100 / 120 HP IFB Service Manual

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1. General Description

The 100/120 HP Spyder IFB is a six cylinder opposed engine that is based on the 1965-1969 Chevrolet Corvair. This is an air cooled engine designed to develop 100 /120 HP at 3200 RPM. The displacement is 164 cu.in. or 2700 cc for the 100 HP or 188cu.in. or 3.1L for the 120 HP version.

The engine has two opposing aluminum cylinder heads, each containing three combustion chambers. The overhead valves use rocker arms and pushrods running off a single camshaft in the lower end of the case. Hydraulic lifters make the adjustment of valve lash unnecessary. The case is made of two halves split vertically with the crankshaft and camshaft supported by four main bearing surfaces. The accessory housing in the rear contains the oil pump and distributor. The oil pump draws oil from the oil pan located under the case and lubricates the engine through the accessory housing and two oil galleries located in the case halves. Filtration of the oil is provided with an externally mounted oil filter and hoses. Some models may have an integral oil filter. Cooling of the oil is likewise accomplished through a set of hoses from the left rear to an external cooler. Different aircraft applications will require different cooler designs and installations. The IFB model engines have an "integral front bearing" that adds an extra bearing to support the propeller and also moves the thrust loads to the front of the engine. Basic Specification and Serial Number information of your particular engine is stamped on the data plate on the top engine cover. This engine is considered "experimental" in design and use and as such carried no warranty and liability is assumed to be the responsibility of the aircraft builder and PIC.

2. Specifications

These are basic specifications. Check your data plate for current data on your engine.

Engine Model	100 IFB /120
Horsepower and Torque * actual at prop will be 15% lower than tested	100 HP @ 3200 RPM / 160 ft/lbs torque 120 HP @ 3200 RPM / 190 ft/lbs torque
Compression Ratio / PSI	9:1 / 120-145 psi
Ignition Timing	30 - 32 BTDC (Maximum Advance)
Valve adjustment	Hydraulic (¾ turn from Zero lash)
Maximum Oil Temp	260 F. (220 F normal)
Maximum Cylinder Head Temp	425 F. (265-350 cruise)
Oil Pressure Range	15 psi (min - idle) 45 psi (maximum)
Spark Plugs	AC 44F - copper gaskets
Spark Plug Gap	.035”
Points Gap	.019 (new) .016 (service)
Oil	Rotella T / Shaeffer 15W40 or equivalent (summer) 10W30 or equivalent (winter)
Oil Quantity	4 quarts min – 6.0 maximum (average)
Charging System	12 Volt / 32 amp Internally regulated
Fuel	Aviation 100LL or 93Non-alcohol mix
Weight	215 lbs - 225 lbs (average)

Bore and Stroke	(100) 3.44” / 2.94” (120) 3.50”/3.25”
Pistons	Forged Std + .040 Oversize / .060 Custom
Rings	Hastings Chrome rings +.040 / Custom
Bearings	Clevite
Camshaft	LS1 / OT10 / OT20
Lifters	Hydraulic Sealed Power
Valves and grind	Stainless and three angle grind
Springs	New Stock

(Engine Specifications continued…..)

Engine Hardware Torques

Case Main Bolts	55 ft. lbs. (in stages) (see build manual)
Rod Bolts	28 ft. lbs.
Head Nuts	30 ft lbs. (in stages) (see build manual)
Front Cover Bolts	20 ft lbs.
Accessory Housing	13 ft lbs.
Oil Pickup Bolt	12 ft lbs.
Oil Pan bolts	100 inch lbs.
Rear Puck Alternator bolt	50 ft. lbs.
Top Cover Bolts	100 inch lbs.
Starter/Alt Brackets	12 ft lbs.
Valve Cover Bolts	60 inch lbs.
Ring Gear Adapter Bolts	20 ft. lbs.
Spark Plug	10 ft. lbs.
Oil Drain Plug	20 ft. lbs. (safety wire)
Exhaust Nuts	25 ft. lbs.

Propeller and Hub

Warp Drive Propellers	3/8” Bolts - 400 inch lbs.
	1/4” Bolts - 120 inch lbs.
Propeller Bolts - wooden	(see propeller manu. Recommendations)

3. Break-In Procedures (or first test run)

If the engine has been run at the factory, it will come with a tag and/or pertinent information concerning this procedure.

The initial installation and break-in of the engine is one of the most important aspects of guaranteeing a good running engine and increased longevity. Remember that these procedures are guidelines and should be modified to meet your individual installation or needs. Refer to other chapters in this Manual for clarity and more information.

1. Propeller must be installed and torqued to manufacture's specifications.

- We recommend that the propeller be "indexed". Indexing refers to the position of the propeller relative to the crankshaft. Proper indexing helps alleviate some of the stresses on the crankshaft due to combustion and propeller forces. When the timing is set at TDC #1 the propeller should be as close as possible to the 9 o'clock and 3 o'clock position. #1 piston is at the rear of the engine near the distributor. #6 Piston is the closest to the propeller. The goal is to have the propeller as close to vertical when the #6 piston is at TDC.
- Check the propeller for run-out. Maximum run-out of a wood propeller is typically 1/8" at the tip. Use a stationary item such as a chair to mark the tip of the propeller. Rotate the propeller 180 degrees and check if the opposite tip is within 1/8" of the mark. If not, check torques, interference in the spinner plates or a faulty propeller.
- ALWAYS TREAT THE PROPELLER AS "ALIVE" - The propeller is extremely dangerous and can cause bodily harm or death. Respect it.
- If you are using a non-standard propeller consider the pitch to be able to attain 2750-2950 RPM at static. Once everything is tuned in you should be able to attain this RPM at the correct pitch. A typical pitch on a Warp Drive propeller 64" long is 6.5-7.5 degrees at the tip using the tool provided by Warp Drive. A Sensenich wood propeller may have 54" of pitch for a 54" long prop but only 34" of pitch on a 72" prop. Find out what has worked well for others to be able to determine what setup you need.

2. Check fuel system for the following:

- Correct fuel flow - The 100HP engine will require about 8 gal/hr maximum fuel delivery. The FAA requires that the carburetor receive 150% of maximum fuel at nose high attitude. Disconnect the fuel line from the carburetor and with the tail low check fuel flow. You should have over 14 gal. /hour from either your gravity feed or fuel pump system with reserve fuel only in the main tank.
- Fuel System: Follow Standard practices for fuel systems. Check all connections and controls for proper torques and security.
- Controls: Check for proper control movements on throttle and mixture.
- Be sure to have a fire extinguisher nearby for test period.
- Use the fuel you will fly with normally for your break-in.
- See *Fuel Systems* for further information

3. Check Oil system for the following:

- All hoses properly made, cleaned and inspected.
- Security of lines, adapters and cooler.
- **Factory run engines are shipped *<u>without oil.</u>***
- If the engine has never been pre-run, use a pre-oil tool to pre-lubricate the engine and lubrication system. Contact maker about borrowing a pre-oil tool or make one using a distributor shaft and housing. Attach the shaft to an electric drill and insert into the accessory housing (remove distributor first)(See Fig below). Run clockwise for several minutes while rotating the propeller occasionally. Done properly this will set the lifters and clean the bearings before the first run. It will also verify your gauges and help find any leaks.

