LYCOMING

Reciprocating Engine

TROUBLE SHOOTING GUIDE

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INTRODUCTION

TROUBLE-SHOOTING

1. Trouble-shooting is the step-by-step procedure used to determine the cause for a given problem and then selecting the best and quickest way to solve that problem. While the use of turbochargers and automatic controllers has complicated the trouble-shooting procedures, always start by discussing the problem with the pilot and the facility management. They will assist you in narrowing the problem to as few possibilities as possible. In the case of twin engine aircraft, make sure you are working on the correct engine. After a thorough discussion and verbal analysis of the problem, you are ready to go to work. If you are an experienced mechanic, you may be able to automatically eliminate some of the probable causes. If you are new on the job, you will have to go through all of the probable causes. The important thing to remember is to always start with the simple and inexpensive things first, and then work toward the more complicated, time consuming, and expensive things later.

2. After you have received all possible information from the pilot and the facility management, a quick observation of the external condition of the engine may give you an indication of the problem. Some areas to look at are the intake and exhaust pipes for leaks, the ignition harness, breather, and the engine compartment for excessive oil stains, gas stains or exhaust stains. More information may be gained rather quickly by doing a compression check to locate any low compression cylinders. Do a boroscope inspection to determine the condition of the combustion chamber. Some information that may be obtained is: the presence of excessive carbon deposits may indicate high oil consumption; the lack of carbon deposits may indicate continuous lean engine operation or detonation; and scratched or scored cylinder walls may indicate broken rings. More information may be compiled by removing the spark plugs to inspect the combustion chamber.

   NOTE

   Be sure to keep track of which piston pin plugs came out of which cylinder. During reassembly the piston pin plugs must be matched up with the cylinder they came out of.

   Another good trouble-shooting tool is the use of spectrometric oil analysis. To be effective the engine must be in the analysis program for an extended period of time to develop a useful history of periodic samples of oil that were analyzed. The program must be carried out by experienced and reputable people in the oil analysis field.

3. The following list of problems, causes, and solutions was selected because we believe it represents the more common and recurring problems encountered by mechanics when doing trouble-shooting. It should be noted that the list is general in nature, and does apply to both normally aspirated and turbocharged engines. The sequence in which the lists are arranged is not necessarily the exact step-by-step procedure to use, but should be used as a guide to determine all of the possible causes and solutions to a problem. Always keep in mind to do the simple and inexpensive things first, then proceed with the more complicated and expensive things later.

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CONTENTS

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HARD STARTING

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Technique.	1. Refer to the Operator's Manual recommended starting procedure.	1. Solution is self-explanatory.
2. Flooded.	2. Clean engine.	2. Crank engine with throttle full open and mixture in idle cut-off.
3. Throttle valve open too far.	3. Set for approximately 800 RPM.	3. Solution is self-explanatory.
4. Insufficient prime (may be accompanied by backfire).	4. Increase same.	4. *NOTE:* Make sure primer is not leaking.
5. Magneto impulse coupling not operating properly.	5. Remove and check for binding, or broken impulse spring.	5. Remove magneto and check that the spring is not broken and flyweights move freely. Check torque on coupling retaining nut. If unable to locate the problem, remove coupling and check according to latest revision of Service Instruction No. 1189.
6. Defective spark plugs or ignition wire.	6. Inspect and replace or repair as necessary.	6. Remove plugs, inspect, clean, and/or replace as necessary. Visually inspect ignition harness for breaks and cracks. Test leads by removing distributor block from magneto and using a Bendix high tension lead test No. 11-8888 or 11-8888-1 or equivalent type equipment.
7. Low voltage at vibrator input.	7. Check with voltmeter and replace battery, if necessary. (Be sure battery terminals are clean and tight, also check leads for condition.)	7. Measure voltage between vibrator terminal marked "in" and ground terminal while operating starter. Must be at least 8 volts on a 12 volt system, or 13 volts on a 24 volt system.
8. Inoperative or defective vibrator.	8. Check and replace vibrator, if necessary.	8. If voltage is okay, listen for interrupted buzzing of vibrator during starting. If no buzzing is heard, either vibrator is defective or the circuit from the "output" terminal on the vibrator to the retard contact assembly is open. Check both switch and retard circuit. Also check for good electrical ground.
9. Retard contact assembly in magneto not operating electrically. Engine may "kick back" during cranking.	9. Check all connections at switch and vibrator. Adjust retard points. See appropriate Bendix Manual for procedures.	9. Retard points may not be closing due to improper adjustment or may not have a good electrical connection in circuit. Check for good contact of switch and retard leads at magneto and vibrator. Check condition of wire.
10. Vibrator – Magneto combination not putting out electrically.	10. Check and replace, if necessary.	10. Disconnect Starter and all Spark Plug Leads. Turn engine in right direction until retard points open on #1 cylinder firing position. Hold #1 plug lead approximately 3/16 in. from ground, energize vibrator by turning switch to start. Plug lead should throw a show of sparks to ground. If spark is weak or missing, replace vibrator. Also check magneto for correct internal timing. Proper duration of shower of sparks may be

