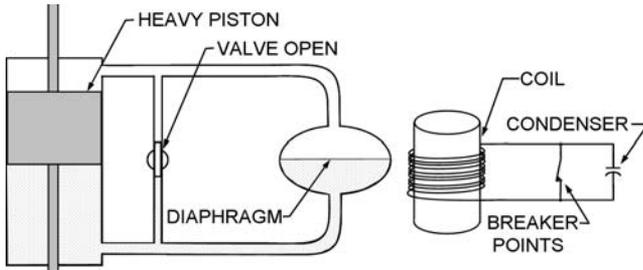
C. The Most Mysterious Part of an Airplane?

The high voltage spark in a magneto ignition system is produced by applying the same principle that makes a half pound hammer strike a nail with a 200 lb. force. Momentum builds through the swing of the hammer until it contacts the nail head.

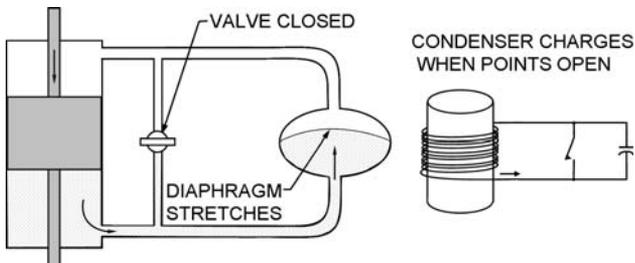


In the ignition system, we build up current in the coil and then stop it by opening a set of breaker points. In an automobile, current is provided by the battery. In a magneto, the current is developed in the coil by a rotating magnet. The principle is the same in either case.

A good analogy of this principle is the action of a heavy piston in a cylinder filled with hydraulic fluid.

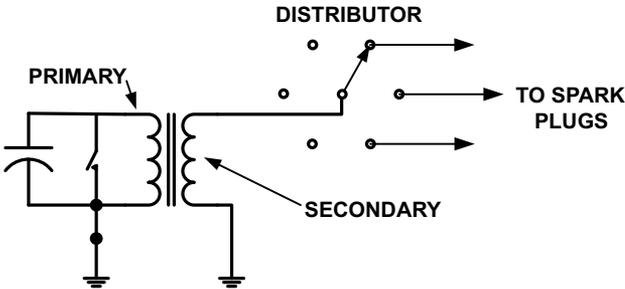


Start the heavy piston down the cylinder and slam the valve shut. The piston wants to keep moving and the pressure built up would burst the valve if the fluid did not have another path to travel into the box containing the rubber diaphragm. The momentum of the piston is converted into a force which bends the diaphragm upward.



In the ignition system, we use this same principle to generate a surge or “kick” of electrical force (current) across the coil. The current in the coil wants to keep flowing so it builds up voltage across the ends of the coil.

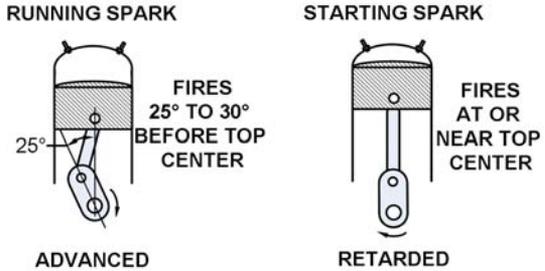
If not for the condenser, the voltage could burn the breaker points when they open. The built up voltage surge can be amplified by adding a transformer to the circuit. On Continental Motors magnetos, the voltage is amplified in the magneto and distributed as high voltage.



D. Engine Ignition Theory of Operation

A piston engine has to be cranked-it can't start itself like an electric motor. Because the starter turns the crankshaft at fewer revolutions per minute (RPM) than normal engine operation, the lower

RPM may not turn the magneto fast enough to generate a spark to ignite the fuel in the combustion chamber. That's why impulse couplings or vibrators are used.