- Adequate air for cooling the oil cooler.
- Oil Quantity : 5 quarts min - check dipstick - Fill oil pan with 4 quarts of oil with aircraft in normal "ramp" position and note level on the dipstick. Mark it if necessary. This is your "LOW" mark. Add 1 to 1.5 more quarts and mark the dipstick. This is your "FULL" mark. Marks will be in different locations depending on angle of the engine due to different airframe configurations.
- See *Cooling System* for further information

4. Ignition system
- Check the firing order and installation of plug wires
- Set the initial timing to 8° BTDC (See *Ignition System*) (Preset if factory run engine)

5. Exhaust system installed .

6. Engine instrumentation should be installed .

7. Secure the aircraft with tie downs and chocks.

8. Have a friend and a fire extinguisher available for any emergency help.

9. Set the ignition on "Points" and with the mixture rich and throttle cracked open start your engine. Upon start-up verify the following:
- Set RPM to about 1500
- Check oil pressure: 20 psi or better. (50-60 psi cold is typical and 30-40 hot)
- As the engine runs perform a quick visual inspection for any fuel or oil leaks. Watch

out for that Prop!

- Allow the engine to run for about three minutes at this rpm then shut down and let the engine cool while you inspect for any problems, leaks, security.

10. Once the engine has its initial run and everything is functioning normally, then install the cowling or a plenum to direct cooling over the cylinder for a longer run. It is critical that the cylinders receive proper airflow.

11. With the plenums or cowl installed, you can run the engine for 30 minute intervals. Keep the rpm at 1500 for the first couple runs. This helps to break in the camshaft and lifters. After the first hour, increase the rpm to 2000 and then to 2500 for a few seconds and then back to 1500. Again, ensure that the aircraft is tied down well. Avoid running at high rpm for too long as the cylinder head temperatures will build up. As the engine breaks in slight carburetor adjustments may be necessary. Set idle speed to 850 rpm. Oil pressure at idle should be at minimum 15-20 psi.

12. Once you have completed a minimum of two hours of running you can increase the throttle to full power for a few seconds to verify static rpm. The engine should run smoother as more hours are put on it and it settles in.

12. Check and adjust final distributor timing (See *Ignition System*) **(<u>Always</u> Check and adjust factory run engines)**

13. After a couple hours of ground running it is a good idea to change the oil and filter. Use Rotella T 30 W. oil for the first few hours of break in. It is also advisable to open the filter and check for metal contamination to see how the engine is doing. A slight metallic sheen in the oil and a few small particules in the filter will be normal on the first few changes. This should decrease as oil changes progress. A high metallic content is indication that something is not right and the break-in procedure should be stopped until the source is found and problem corrected. Engines that are pre-run have their oil filters checked and that information is available on request.

14. Once you are assured that the engine is running well you can begin your taxi tests and flying. With the engine fully cowled it may act differently due to temperature differences and airflow changes. Most problems are associated with carburetor setups and oil coolers. Read and understand your individual carburetor installation procedures to ensure that it is working properly. Watch your CHT's and Oil Temperatures during these tests to not exceed operating limitations.

15. It takes about 8 hours to fully break in an engine. Most of this can be done in the air. Keep the power setting to 75% in cruise to allow for maximum cooling and comfort. Temperatures and Pressures should be as follows:

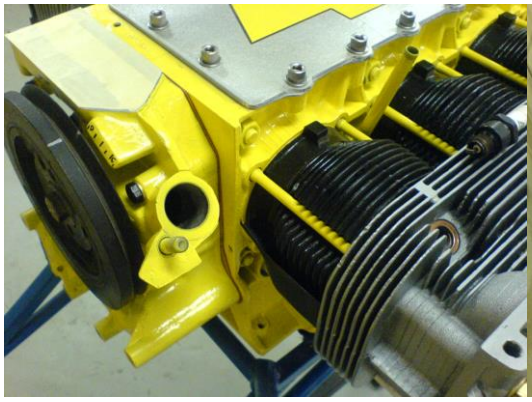
- Oil Pressure in flight: @40 psi
- Oil Temperature in flight: 200 -230F
- CHT in flight : 250-350 F Will be higher (low 400s) in climb
- EGTs (are relative to power setting, altitude, and installation) 1200 F at 75%
- 75% Power is about 24" MAP or about 3000 rpm with most approved props. Your numbers may be different depending on your combination.

4. Ignition System

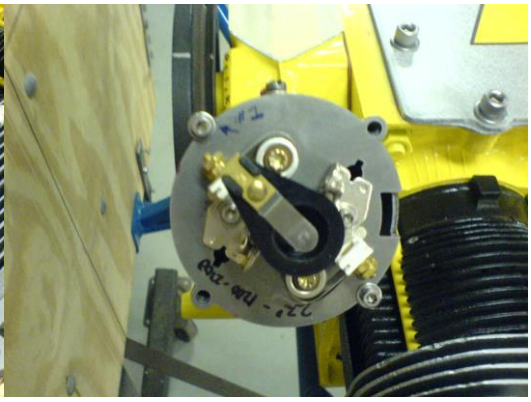
The 100/120 HP engine typically arrives with the distributor installed and timed and with plug wires installed. However, it is good to have all this information for servicing.

A. Distributor Installation

The first step in installing your distributor is to set the engine at TDC (top dead center) for the #1 cylinder. The #1 cylinder is the rearward cylinder on the passenger side. The easiest way is to remove the #1 spark plug and place your finger over the hole as you rotate the propeller in correct direction. When you feel compression on your finger you are nearing TDC. Line up the mark on the harmonic balancer to 0 degrees on the accessory housing. The housing has five marks - 0 - 4- 8- 12- and 16. Line up the 0 mark to the harmonic balancer line. This should be TDC #1. (See Pic 1)



Pic 1



Pic 2

Before installing the distributor look at the bottom of the distributor housing and see if there is any timing information written there. Make note of this information and copy into your logbook or other paperwork that can be accessible later. Remove the cap from the distributor and line up the rotor to #1 spark plug tower location (should be marked on the cap). Make sure the gasket is installed on the distributor base and install into the accessory housing. As you slide it in make sure the #1 tower and rotor are pointing to the 10 o'clock position. The slot in the points plate should be at the 3 o'clock position. The shaft will rotate a bit as the teeth on the drive gear engage the crank gear. (Pic 2) The distributor may not drop down all the way as the oil pump drive may not be aligned. Gently rotate the prop until the distributor drops all the way into place and then bring the prop back to the #1 TDC location. Install the distributor hold down clamp and nut. Don't tighten yet. Connect the wires according to the installation diagram. It is a good idea to identify your points on the dual points system as to which is primary and secondary, or A - B, or #1 - #2 to be in agreement with your switch on the panel. This helps with troubleshooting later. On the electronic points setup install the grounding wire to the engine or airframe.