HART STARTING (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
10. Vibrator – Magneto combination not putting out electrically. (Cont.)	10. Check and replace, if necessary. (Cont.)	10. (Cont.) checked by holding switch in start position, and hand turning propeller until sparks stop. Degrees of propeller rotation may be measured or estimated to determine if retard points are adjusted properly. *NOTE:* All checks must be made with starter and plug leads disconnected.
11. Magneto improperly timed to engine.	11. Check magneto timing as per engine manufacturer's instructions.	11. Disconnect starter. Turn engine in proper rotation to #1 cylinder firing position. Attach timing light to primary leads (marked switch) of magneto and ground lead to engine. Rotate engine until advance points break, indicated by timing lights going out or coming on, depending on type of light used. Observe that when points break, timing marks on engine are aligned. Engine timing marks are located on engine as follows: Direct Drive – Line on starter ring gear to dot on starter housing. TIGO – Degree markings on crankshaft to split of case observed at top front of engine. Geared Supercharged – Pointer mounted to accessory housing to lined bevel tooth on camshaft gear observed on right side of engine in accessory housing.
12. Magneto internal timing not adjusted properly or "E" gap drifting because of point or follower wear.	12. Adjust magneto internal timing, or replace points if either follower or points are worn.	12. Remove magneto from engine and turn magneto to #1 firing position, attach timing light, turn magneto in proper rotation. Observe that when lights go out, built-in pointers in the magneto are aligned in the observation window provided. (See Bendix Maintenance Instruction Manual for your particular magneto.)
13. Impulse coupling on magneto inoperative.	13. Repair or replace impulse coupling.	13. Remove magneto from engine, turn in proper direction by hand and observe that flyweights in impulse coupling contact stop pins. If this condition does not exist, flyweight axles are worn excessively and impulse coupling must be replaced. If flyweights are in good condition, rotate magneto several times to snap impulse and determine that impulse spring is not broken. Check torque on impulse coupling nut to be sure it is not binding due to an over torque condition.

HARD STARTING (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
13. Impulse coupling on magneto inoperative. (Cont.)	13. Repair or replace impulse coupling. (Cont.)	13. (Cont.) For complete information on magneto impulse couplings, get a copy of the booklet, "I AM YOUR IMPULSE COUPLING", #L-1019 from Bendix at Sidney, N.Y.
14. Impulse coupling is magnetized.	14. Remove and demagnetize or replace impulse coupling.	14. Solution is self explanatory.