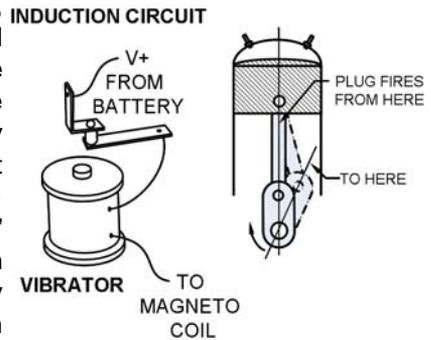


Ignition timing must be advanced to get maximum power output from a combustion engine at high RPM. If we try to start the engine with advanced ignition timing, combustion occurs too early and the engine kicks back and fails to start. Starting ignition can be improved by retarding (delaying) ignition timing until the piston is close to the top of the

cylinder on the compression stroke. If ignition occurs too late, the engine won't develop momentum after ignition.

Both starting and running spark timing has to be synchronized to the engine crankshaft/piston position. For best results, retarded starting spark occurs when cylinder pressure is highest, requiring higher voltage.

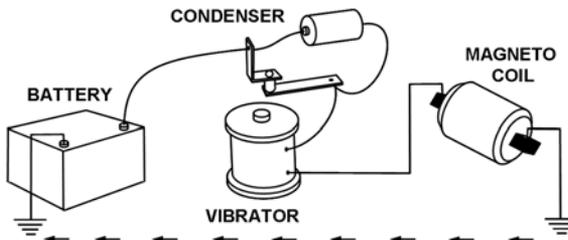
In cold weather the battery, engine oil and fuel are all adversely affected. Engine friction increases, fuel is more difficult to ignite, and the battery has less power...right when it needs the most. Under these conditions, a single "one-shot" type of spark delivered by an impulse coupling magneto may not be enough to ignite a lean fuel mixture in a cold cylinder.



By starting at top center, and throwing a continuous stream, or "shower" of sparks across the spark plug, we increase the likelihood of igniting the fuel mixture in the cylinder. The induction vibrator does exactly this. It is a special form of buzzer which provides about 200 sparking pulses per second!

E. Circuit Theory

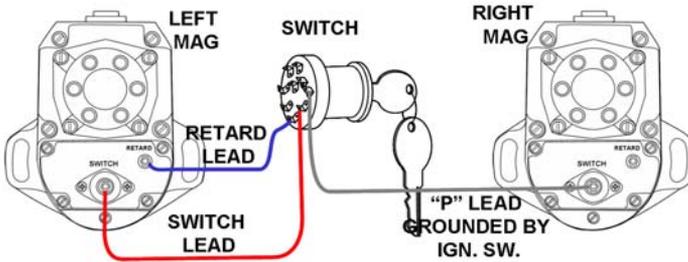
To keep it simple, here's how the vibrator does its job: Current flows from the battery to the vibrator coil and contacts and on to the magneto coil, completing its return circuit through the engine and airplane ground.



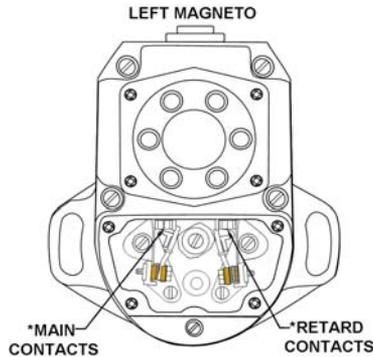
This does two things:

- sets up a current in the magneto coil.
- magnetizes the core of the vibrator coil, which pulls the vibrator contacts apart.

When the vibrator contacts break the circuit, the current is brought to a sudden stop, producing the required voltage surge in the magneto coil for ignition purposes. The condenser prevents excessive arcing of the vibrator contacts. In most systems only one magneto is boosted for starting. The second magneto is automatically grounded to prevent possible advance ignition and engine “kick-back.”



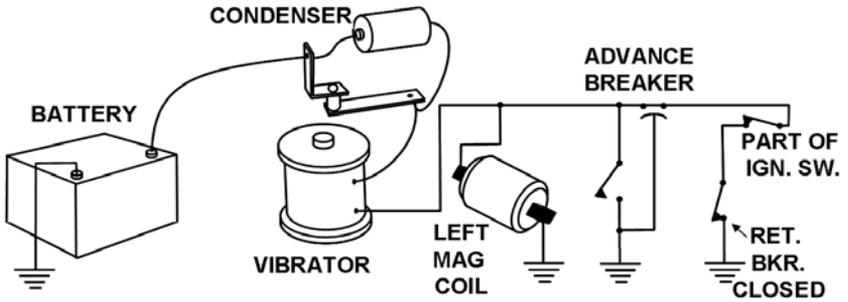
To get a retarded or late spark for starting, the LEFT magneto is assembled with two contact assemblies in it. The “ADVANCE” or “MAIN” contacts are synchronized to the crankshaft timing mark before piston top dead center. The “RETARD” or “START” contacts open a few degrees after the “ADVANCE” or “MAIN” contacts open, depending on engine requirements.