B. Ignition Timing

Now that the distributor is in position it is time to statically set the timing. Look at your notes about the timing information on the distributor or data plate. For example: If the timing on the bottom of the distributor is 20 degrees then we can statically set the

timing to 10-12 degrees. You are looking for a maximum timing advance of 30-32 degrees so a static timing of 12 degrees plus 20 (marked on distributor) equals 32 degrees total. We will use 32 degrees total in this discussion.

There are a couple ways to set static timing:

1) Set the prop at 8-12 degrees BTDC (second or third mark on timing marks) I like to turn 'ON" the ignition on the points side (or secondary), remove the distributor cap, then slowly turn distributor until the points open. You should be able to hear and see the small spark from the points. This gets the setting close. Snug up the hold down nut. Now back the propeller up about 20 degrees and then slowly move the prop forward until the points "pop" open. You should be at the 12 degree mark. If not then move the distributor slightly and retry. Do this as many times as it takes until the points open at the 12 degree mark.

2) Another way is to install a 12V test light on the negative side of the coil that is "ON" to ground. The light will be on until the points open. The procedure is basically the same as above but using a light to see when the points open.

3) You can leave the ignition off and use a continuity tester in the points circuit to see when the points open.

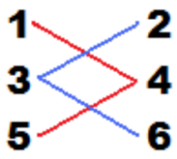
When you have the timing set, tighten the hold down nut and check the timing one last time in case it moved. Now check that the wires are attached properly to the coils and that the nuts on the points are tight. Reinstall the distributor cap making sure that the wires don't get pinched. The distributor is now set for startup and initial testing. Full advance testing will be done later.

Final timing checks:

Once you know that the engine runs (See *Break-in Procedures*) you need to perform the final timing checks. Using an automotive style timing light (preferably with a timing dial) check the idle timing for the 12 degrees that you set the distributor for. This tool is worth purchasing to include in your engine maintenance kit. Set the dial on the timing light set at 0. With the engine running at an idle, the strobe should light up the timing mark at the 12 degree mark on the accessory housing. If not, then adjust the distributor accordingly until it does. Make adjustments with the engine off. The next test should be performed with the airplane tied down securely, chocked, and preferably with someone at the controls. Set the timing light to 32 degrees on the dial and run up the engine to 2600 rpm for a few seconds. The timing should read 0. If you don't have a dial type timing light you can make an extra mark on the harmonic balancer at 32 degrees and use that for your reference. Now adjust the distributor for the total advance of 32 degrees. If the idle timing moves only a degree or two that is fine. Just make sure that you don't have more than 32 degrees at full throttle. This could cause overheating and detonation. If you are going to run 93 octane auto fuel or mixed fuel then set your max timing to about 28-30 degrees. This will lessen the chances of detonation common with lower octane fuels. With the introduction of alcohol in auto fuels it is our opinion that 100 LL is the best fuel to be using in aircraft at this time. Check both ignition circuits to make sure they are in agreement with each other. A 2-4 degree variation is okay as long as neither is over the 32 degrees. I like set up my distributor so that my primary is at 32 degrees max and secondary is at 28 degrees…sort of a limp-back mode. The engine still runs well but less chance of overheating and detonation.

C. Plug wire installation:

The Firing Order of the Corvair distributor is 1-4-5-2-3-6. An easy way to remember this is that the firing order looks like to overlapping "V"s. Starting at #1 you move to the point of the first "V" on the opposite side of the engine (#4) and then back to the other side to finish the "V" at #5. The next "V" starts at #2...Got it ? Once you see it is hard to forget. Here is a diagram.



(prop)

I like to mark my plug wires using a marking kit from most auto stores. They have shrink wrap numbers that go on the plug wires when you install them. I also like to write the numbers on the Distributor cap. At least put the #1 on the cap. The numbers are in a clockwise rotation. Also make sure to think about your baffling pass through when you make your plug wires up.
Always double check your plug routing and wiring. If you have crossed wires you may not have a smooth running engine or at worst backfiring that can cause internal damage. Make sure that the wires will not chafe or be too loose in the engine compartment. Secure them with wire ties and clamps if necessary. A clean and careful installation will give you years of good service.

D. Spark Plug Installation

Make sure the plugs (AC R44F) are installed with antiseize and torqued (12 ft/lbs). I prefer to use copper washers with the plugs as they provide a better sealing surface and wont bind on a insert and unthread it if you have them installed. Check plug gaps and security of the plug wires. Upon running the engine check the plug electrodes periodically (every 100 hrs) for color and cleanliness. A nice tan electrode indicates clean burning normal conditions. Black and dirty notes oil or an over-rich fuel mixture. White electrodes are indications of a hot plug due to over-lean conditions or timing too far advanced. Reading spark plugs can help in troubleshooting and adjustments.

E. Troubleshooting:

1. One ignition circuit does not work:
- Check for power to the coils when turned on - 12 volts on + side of coil
- Check for burned out points <Replace points>
- Check for loose wire at points - install a ground wire <check schematic>
- Selector switch may be defective <Replace and check>
- Electronic ignition not installed correctly it will be "fried" - <check installation and schematic>

2. Erratic behavior in flight:

- Check all connections
- Look for wear in the distributor shaft - too much causes timing to shift <replace bushings>
- Coil breaking down <replace coil>
- Plug fouling <not common - replace plug - check why>
- Defective plug wire - use timing light or ohmmeter to find <replace wire or repair>
-

3. Two ignitions not in agreement -(too much rpm drop)

- The electronics are fixed so adjust the point gap on the points
- On dual points set one at .016-.019 point gap and set timing. Adjust other to match timing. The point gap may be slightly different. <See points install section>

4. Rotor is hitting cap.

- Always check to see if the rotor is all the way on the shaft. Sometimes a bit of plastic or trash is on the rotor and it wont seat all the way down.