ROUGH IDLE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Mixture is too rich or too lean. (If mixture is lean, poor acceleration may be noticed.)	1. Adjust idle mixture.	1. Lean engine if mixture is too rich. Engine will smooth out and pick up RPM as it is leaned. If mixture is too lean, condition will become more aggravated as engine is leaned. Adjust for proper mixture by turning scalloped wheel at side of injector to either rich or lean condition, as indicated by arrow and letter "R" located on injector linkage. *NOTE:* After mixture is set, readjust idle speed to desired RPM, if necessary.
2. Plugged nozzles. (Usually accompanied by indicated high fuel flow.)	2. Clean nozzles, inspect with magnifying glass before cleaning if contamination is found, remove same. No need to check further. *NOTE;* May locate problem by feeling for cold cylinder.	2. Wash in acetone or MEK, blow out with compressed air. *NOTE:* Flow check nozzles in containers of equal or partially plugged nozzles. (See latest revision of Service Instruction No. 1275.)
3. Induction air leak at one of the following locations: a. Hoses and hose clamps. b. Cracked intake pipes. c. Bad gaskets. d. Loose flange bolts. e. Loose plugs in intake port of cylinders. f. Fuel drain valve not seating properly.	3. Check previously mentioned locations and tighten or replace as necessary.	3. Solution is self-explanatory.
4. Cracked engine mounts or defective mount bushings.	4. Replace same.	4. Solution is self-explanatory.
5. Mount bushings improperly installed.	5. Install as per manufacturer's instructions.	5. Solution is self-explanatory.
6. Internal injector leak (usually unable to adjust injector at idle) or will not hold adjustment.	6. Replace injector.	6. Check by disconnecting induction system at injector inlet to observe impact tubes, then put throttle in full forward position and mixture in full rich position, cap fuel line to flow divider, turn on boost pump, and if fuel is observed coming out of impact tubes, then injector has internal leak and must be replaced.
7. Fuel vaporizing in lines and distributor, (encountered only at high ambient temperatures and prolonged operation at low or idle RPM).	7. Keep ground operation to a minimum and operate with cowl flaps in full open positions. (If necessary, operate with booster pump on.)	7. Solution is self-explanatory.

ROUGH IDLE (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
8. Nozzle screen and shroud deformed to extent it blocks or partially blocks air bleed hole.	8. Replace nozzle.	8. Remove nozzles from cylinder so that they may be adequately inspected.
9. Sticking valve in fuel flow divider.	9. Disassemble and clean.	9. Remove divider from engine. Disassemble and flush out dirt. Also divider valve may be hand lapped in seat to remove any burrs that may be present. *NOTE:* Never interchange fuel flow divider parts and do not damage diaphragm.
10. Uneven cylinder compression.	10. Differential check cylinders to determine if further disassembly and repairs are necessary.	10. Differential compression check is accomplished by rotating cylinder to be checked to T.D.C. on compression stroke and introducing 80 psi air into cylinder and observing how much is retained. Step-by-step procedures and equipment requirements will be found in the latest revision of Service Instruction No. 1191.
11. Improper fuel pressure.	11. Adjust as necessary.	11. Minimum and maximum limits are found in engine and airframe manufacturer's Operator's Manual.
12. Faulty ignition system.	12. Check magneto drop and condition of plugs and leads.	12. Set engine to produce 50-65% power with propeller at minimum angle. Check both magnetos for excessive drop off. *NOTE:* Smooth drop off that exceeds limits may indicate a lean or rich injector or carburetor. Leads must be checked by removing distributor block from magneto and using a Bendix high tension lead tester, #11-8880 or 11-8880-1 or equivalent type equipment to determine lead condition. A visual check is also helpful. *NOTE:* The difference in drop between magnetos is just as important as the total magneto drop (not more than 50 RPM difference between magnetos).
13. Fuel pressure too low.	13. Adjust to at least minimum pressure as found in Operator's Manual.	13. *NOTE;* If unable to adjust pressure, replace pump.
14. Primer not locked or leaking.	14. Lock securely or replace primer if leaking.	14. Solution is self-explanatory.

ENGINE WILL NOT IDLE UNLESS BOOST PUMP IS ON

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Idle mixture extremely lean.	1. Enrich idle mixture at injector.	1. Turn scalloped wheel at side of injector toward rich condition. *NOTE:* Arrow on linkage indicates rich and lean. Idle speed will have to be adjusted.
2. Engine fuel pump failed, or pressure too low at idle speed.	2. Replace fuel pump, or adjust pressure as necessary.	2. Solution is self-explanatory.

ENGINE WON'T IDLE UNLESS BOOST PUMP ON (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
3. Fuel pump bypassing fuel internally. (*NOTE:* AN type pump.)	3. Replace fuel pump.	3. Solution is self-explanatory.
4. If engine has diaphragm type fuel pump consider either a loose fuel in fitting or a missing or defective "O" ring. *NOTE:* Check "O" ring seat machined in fuel pump to be sure seat is smooth.	4. Tighten fitting or replace "O" ring as required. If "O" ring seat is damaged, pump may have to be replaced.	4. *NOTE:* Engine may also lose fuel pressure as aircraft climbs to altitude. See latest revision of Service Bulletin No. 374.
5. Fuel vaporizing in fuel lines.	5. Keep engine nacelle as cool as possible.	5. Solution is self-explanatory.