NOTE: *MAIN AND RETARD BREAKERS MAY BE REVERSED DUE TO MAGNETO ROTATION.

The ignition switch connects the retard contacts and the main contacts together during starting. As long as either contact is closed, the magneto coil will be short-circuited to ground and cannot produce ignition voltage. Thus the vibrator cannot produce a spark until the retard contacts open.

When the engine starts, the spring loaded ignition switch is released to the "BOTH" position. This disconnects the retard contacts, vibrator and starter from the circuit, and removes the ground from the RIGHT magneto.



F. Circuit Analysis

1. Figure 1 represents a magneto circuit with the engine not running and all switches in the OFF position. As the illustration points out, each magneto "SWITCH" input is connected to ground through the ignition switch.

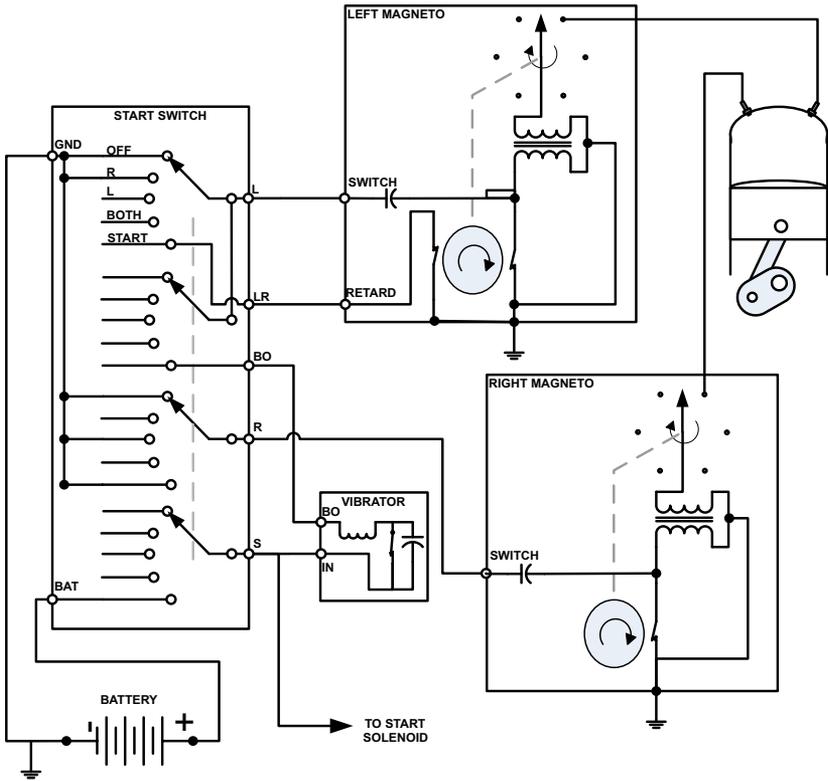


Figure 1. Magneto Circuit OFF

2. Turn the ignition switch to the "START" (Figure 2) position. Lines in the illustrations indicate the circuit path.
 - a. The starter solenoid energizes, engages the starter and turns the crankshaft.
 - b. Vibrator pulses flow to both contacts in the "L" magneto but are shorted to ground.
 - c. The "R" magneto is grounded through the ignition switch.