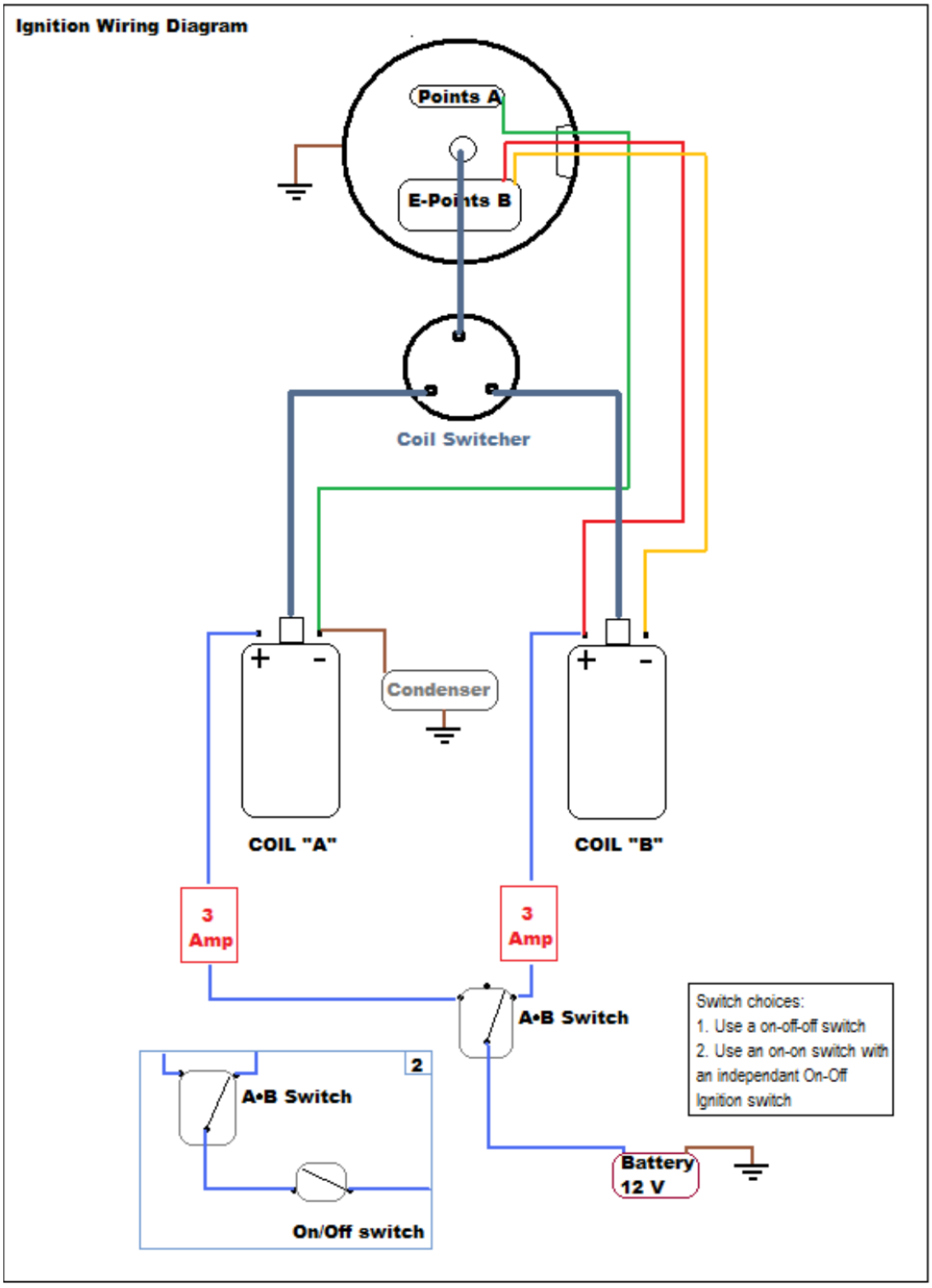
F. Ignition System Inspections

If you fly more than 100 hr a year it is good to perform these checks every 100 hrs or annually.

- Check point gap to see if within tolerances. Don't adjust if not necessary as this changes your timing. If they appear wrong then go ahead and replace the points and retime the distributor.
- Check the timing at full throttle - again make sure to tie down the airplane.
- Check for difference between primary and secondary points. Look for obvious signs of bushing wear. Check by trying to move shaft side to side. Too much wear is cause for overhaul as timing gets erratic.
- Check wiring for chafing and condition.

G. Distributor Electrical

The following figure is a breakdown of the distributor ignition system. Each installation may have unique differences but the principles are the same.

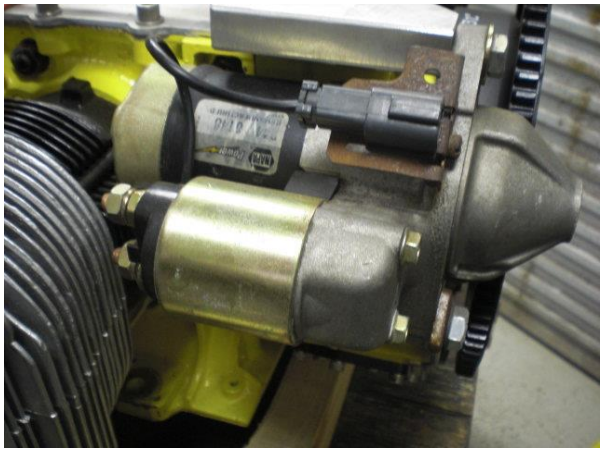

Ignition Wiring Diagram
Points A
E-Points B
Coil Switcher
Condenser
COIL "A"
COIL "B"
3 Amp
3 Amp
A•B Switch
Switch choices:
1. Use a on-off-off switch
2. Use an on-on switch with an independant On-Off Ignition switch
2
A•B Switch
On/Off switch
Battery 12 V

5. Electrical System

A. Starter System:

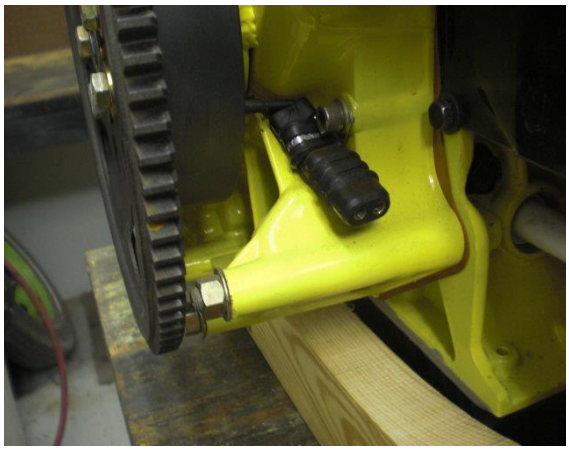
The starter on the Spyder engine is located at the rear of the engine and attached by two main starter bolts to the brackets at the accessory housing. A heavy 4 gauge wire is required from the battery to the main B+ terminal on the Solenoid. The Start terminal on the Solenoid requires a 14 gauge wire from the starter switch. An optional starter warning light can be wired to the Main B+ terminal of the starter motor to give an indication of when the starter is engaged. If the solenoid sticks "on" the light will remain lit even though the switch is off to indicate the fault. A faulty solenoid can damage wiring or cause overheating of the starter circuit. A simple key or push-to-start switch is all that is required for the starter.

Maintenance of the Starter and Ring Gear: Check the Ring gear for warpage, cracks, worn out teeth, and security. Check Starter for security, worn bendix gear, and security of wiring. Check starter bracket for cracks. If the sound from the starter sounds "ringy" when starting, you may need to check for proper Bendix to starter alignment. Go to the Engine Assembly Manual for this information.