ENGINE WILL NOT IDLE UNLESS BOOST PUMP IS OFF

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Idle mixture extremely rich.	1. Lean idle mixture at injector.	1. Turn scalloped wheel at side of injector toward lean condition. *NOTE:* Arrow on linkage indicates rich and lean. Idle speed will have to be adjusted. Condition indicated by excessive black smoke.
2. Engine pump fuel pressure set too high.	2. Adjust fuel pressure at pump if AN type. Replace fuel pump if diaphragm type.	2. Solution is self-explanatory.
3. Booster pump pressure too high.	3. Adjust pressure or replace pump.	3. Solution is self-explanatory.

POOR IDLE CUT-OFF

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Improper rigging of mixture control linkage.	1. Adjust same.	1. Solution is self-explanatory.
2. Mixture control valve scored or not seating properly, or "O" ring on mixture jet broken or deformed.	2. Disassemble and remove scratches and burrs. Replace "O" ring, if necessary.	2. Remove mixture control assembly from injector lap idle cut-off jet and valve assembly on a good lap plate using a mild abrasive until all scores and burrs are removed. Clean thoroughly and reassemble. Also observe the condition of the "O" ring on mixture control jet. *NOTE:* Check for a leak by disconnecting fuel line at entrance to flow divider. Keep throttle and mix off and boost pump on. There should be no fuel flow.
3. Vapor in lines.	3. Avoid prolonged ground operation at low RPM and idle. Keep nacelle as cool as possible. *NOTE:* Use boost pump, if necessary.	3. Solution is self-explanatory.
4. Dirt in air bleed hole of nozzle.	4. Remove and clean.	4. Wash in acetone or MEK and blow out with compressed air.
5. Fuel jets in nozzle improperly located.	5. Replace nozzles.	5. Nozzles may be tested by fabricating a test rig as explained in latest revision of Service Instruction No. 1275. *NOTE:* No visual check of jets is possible.

POOR IDLE CUT-OFF (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
6. Valve in flow divider sticking.	6. Remove and clean.	6. Remove flow divider from engine and disassemble. Flush out any dirt that may be present. Flow divider valve may be hand lapped in seat to remove any burrs. Clean thoroughly and reassemble. *NOTE:* Never interchange flow divider parts.
7. Loose fuel line at flow divider or nozzle. *NOTE:* Engine may be rich at idle.	7. Tighten all fuel connections.	7. Check main fuel line at flow divider and fuel injector. Also all fuel lines at divider and nozzles. Make sure nozzles are tight in cylinders and not cross-threaded.
8. Mixture valve stuck, (corroded) to valve seat. (Carbureted engines.)	8. Disassemble carburetor to enable cleaning (and lapping, if necessary) the mixture valve and seat.	8. Solution is self-explanatory.

HIGH FUEL FLOW

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Plugged nozzles.	1. Clean or replace same. Inspect with magnifying lens first.	1. Flow check nozzles in containers of equal size to locate plugged nozzles. If plugged, wash in acetone and blow out with compressed air.
2. Air leak or restriction in deck pressure gage line (airframe).	2. Locate and repair.	2. Pressure check to 9 lbs. and observe gage for drop in pressure.
3. Injector rich.	3. Replace same. Check magnetos for excessive smooth drop in RPM. Recalibrate and/or overhaul injector at an approved facility.	3. Run engine at a given power setting full rich. Observe fuel flow and compare to fuel flow requirements for that power setting as found in Operator's Manual.
4. Faulty gage.	4. Replace same.	4. Prove by installing master gage and running engine to compare gages.
5. I.D. of fuel lines too small.	5. Replace lines.	5. Lines must be between .085-.090 in. I.D. Check with gage and be sure not to mark inside of fuel lines.
6. Incorrect nozzle flow.	6. Replace nozzles.	6. Flow check nozzles in containers of equal size to locate problem nozzles. Flow rate of nozzles may be determine by following procedures set for in the latest revision of Service Instruction No. 1275.
7. Cracked or broken fuel injector nozzle line. *NOTE:* Separation may be at silver solder connection	7. Replace defective line.	7. While pressurizing system with boost pump, give it a good visual inspection for signs of fuel dye.
8. Deck pressure gage line plugged (turbocharged).	8. Remove any obstructions.	8. Disconnect line from gage and engine. Use compressed air to blow through liens to remove any dirt that may be present.