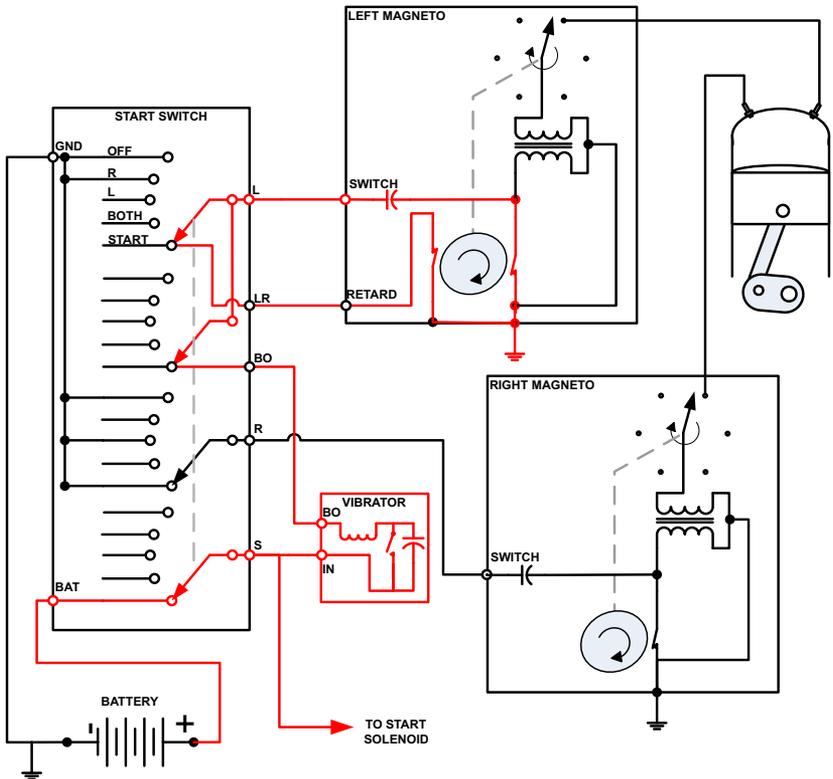


Figure 2. Vibrator Energized

3. When the crankshaft reaches the full advance position, the advance contacts in the "L" magneto open but the closed retard contacts short the vibrator current to ground. The "R" magneto is grounded through the ignition switch so no spark reaches either spark plug.

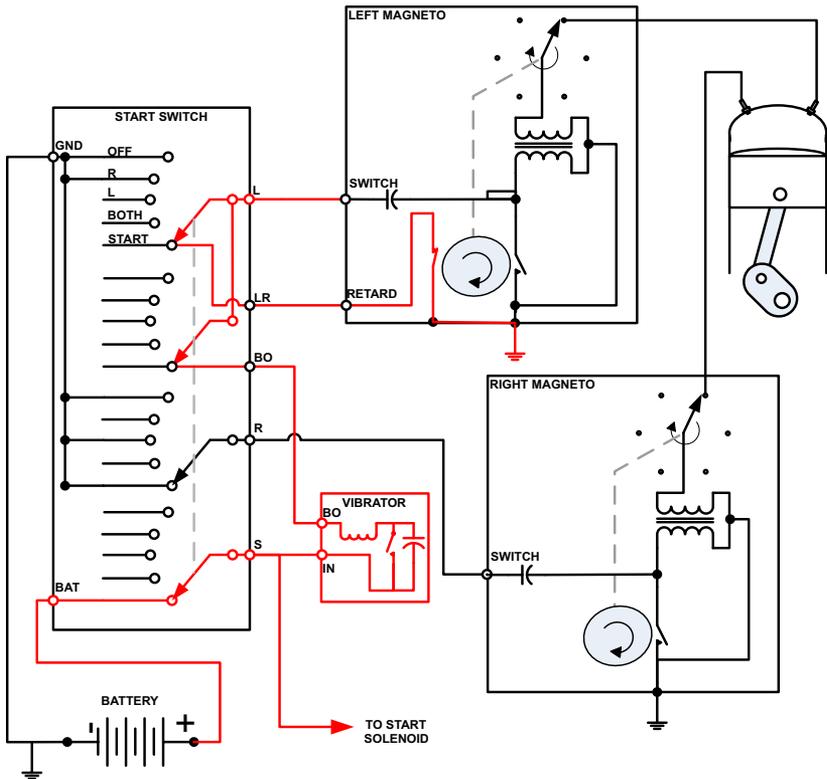


Figure 3. Advance Contacts Open

- When the crankshaft reaches the piston TOP CENTER position in Figure 4, the retard contacts open and remove the ground from both contacts. Vibrator pulses pass through the primary winding of the "L" magneto and induce high voltage in the secondary winding. The high voltage transmits through the distributor to the spark plug. The left magneto will continue to supply retard spark as long as the switch remains in the "START" position.