B. Alternator System:

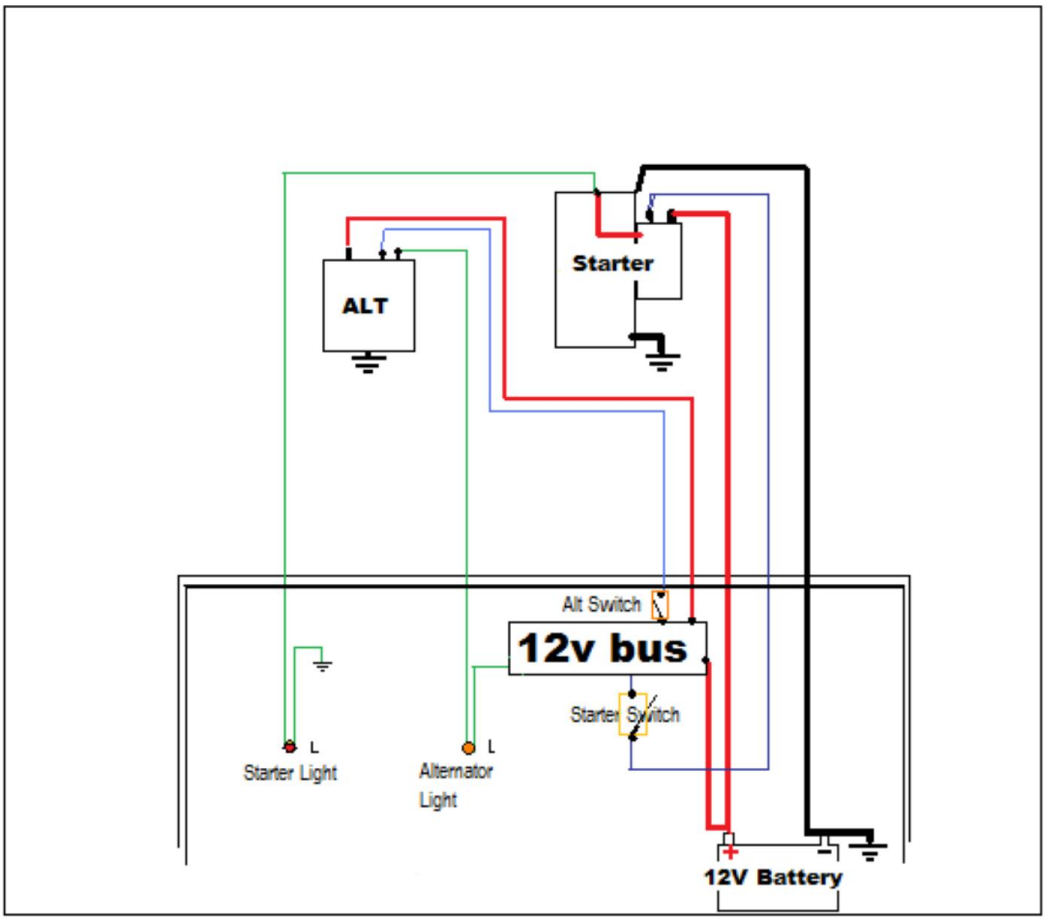
The Alternator on the Spyder engine is a located in the rear of the engine. It is a 32 Amp integral rear alternator that is driven by the crankshaft. A small plug is located at the rear to which the voltage regulator is plugged in. This is an A/C alternator and the voltage regulator changes it to DC. Be sure to mount the regulator where air can flow around it to cool it. If any part of the alternator circuit will fail it will probably be the regulator and normally due to inadequate cooling. If you wish to remote mount the regulator you may cut and splice in longer wires into the regulator. The single wire coming from the regulator connects to your main + (positive 12v) bus bar via a 40 amp circuit breaker.



Note: Above is the plug in for the voltage regulator. Use a tie wrap to secure wires away from the ring gear.

C. Wiring Diagram

Below is a basic wiring diagram. The Integral Rear Alternator wiring is simpler than that shown with only one lead going to the bus bar. A more detailed supplemental diagram and instruction are also available in the FWF kits.



The starter solenoid switch should be a momentary, key or push-button style switch. An ignition switch is included in our FWF kit.

The Odessey 680 makes a good battery for the 100/120HP engine. It is a sealed gel cell type that is lightweight (13lbs) with plenty of cranking power. Verify your power consumption needs to match available battery and charging capabilities.

6. Fuel System

The intake and fuel components of the Spyder engine are very important as to their installation and adjustment. Many problems in engine operation or have been known to cause accidents in aviation are fuel system related. There are a few components that are critical to discuss in this system.

A. Tank and Delivery

Two types of fuel tank arrangements are typical in aircraft. Gravity feed and fuel pump. Be sure that you use a good gascolator in the correct placement for adequate fuel supply.

1. Gravity Feed: Either wing tanks or a header tank provide the fuel pressure due to height above the gascolator and carburetor. This system requires a fuel flow test in a nose high attitude to see if there is enough fuel flow to the carburetor under worst conditions. You should only have reserve fuel only in the tank and still be able to flow about 14 gallons/hour. If gravity feed won't accomplish this then a fuel pump or a higher tank will be required. Typically a tank that is at least 12 inches above the carburetor with a 3/8 I.D. line is adequate. Most aircraft carburetors work well with a gravity fuel system and since they have less parts are less prone to problems. Also ensure a good vent system for the tanks.

2. Fuel Pump: Where a gravity feed is not applicable electric fuel pumps may be required. Two 1.5 psi 12V Facet pumps installed inline are adequate for this system. I recommend that each pump be wired to a side of the ignition switch so that pumps can be switched with the ignition. You can also wire in a separate switch to choose which pump is on. Remember that if the alternator fails that the fuel pumps draw quite a bit of power and will drain the battery quickly so be sure to land and make repairs. It is a good idea to keep the fuel pumps out of the engine compartment if possible or to shield them from engine heat. Some carburetors will require a good fuel pressure regulator to make them work properly. Follow the instructions from your carburetor manufacturer.

B. Carburetors

A variety of Carburetors will work well with the Spyder engine. We recommend the use of carburetors designed for aircraft. Three common styles of carburetors we recommend are discussed below. We supply intake manifolds for the following carburetors but can modify or custom make one to suit your needs. Insure that an adequate air filter is used with any carburetor you choose.

1. MA3SPA - or MA3

This carburetor that can be purchased as a rebuilt unit. It is not cheap but works very well. Gravity feed and fuel pumps work equally well with this carburetor. It is virtually a bolt on and use devise with very little adjustment required. Typically only the idle mixture and idle speed need be adjusted for a properly running engine. This style of carburetor requires a good carburetor heat system due to tendency of the carburetor icing. Be sure that the MA3 you install has been jetted in a way that will work with your Spyder engine. D&G Fuel systems has some experience with this. However, never assume the carburetor you buy or receive is jetted correctly. Perform the carburetor tests on your aircraft to insure it is correctly jetted.