LOW FUEL FLOW

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Dirty fuel filter screen.	1. Clean same.	1. Remove and clean in acetone or MEK. Blow out with compressed air.

LOW FUEL FLOW (CONT.)

CASUE	SOLUTION	PROCEDURE FOR SOLUTION
2. Injector lean.	2. Replace same or recalibrate or overhaul at approved facility.	2. Run engine at a given power setting full rich. Observe fuel flow and compare to fuel flow requirements for that power setting as found in Operator's Manual. An increase in cylinder head temperature, EGT or oil temperature may be an indication of a lean injector.
3. Faulty gage.	3. Replace same.	3. Prove by installing master gage and running engine to compare gages.
4. Flow divider does not open all the way (problem may not occur at all times).	4. Disassemble, check for dirt, and drag on diaphragm stem. Also parts may be lapped together to insure free operation.	4. *NOTE:* NEVER INTERCHANGE FLOW DIVIDER PARTS. THEY ARE FLOWED AS AN ASSEMBLY.
5. Fuel line to fuel flow gage broken, loose or plugged.	5. Repair or replace line.	5. To detect broken or loose line, check for fuel dye stains. To check plugged line, disconnect at gage and injector and blow out with compressed air.
6. Low fuel pressure.	6. Increase fuel pump pressure to limits in Operator's Manual and also check for leaks.	6. Solution is self-explanatory.
7. Improper gasket installed on cover plate in flow divider.	7. Replace with correct gasket.	7. Step-by-step procedure for inspection and repair of this problem are found in latest revisions of Lycoming Service Bulletin No. 382 or Bendix Service Bulletin No. RS 43.

ENGINE WILL NOT TURN STATIC RPM

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Restriction in induction air system, incorrect airbox, or airbox improperly installed.	1. Inspect and remove restrictions.	1. Solution is self-explanatory.
2. Injector too rich or too lean.	2. Replace same or recalibrate or overhaul at approved facility.	2. Run engine at a known power setting, full rich. Observe fuel flow and compare to fuel requirements as found in Operator's Manual. Lean injector. If too rich engine will pick up RPM and run smooth. If injector is too lean, engine will be more aggravated.
3. Propeller out of adjustment (low pitch).	3. Adjust same.	3. Solution is self-explanatory.
4. Governor linkage not adjusted properly.	4. Adjust for full travel.	4. Solution is self-explanatory.
5. Crankshaft to camshaft timing off.	5. Remove accessory housing and time correctly.	5. This condition may be checked by first disconnecting starter. Remove top spark plugs and rocker box cover on #2 cylinder. Turn engine to T.D.C. on compression stroke on #1 cylinder, observe that when piston in #1 cylinder goes over T.D.C. on compression, the intake valve in #2 cylinder is just starting to open and the exhaust is just closing. If this condition does not exist, the crankshaft to camshaft timing is off.

ENGINE WILL NOT TURN STATIC RPM (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
6. Exhaust muffler internal baffles broken and blocking exhaust outlet	6. Remove muffler for thorough inspection and replace same, if necessary.	6. *NOTE:* If baffles are broken and are free to move around in muffler, engine may turn static and develop power sometimes and other times it may not due to the restricted flow of exhaust gases. Strike muffler with rubber mallet or soft object and listen for rattle in muffler.
7. Excessively dirty air filter.	7. Replace at regular intervals. Time between filter changes will depend on operating conditions of individual aircraft.	7. *NOTE:* Sometimes new filters may have an excessive air drop through them. If this condition is suspected, remove filter and run engine to F.T. without filter installed to observe whether the engine performs better. (This test should be performed in a dust-free area and on a hard surface.)
8. Carburetor heat door not rigged properly.	8. Rig so that door goes from full open to full closed.	8. *NOTE:* Even though door is going from full open to full closed position when aircraft is shut down, when aircraft engine is operating vibrations and airflow may cause door to open slightly. If this condition is suspected, tape or wire the door shut for test purposes. If this solves the problem, adjust and replace parts as necessary.
9. Incorrect magneto to engine timing.	9. Check and adjust as necessary.	9. Solution is self-explanatory.
10. Fouled spark plugs.	10. Remove and clean or replace as necessary.	10. Solution is self-explanatory.
11. Tachometer reading is incorrect.	11. Have tachometer repaired or replace same.	11. Solution is self-explanatory.