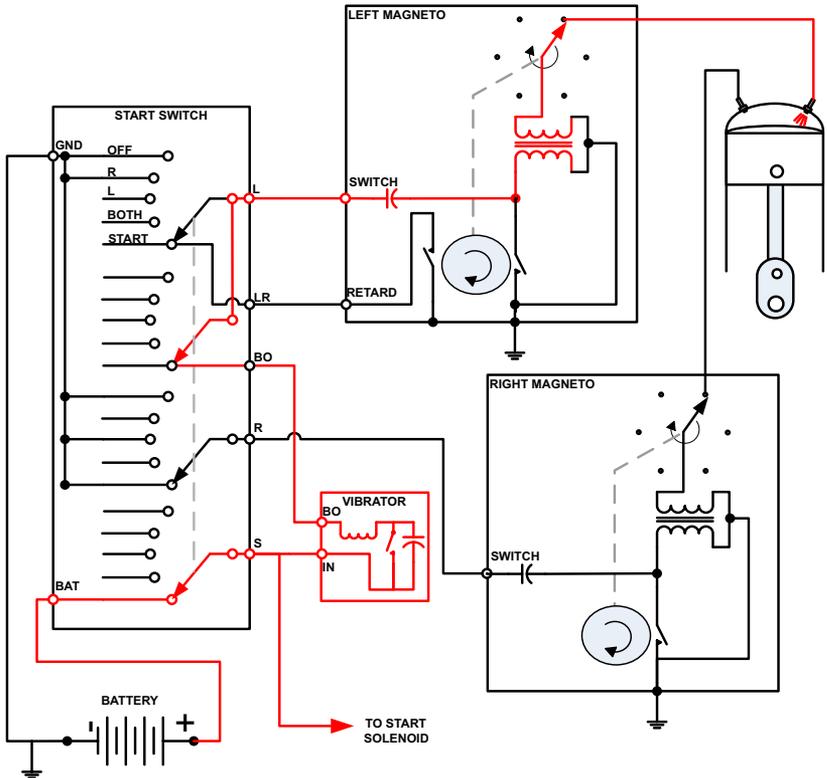


Figure 4. Both Contacts Open

5. Release the ignition switch to the "BOTH" position (Figure 5) and the circuit changes to normal operation.
 - a. Magneto fire at specified ignition position.
 - b. The vibrator and starter are disconnected.
 - c. Both spark plugs fire during ignition.