2. Aerocarb 35mm.

A simple slide carburetor designed for experimental aircraft. Made by Sonex Aircraft, it works very well with a gravity feed fuel system and fuel pump systems with fuel pressure regulators. The advantage of this carburetor is its simplicity and low cost for a new unit. It is easy to install but requires a couple hours to tune in. Follow manufactures' information for installation and set-up. We have found that needle #3 works the best in the 100HP application. A simple cone style air filter from K&N or one made by Sonex works well. Requires an independent fuel shut-off.

3. Revflow 36mm and 40mm.

We have been using the Revflow carbs on our 100 and 120 engines for a while now. They have a similar design to the Aerocarb but have a couple advantages. The carburetor is made in a variety of sizes, as well as has integrated cable hold downs. The throttle plate is also spring loaded to "OPEN". We provide further information in the kit about this carb and its installation.

3. Troubleshooting the Fuel System

This is a list of items that can be checked to insure the fuel system will operate safely.

- Cleanliness: If the fuel tank is dirty from either the manufacturing process or from dirty fuel it can clog the filter or carburetor. Flush the tank and lines to insure a clean system. Check the gascolator screen often.
- Lines and hoses: Poorly made lines and hoses can have kinks, blockages or trash inside them that can cause fuel starvation. Double and triple check these. Blow them out and then visually check them for cleanliness and proper installation.
- Heat: Engine compartment heat can be a problem. A carburetor may work well with a cool engine but run rough after the compartment heats up. The gascolator may require a blast tube or insulation to keep it cool. The line from the gascolator to the carburetor should also have fire sleeving and be kept away from any hot spots such as exhaust systems. The Aerocarb may have to have the mixture needle enriched slightly since the warm cowl air leans out the fuel/air mixture. If you have indications of vapor lock then work on keeping the fuel lines and carburetor cool either though blast tubes or a cowl flap to dump the hot engine compartment air.
- Carb Heat: If the carburetor requires a carb heat system ensure that it works

smoothly and that you get at least a 50 rpm drop at idle when it is on. We have a simple carburetor heat muff for our exhaust systems that works well.

- Air cleaners: Ensure that you have a good quality air cleaner to use with your carburetor. A dirty air filter can cause the fuel/air mixture to change and cause the engine to run poorly.
- Ram air: Ram air can be used on some installations to get a little more power out of their engine. We have found that it only works well with certain carburetors and only if the installation is done carefully. Study the instructions from your carburetor manufacturer about this installation.
- Controls: Some difficulties in engine management can be traced to not being able to adjust the carburetor properly due to control cable slippage or disconnection. Make sure that control cables are lubricated on schedule, check for kinks and proper attachment. Again, study your carburetor instructions and recommendations for proper control installation. Visually check for full travels and stops.

7. Instrumentation

Proper engine care entails having appropriate and accurate instrumentation. There are several types of instruments that work well with the Spyder engine. Below is a minimum list that we believe is required for the engine.

	Green Range	Yellow Range	Red line
A. Oil Pressure	20-50 psi	50-60 psi	15psi
B. Oil Temperature	180-235 F	235-260 F	260 F
C. CHT (at least one)	250-425 F	425-450 F	450 F
D. EGT (at least one)	1600 F max	(varies with power setting)	
E. Tachometer	0-3500 rpm	(Varies with Prop Installation)	
F. Voltmeter	12.5-15.5 Volts	15.5-16V	12/16V

Here is an overview of each of these.

A. Oil Pressure. The oil pressure gauge can be either electric or hydraulic. The outlet for the sender (1/8 NPT) should be installed inline into the return side of the oil filter assembly. This can be done with an adapter from Summit Racing. Oil Pressure should indicate 20 psi at idle and 40 psi at cruise rpm with the engine at normal operating temperature.

B. Oil Temperature. The temperature sender for most gauges is a small 1/8"NPT sender that can be installed in the location provided for it near the starter. This is marked with a "T" and is located near the oil outlet on some engines. The temperature from this location is "pre-cooler" temperature so keep in mind that it is the highest temperature you will read. The cooler will drop the oil temperature somewhere between 20 and 40 degrees depending on size and installation. Therefore a temperature of 250 F is in reality about 220 F.

C. CHT. There are a couple different Cylinder Head Temperature probes that are available for most gauges. The engine can use either the 14mm "plug" style or the bolt on style. The "plug" style probe should be placed under the center cylinder on either side. The bolt on style can be bolted onto the head on the boss located on the underside of the head. We recommend having one CHT on either side to monitor the engine but have had good luck with just one. A CHT of @325 F in cruise and 375 - 415 F in climb out is typical. If the temperature climbs higher than 425 F reduce power and lower the nose to improve cooling.

In these conditions suspect either insufficient cooling to cylinders (baffling or blockage) or detonation. (timing has shifted, lean condition, poor fuel quality).

D. EGT. The Senders for EGT are located in the exhaust system and are used to monitor fuel mixture settings. The temperature you read on the gauge is relative to the power setting. The higher the power setting, the higher the temperature will be. Use the EGT to lean the carburetor to its ideal setting. Ideal for the Spyder engine is 100 F on the Rich side of peak. Lean out the carburetor as you monitor the gauge. Do this slowly and gradually. When the EGT peaks, slowly enrich the mixture 100 F. If you have two gauges, one for left bank and one for right, pick the gauge that is the hottest to adjust by. With different power settings it is not uncommon to see one head hotter than the other by a few degrees and then be cooler at another power setting.

E. Tachometer. There are a variety of tachometers that are available to use with the engine. There is no provision for a mechanical style tachometer so an electronic one will have to be used. Some have a bayonet pickup that reads teeth on a ring gear and others use the pulse from either the coil or the alternator. Use the instructions for your tachometer for installation. We can also help provide more information about recommended tachometers. A typical cruise RPM will be @ 3000 rpm depending on propeller selection. An accurate tachometer will be necessary for selecting power settings and knowing how well the engine is running.

F. Voltmeter. A simple gauge to monitor the condition of the battery and charging condition. A functioning alternator should charge at about 14 volts. If the voltage drops to 12 or less then suspect a faulty alternator or belt. If you have the indicator light installed it should also help show this. If you notice this condition you should begin by reducing your electrical load (shut off unnecessary systems) and prepare to land as soon as practical. A fully charged battery may operate the ignition system for a certain length of time but higher load items such as fuel pumps and lights drastically reduce the available power. A quick diversion to an airport for repairs is highly recommended.

Other Engine Instruments:

There are a variety of other instruments that help in engine monitoring. Here is a small listing of ones that we recommend.