ENGINE SURGES

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Injector nozzles dirty.	1. Remove and clean.	1. Clean by flushing in acetone or MEK and blow out with compressed air.
2. Faulty governor.	2. Replace governor.	2. Solution is self-explanatory.
3. Air in oil lines or wastegate actuator (turbocharged).	3. Bleed system.	3. Engine will usually bleed air out of actuator and control system by running. If this does not work, loosen lines and bleed system.
4. Breather plugged.	4. Remove any obstructions from breather.	4. Solution is self-explanatory.
5. Injector nozzle pressure reference system leaking (turbocharged).	5. Repair leak.	5. Check all hose connections, "O" rings, tubing and hoses for breaks or loose connections.
6. Incorrect propeller governor.	6. Replace governor.	6. *NOTE:* Check Part Number of governor to be sure that a worn governor was not installed.
7. Defective oil pump.	7. Repair or replace oil pump.	7. Erratic oil pressure may be traced to the fact that pump may be sucking air. On TIO and TIGO-541 engines inspect "O" rings on inlet and outlet of pump, also high pressure oil relief at pump may be defective.

ENGINE SURGES (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
7. Defective oil pump. (Cont.)	7. Repair or replace oil pump. (Cont.)	7. (Cont.) *NOTE:* To remove oil pump from 541 engines, the sump must be removed.
8. Propeller blades sticking in hub intermittently.	8. Remove and overhaul propeller.	8. Check for propeller blade movement and sticking. Check stops and angle on blades when against flat pitch stops.
9. Carburetor too rich.	9. Repair or replace carburetor.	9. Solution is self-explanatory.
10. Wastegate binding intermittently.	10. Free wastegate butterfly with a corrosion penetrant or replace same.	10. *NOTE:* Use a wrench to move butterfly from full open to full closed to determine if shaft binding is occurring.

FAILURE OF ENGINE TO DEVELOP RATED POWER

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Leaks in induction system and exhaust system (turbocharged).	1. Tighten all plugs and clamps and replace any defective parts.	1. Solution is self-explanatory. *NOTE;* This condition is more noticeable at altitude.
2. Improper fuel flow.	2. Check screen and gage, and replace injector, if necessary.	2. Remove screens and flush out dirt. Disconnect gage and install master to determine accuracy of aircraft instrument.
3. Restriction in air inlet or manifold.	3. Check and clean or repair as necessary.	3. *NOTE:* Always make sure air filters are kept clean and there are no breaks in ducting to allow foreign material or heated air from nacelle to enter induction system.
4. Improper fuel.	4. Drain tanks and refill with recommended octane fuel.	4. *NOTE:* Never use a lower than recommended grade of fuel. Consult latest revision of Service Instruction No. 1070.
5. Controllers out of adjustment (turbocharged).	5. Adjust same.	5. Variable absolute controller is adjusted by turning adjustment screw at cam end of controller counterclockwise to increase boost, and clockwise to decrease boost. Controllers are set to obtain a specific manifold pressure and no compensation for density and temperature is necessary. Required manifold pressure settings will be found in Operator's Manual. Adjust for full throttle setting only. Density controllers do compensate for temperature and pressure and require special equipment to adjust. The latest revision of Service Instruction No. 1187 sets forth procedures and required equipment for adjusting density controllers in the field. Differential pressure controllers are set to maintain 6 in. differential between deck and manifold pressure, special equipment is required for adjustment. *NOTE:* This is not normally adjustable in the field.