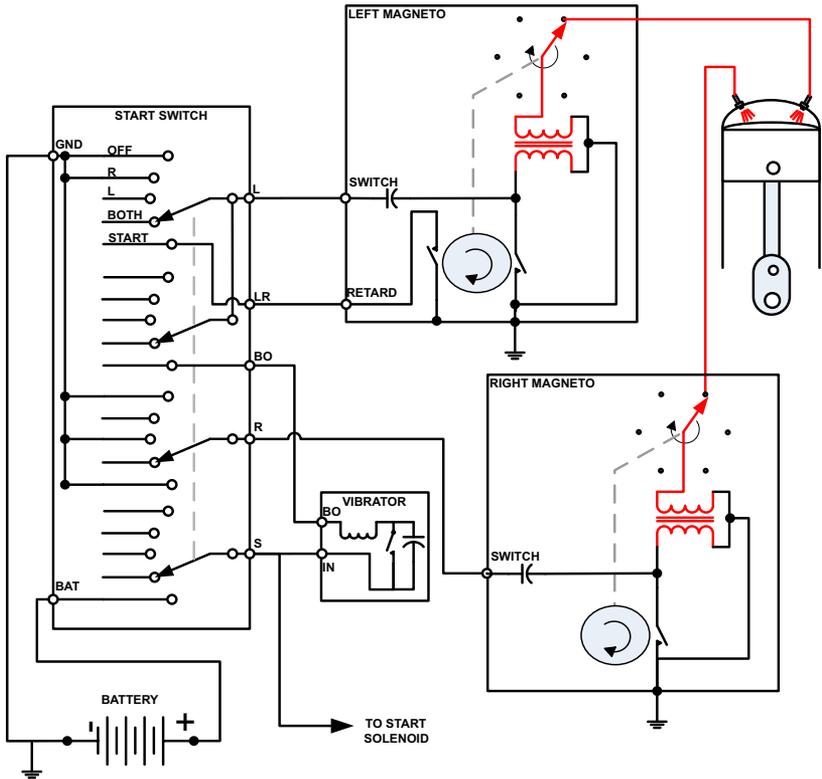


Figure 5. Normal Operation

G. At the Maintenance Hangar

General Troubleshooting

If you have an engine ignition problem, remember: the vibrator can't do its job unless:

1. It has enough input voltage.
2. The retard and advance contacts are BOTH correctly timed.
3. The magnetos are correctly timed to the engine.
4. The vibrator is correctly adjusted internally.

Refer to the airframe maintenance manual; trace the circuit feeding the vibrator battery current. Several components such as circuit breakers, switches, and intermediate connections, etc. could reduce the input voltage. Unless you have good clean connections through the circuit, current may not reach the magneto.

Listen to the vibrator buzz while cranking the engine. The tone should change as the magneto breaker points open and close. If no buzzing is heard, check the voltage at the "IN" terminal of the vibrator while cranking. Minimum voltage must be at least 8V on 12V systems or 13V on 24 V systems. If the tone doesn't change, check the magneto wiring and the contact springs in the magneto breaker cover.

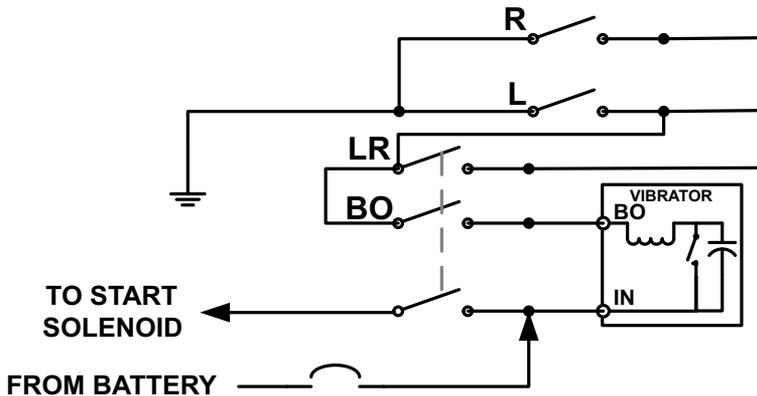
More on Troubleshooting

If the RETARD contacts don't open, you'll get no spark...and no start! If the RETARD contacts don't close, you'll be cranking with a fully advanced, boosted spark and may experience kick-back; this may also result if the RETARD contacts wiring is broken, or RETARD circuit connections are loose or damaged. If the RETARD contacts open too late, the engine may fire but not develop the momentum to run. Check ignition timing!

If the ADVANCE contact wiring is broken or circuit connections are faulty the magneto will be permanently "HOT"; vibrator current will have no path to the magneto. The tip-off to this condition is the sound from the vibrator: instead of changing tone the vibrator will stop and start as the engine is cranked. It is a good idea to inspect both ADVANCE and RETARD magneto connections when difficulty is experienced. If you can't feel the terminal, compress the contact spring in the S-200 or D-3000 magneto slightly; you may not be getting good contact. Look at the contact springs in the magneto with a flashlight; dirty or burned contacts may be the cause.