Fuel flow computer
Manifold Pressure
Engine Monitoring system (several available)
Six cylinder EGT
Six cylinder CHT
Ammeter

8. Lubrication System

The oil system of the Spyder engine is an area where care and detail of installation is critical. The oil outlets are marked "O" for out (out to filter) and "I" for in(return from filter). Proper routing of lines and components will ensure a cool and reliable engine. There are a couple different ways to route lines. Fig 1 below shows a typical filter installation. Utilizing a "sandwich" adapter on the filter housing allows for an installation of a cooler off of the primary oil filter outlet lines. Using this system required a blocking plate (available from us if not installed) at the stock oil cooler outlet on the left side of the case. We have an oil filter kit available in the FWF kit to aid in this installation. A properly working gauge will aid in ensuring that the system you install is working properly. A good filter such as K&N HP2004 with an internal bypass is recommended. Fig#2 shows one of our oil cooler installations. Here the cooler is mounted to the front bottom of the engine mount. A little bit of baffle material will be added to seal the cooler to the bottom cowling which will have an opening in it. A variety of oil cooler locations have worked well. As you start your flight testing you will soon learn if your system is adequate or requires a little modification.

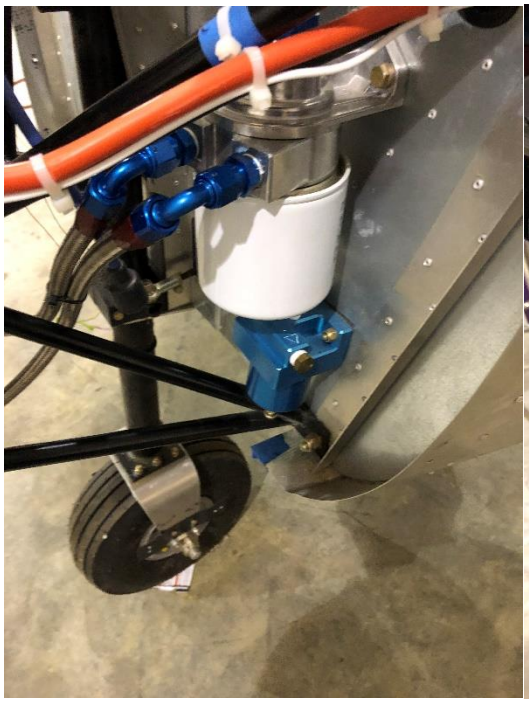


Fig 1

Fig 2

9. Cooling Systems

A. Forced Air

The Spyder engine is an air cooled engine and as such requires a large amount of cooling air to keep the temperatures in their normal range. There are two basic ways of achieving this. Either a plenum (Fig 1) or baffling (Fig 2) system can be used to forced air from outside into the engine compartment and through the cylinders and heads. With both of these systems you have to make sure that the air remains properly pressurized by insuring

a tight seal. We are able to help with information and parts for making either of these systems for your application. Plenum and baffling kits are available. Another area of the engine compartment to look at concerning cooling is the exit of the heated air from the engine compartment. The exit air outlet is to be 150% of the size of the air inlet. Sometimes the installation of an adjustable cowl flap door works well in controlling temperatures. High CHT's or oil temperatures can sometimes be attributed to poor baffling design or leaks in the seals.

Fig 1

Fig 2

B. Oil Cooler

Because the Spyder engine is used in many aircraft applications an oil cooler needs to be chosen that will work well with that use. Slower aircraft may require a larger cooler since there is less airflow. We have a variety of coolers and installations that can work in different applications. In cruise, oil temperature of 200-250 F is ideal. This allows moisture and other contaminates to be boiled off and keeps the oil cleaner. Excessively high oil temperatures (over 260 F) can also be problematic since the oil will thin out and cause premature bearing wear. High oil temperatures can be caused by a cooler that is too small, incorrect oil being used, insufficient cooling air to the cooler, and ignition issues. There are a couple ways to mount a cooler. We use a "sandwich" adapter attached to the oil filter mount that has two hoses running to a cooler. Contact us about cooler installation guidelines.

Oil cooler mounted behind engine on mount. This worked well on this Tailwind. Not the filter assembly on the left firewall side. Voltage regulator on the right side. Coil and coil switcher are above the cooler.

10. Troubleshooting Guide

Here are problems that are found with engines in general and some directions to investigate and find solutions. This is a guide and not necessarily an answer. Contact Us directly if you need further help or clarification. Always start fixing problems by trying the simplest solution before trying the most difficult or costly.

High Cylinder Head Temperatures

Timing has shifted or a defective distributor causing incorrect timing
Power setting too high for conditions
Poor air flow / cooling
Wrong or dirty fuel
Mixture too lean – carburetor not jetted or tuned correctly
Defective gauge or sender
Typically high CHTs of 500 or more are indicative of detonation

Low Oil Pressure

Engine Temperatures too high
Oil pump defective
Oil Cooler ineffective
Engine bearings worn
Oil Hoses Leaking
Leak at cooler/filter – check o-ring
Lack of oil
Blockage in oil pickup
Stuck oil pressure control valve
Defective gauge or sender

High Oil Pressure

Oil Viscosity too high
Stuck oil pressure control valve
Cold oil – can cause blow out of filter gasket
Blocked oil passage
Defective gauge or sender

Static RPM too Low

Too much Propeller pitch
Carburetor too small or not tuned properly
Fuel starvation
Ignition problem
Compression low
Defective Tachometer or sender

Engine RPM too High

Not enough propeller pitch/diameter
Damaged Propeller
Defective Tachometer or sender

Engine Vibration

Cylinder misfiring - detonation/wiring
High CHTs - cooling/detonation
Propeller out of balance or loose
Motor mounts loose
Alternator belt loose
Crack in ring gear or ring gear loose
Poor Compression
Internal engine failure such as dropped valve seat

Engine Misses

Improper timing
Improper mixture on Carburetor
Intake manifold leak
Dirty fuel
Carburetor Ice
Bad ignition wire
Spark plug defective
Improper points gap
Worn distributor bushings
Plugged fuel or air filter
Valve component defective

Engine Idles but does not run high RPM

Improper carburetor mixture or throttle controls
Improper fuel mixture settings/jetting on Carburetor
Air filter or fuel filter dirty
Fuel supply not adequate
Distributor advance not working
Propeller improperly set

Engine Does not turn over

Battery condition or connections
Defective starter switch
Defective starter
Bad wire connections / grounds

Engine turns over but won't start

Defective ignition switch or wiring
Improper wiring of coils and distributor
Improperly installed distributor
Bad grounds in ignition circuit
Improper timing
Defective distributor
Fuel starvation
Carburetor improperly set up
Defective carburetor
Plugged fuel valves or vents
Wrong firing order
Flooded engine
Vapor lock due to high cowl temperatures
Intake manifold leak

Engine Starts but dies

Lack of fuel
Plugged fuel lines - vents
Water/dirt in fuel system
Improper firing order
Carburetor defective
Mixture too lean
Cold engine
Carburetor ice
Worn rings
Vapor lock due to high cowl temperatures

11. Inspection Procedures

25 Hour Inspection

This inspection is a routine check of most systems of the engine and related components during the normal oil change. It should be a fairly simple inspection and general in theme. Look for obvious problems in the items below and make necessary repairs.