FAILURE OF ENGINE TO DEVELOP RATED POWER (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
6. Damaged turbocharger impeller, binding or tight turbocharger wheels (turbocharged)	6. Visually inspect for damage and check for free rotation of turbocharger. Disassemble and clean, if necessary.	6. *NOTE:* If turbocharger wheel is damaged or tips of blades are missing, turbocharger must be replaced. Because this condition will cause turbocharger to become unbalanced and severely wear the bearings causing complete turbocharger failure.
7. Throttle lever not properly adjusted.	7. Check and adjust, as necessary.	7. Solution is self-explanatory.
8. Excessive dirt build-up in compressor housing or on compressor wheel (turbocharged).	8. Inspect and clean.	8. Solution is self-explanatory. *NOTE:* Excessive dirt build-up on compressor wheel may create an out-of-balance condition and accelerate bearing wear.
9. Kinked or restricted oil lines from engine to actuator, and actuator to controller.	9. Remove and inspect or replace, as necessary.	9. Solution is self-explanatory.
10. Wastegate out of adjustment (turbocharged).	10. Adjust same to correct open and closed limits.	10. The wastegate is adjusted to full closed position first, then full open. To adjust full closed, cap off outlet of actuator and apply 50 to 60 lbs. oil pressure to inlet. When oil pressure closes wastegate, measure clearance between butterfly and housing. If adjustment is improper, disconnect linkage and lengthen or shorten as required. After full closed adjustment is correct, set full open by disconnecting oil supply and allowing spring in actuator to open wastegate. Again, measure clearance between butterfly and housing. If adjustment is improper, loosen jam nut at end of cylinder and turn adjustment rod in or out as required to obtain proper full open setting, then retighten jam nut.
11. Inlet orifice in actuator plugged (turbocharged).	11. Remove inlet line at actuator and clean orifice.	11. *NOTE:* If orifice is plugged tight, it may be necessary to remove cylinder from actuator in order to be able to clean orifice.
12. Wastegate stuck open (turbocharged).	12. Remove actuator and loosen wastegate butterfly.	12. Wastegate butterfly may be freed by removing from engine, and using a wrench on the butterfly shaft. Rotate back and forth until all corrosion is removed and butterfly moves freely. This operation may be aided by using a corrosion penetrant to help loosen butterfly. One penetrant used by some people in the field is mouse milk, manufactured by Worldwide Aircraft Filter Corp., 1685 Abram Ct., San Leandro CA 94577. This penetrant could be used at each 25-hour inspection as a preventative measure. A little at each end of the shaft may help keep shaft from binding.

FAILURE OF ENGINE TO DEVELOP RATED POWER (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
13. Piston seal in wastegate actuator leaking. Noted by excess oil coming out of drain (turbocharged).	13. Disassemble, clean cylinder, and replace seal, or replace wastegate actuator assembly.	13. *NOTE:* Any time wastegate actuator is disassembled or parts are replaced, the full open and full closed positions of the butterfly should be checked and reset, if necessary. (Reset according to item #10 of this section.)
14. Oil pressure too low to close wastegate (turbocharged).	14. Adjust oil pressure to at least minimum low limit in manual.	14. Check to make sure that the proper oil pressure relief spring is in engine and that it is not broken, or that relief valve ball does not have any dirt under it causing the low oil pressure.
15. Injector and controller linkage not adjusted properly (541 series engine).	15. Adjust as per latest revision to Service Instruction No. 1211 to get full travel on both controller and injector.	15. Procedures set forth in the latest revision of Service Instruction No. 1211 include the use of two special tools, ST-318 and ST-319, to position the cross shaft and establish the clearance settings at full throttle and idle when making linkage adjustments. These step-by-step procedures should be followed to insure accurate linkage adjustment.
16. Broken baffles in muffler (normally aspirated engines).	16. Remove from engine and replace muffler system.	16. *NOTE:* If section of baffle is loose in muffler, engine may operate satisfactory at times and may be low on power at other times. This indicates baffle is moving around in muffler, blocking exhaust gases at times and at other times allowing an unrestricted flow of exhaust.
17. Poor combustion.	17. Do a differential compression check and borescope inspection to locate excessively leaking valves, valve guides or rings and to locate any broken rings.	17. Do a top overhaul to correct this problem.
18. Butterfly in wastegate is warped.	18. Replace wastegate.	18. Solution is self-explanatory.
19. Crankshaft to camshaft timing incorrect.	19. Remove accessory housing and correct timing.	19. This condition may be checked by first disconnecting starter, remove top spark plugs and rocker box cover on #2 cylinder. Turn engine to T.D.C. on compression stroke on #1 cylinder, observe that when piston in #1 cylinder goes over T.D.C. on compression the intake valve in #2 cylinder is just starting to open and the exhaust valve is just closing. If this condition does not exist, the crankshaft to camshaft timing is off. *NOTE:* On engines with fixed pitch propellers the engine probably will not turn static R.P.M. On engines with constant speed propellers the engine will probably turn up static R.P.M. but manifold pressure will be a little low.