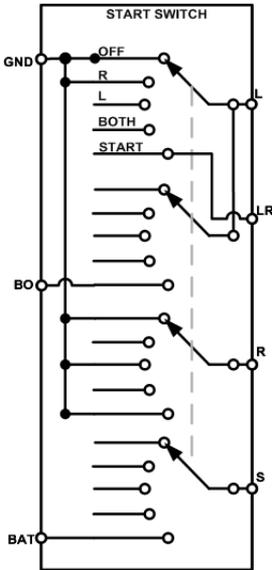
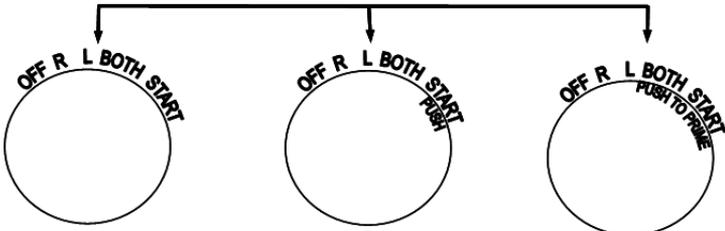
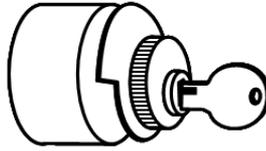
H. Airframe Circuits Variations

The circuit depicted below is common, but variations exist. On some dual engine airframes, the “IN” terminal of the vibrator connects directly to the battery bus (usually through a circuit breaker) to allow the same vibrator to serve both engines with the advantage of providing full battery power to the vibrator without the increased resistance of complex wiring circuits.

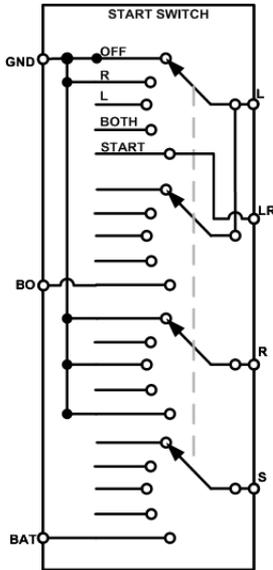


Some switches feature a spring loaded start function while others are designed with a “PUSH-TO-START” feature. Many combinations are available, limited only by the demand for possible start and run combinations.

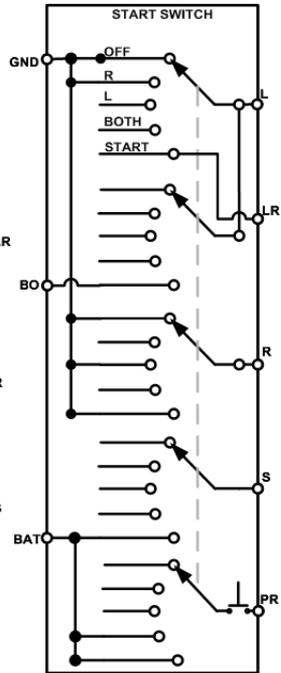
Some switches feature a spring loaded start function while others are designed with a “PUSH-TO-START” feature. Many combinations are available, limited only by the demand for possible start and run combinations.



**ROTARY SWITCH
TWIST TO START**



**ROTARY SWITCH
PUSH TO START**



**ROTARY SWITCH
PUSH TO PRIME**

I. Ignition Switch and Starting Vibrator Reference

Ignition and Starting Switches		
Part Number	Description	
10-357200-1	Key, Twist/Start	
10-357210-1	Key, Push/Start	
10-357230-1	Lever, Twist/Start	
10-357240-1	Lever, Push/Start	
10-357250-1	Lever, Twist to Start/Push to Prime	
10-357290-1	Key, No Start	
10-400185-1	Lever, No Start	
Starting Vibrators		
Part Number	Description	Used with Ignition System
10-176487-121	12VDC	S-200
10-357487-241	24VDC	S-200
10-176487-122	12VDC	S-1200
10-357487-242	24VDC	S-1200
10-382775-12	12VDC	D-2200, D-3200
10-382808-24	24VDC	D-2200, D-3200
10-400608-121	12VDC W/Relay	S-200
10-400608-241	24VDC W/Relay	S-200
10-400608-122	12VDC W/Relay	S-1200
10-400608-242	24VDC W/Relay ¹	S-1200
10-400608-123	12VDC W/Relay ¹	D-2200, D-3200
10-400608-243	24VDC W/Relay ¹	D-2200, D-3200
<p>NOTE: Not a comprehensive parts list. Consult airframe manufacturer's parts catalog for ignition switch and starting vibrator application.</p>		

1. When using other than combined Continental Motors ignition and starting switches, use starting vibrator with relay. Consult airframe parts catalog for ignition switch and starting vibrator application.