- Inspect air filter
- Inspect Exhaust for leaks and cracks
- Inspect Intake for leaks and cracks
- Change oil and filter - open filter and inspect for metal contamination
- Torque Propeller (check manufacture's specifications)
- Check spinner for cracks
- Check any belts and wires
- Check ring gear for security
- Look for obvious oil leaks and fuel leaks

100 Hr / Annual Inspection

This inspection is more specific in nature and will require a several hours of work and specific tools to complete. If you do not have the authorization to perform this inspection make sure the A&P or inspector has all necessary information concerning your engine and installation. Use information in previous chapters to perform repairs or servicing.

Pre-Inspection Run-up:

- Run engine to operating temperature
- Check oil pressures - low and high
- Check engine gauges for proper operation
- Check for smoothness and unusual vibration
- Check ignition system for function and RPM drop
- Check carb heat - if installed (50-100 rpm drop)
- Check static RPM or manifold pressure
- On shutdown ensure mixture idle cutoff.

Once the engine is warmed up:

- Remove the cowling
- Drain oil – warning "HOT"
- Remove oil filter and cut open for contaminant check
- Check for obvious oil and fuel leaks.
- Inspect IFB oil line for security and any chaffing

Intake system:

- Remove air cleaner and service
- Observe the throat of carburetor and verify full travel of throttle control.
- Check mixture control for proper travel

- Check hoses and clamps for security
- Reinstall air cleaner
- Lubricate controls

Exhaust system:
- Inspect for leaks (carbon traces are black or grey)
- Verify the nuts or fasteners for torque
- Be sure nothing is rubbing against the pipes

Ignition system:
- Remove spark plugs, inspect and clean or replace (use anti seize)
- Check plug wires for deterioration
- Remove Distributor cap and check for condition
- Inspect inside distributor for dirt/dust/contamination
- Refer to Ignition section to check for bushing wear/points condition
- Check coils/splitter for condition and security

Compression Check:
- While the spark plugs are removed perform aviation compression check
- Documented results and reinstall plugs with antiseize
- Reconnect the plug wires
- Typical Compression will be 65-75 psi over 80 in differential compression test
- If below 65 on a cylinder, monitor every 10 hours. It below 50 look for reason

Propeller:
- Remove spinner
- Check propeller torques
- Check spinner bulkheads for cracks
- Reinstall spinner

Engine Attachment:
- Check engine mount for cracks/distortion
- Check rubber bushings for deterioration/bolts for slop or wear
- Check that nothing is rubbing or wearing against mount

Fuel System:
- Inspect and clean gascolator according to its guidelines
- Run some fuel through the gascolator drain to check flow
- Inspect lines and hoses

Baffling or Plenum:
- Look for any obvious deterioration of seals
- Repair any cracks in material

Accessories:

- Check ring gear for cracks / warpage
- Check Alternator for security (non IRA)
- Check Alt. Belt for tension and wear (non IRA)
- Check security of starter / wear of bendix gear.
- IRA – check ring gear bolt torque (360"lbs)
- Main Rear Bolt – check torque – 50 ft.lbs

500 Hr. Inspection

This inspection should be the same as the annual or 100 hr with some differences. Included should be the following items.

- Remove and replace the distributor with rebuilt unit (new bushings, points,cap)
- Replace alternator belt (may require removal of ring gear) (non IRA)
- Replace Spark plugs
- Replace air filter
- Removal of top cover for inspection of interior (new gasket)
  -check crankshaft/camshaft/lifters/cylinder walls
- Replace motor mount bushings
- Remove the propeller, check for wear on hub, reinstall
- Check bearings in alternator by removing belt and checking side play (non IRA)

12. Operational Procedures

These procedures are to be used as a guide and may be slightly different for individual installations.

A. Start-up

- Ignition "ON"
- Fuel "On"
- Mixture Rich
- Coils on "Secondary/Points"
- Throttle Cracked open "Clear Prop"
- Start engine and set idle: 1000 rpm
- Check oil pressure: 20+ psi at idle

B. Run-up

- Set brakes
- Run engine to 2000 rpm
- Select coil "Primary" (no more than 50 rpm difference)
- Check Carb heat if equipped (50-100 rpm)
- Check oil pressure and oil temp
- Back to idle

C. Takeoff

- Slowly advance to full throttle
- Check RPM: 2900 depending on propeller and altitude
- Check Manifold Pressure: 29" at sea level - a guide is a 1" drop/1000'
- Check oil pressure: 40-55 psi (cold) 35-45 (hot)
- Adjust mixture for high altitude if required

D. Climb

- Full power to 1000 above pattern in Vy climb
- Reduce power slightly and change to cruise climb (better cooling)
- Adjust mixture as necessary
- Monitor: CHTs (425 F max) Oil Temp (245 F max) Oil Press (40 psi min)

E. Cruise

- Level off and let plane accelerate to cruise speed
- Reduce power to cruise setting
- Adjust mixture using EGT as reference (will change with power change and altitude)
- Monitor: CHTs (250-350 F) Oil Temp (180-250 F) Oil Press (35 psi min)

F. Descent

- Reduce power for standard descent - 500ft/min descent at moderate power
- Increase mixture throughout descent
- Be aware of "shock cooling" the engine

G. Landing

- Use appropriate power for landing procedures
- Mixture "Rich"
- Carb Heat "ON" if equipped

H. GO-Around

- Mixture "Rich"
- Throttle "Fulll"
- Carb Heat "Off"

I. Shut Down

- Throttle - Idle 1000 rpm
- Shut off Avionics
- Mixture - Idle Cut-off
- Ignition "OFF"
- Fuel Valve "Off"

J. HOT Start

(Hot starts can be tricky depending on conditions and temperatures. High cowl temps will cause the air/fuel mixture to be rich and also cause vapor lock in the fuel lines. Typically the mixture is too rich for conditions so a open throttle with mixture lean clears the cylinders of this rich mixture. If engine or cowl temps are too high you may have to let it cool down before starting. High Cowl temps can be adjusted with better baffling or cowl flap doors)

- Fuel valve "on:"
- Throttle - ½ - Full open
- Mixture - Idle cut off
- Start
- As engine starts reduce the throttle and slowly advance mixture to full rich
- Set idle to 1000 rpm

K. High Altitude

- Prior to takeoff set the brakes
- Throttle "Full"
- Mixture - Slowly lean to 200 degrees rich of peak EGT

(This is an approximate setting to give you best power for takeoff. Setting will be different according to density altitude.)

13. Conclusion:

We hope that the information contained in this ***Service and Operations Manual*** has been helpful. We are growing and learning to improve our product. Any information or insight you, our customer, would like to see adapted or included in this manual is appreciated.

Thank you.

Bill Clapp CEO

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