LOSS OF POWER GOING TO ALTITUDE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Leak in turbocharger system.	1. Check all clamps and bolts on induction and exhaust system. *NOTE:* Make sure alternate air door closes completely, and suck-open door is properly adjust and gasket is not damaged.	1. Observe that all clamps are tight on turbocharger induction and exhaust system. Inspect all gaskets and "O" rings on intake pipes to be sure they are in place and properly seated. Check for cracks on both intake and exhaust system. Green stain on induction system indicates induction leak. White stains on exhaust system indicates an exhaust leak. Make sure that all nuts on exhaust stacks are tight and that no exhaust gaskets are burned out.
2. Density controller does not follow curve to altitude.	2. Replace controller.	2. To check density controller, disconnect differential controller from system and block oil lines. Fly aircraft to altitude and observe that you get a steady rise in manifold pressure not to exceed airframe manufacturer's limits. If no rise is indicated, density controller must be replaced. *NOTE:* Exercise extreme caution as there will be severely staggered throttles at part throttle conditions.
3. Oil line to actuator inlet kinked or blocked.	3. Remove line. Clean or replace and eliminate kinked condition.	3. Solution is self-explanatory.
4. Actuator piston seal failed and leaking excessively.	4. Disassemble, clean cylinder, and replace seal.	4. *NOTE:* Any time wastegate actuator is disassembled you must check the full closed and full open positions of the wastegate. If adjustment is necessary, always adjust full closed first then full open. (Never plug the wastegate actuator drain as it may cause a hydraulic lock.)
5. Differential controller poppet valve leaking.	5. Replace differential controller.	5. Apply 80 psi oil to inlet port of differential controller, only minute drainage should be observed at drain port. If excessive, oil is observed at drain port, this indicates controller valve is leaking oil at all times and must be replaced.
6. Poor combustion.	6. Do a differential compression check and borescope inspection to locate excessively leaking valves, valve guides or rings and to locate any broken rings.	6. Do a top overhaul to correct this problem.
7. Binding turbocharger.	7. Overhaul or replace turbocharger.	7. Solution is self-explanatory.
8. Lean injector.	8. Replace injector or recalibrate or overhaul at approved facility.	8. Solution is self-explanatory.
9. Differential pressure controller lines hooked up improperly.	9. Attach controller sensing lines to proper locations.	9. One side of differential controller diaphragm senses deck pressure and the other side senses manifold pressure.

CANNOT REACH SPECIFIED CRITICAL ALTITUDE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Dirty induction air filter.	1. Replace same.	1. *NOTE;* Also check for any type of blockage in induction system.
2. Damaged compressor or turbine wheel (turbocharged).	2. Replace or overhaul turbocharger. *NOTE:* Determine reason for damage and eliminate.	2. Visually inspect to see if the turbine or compressor wheels are damaged or tips of blades are missing. If this has happened, turbocharger replacement is necessary because this damage causes a severe out-of-balance condition which will rapidly wear out the turbocharger bearings.
3. Wastegate does not go to full closed position (turbocharged).	3. Adjust for full travel. If butterfly is sticking, work free and apply corrosion penetrant. If actuator seal is leaking, disassemble, clean cylinder and replace seal.	3. When setting closed and open positions, always set full closed position first, then full open. The procedure for checking full closed position is to cap off actuator discharge, apply 60-65 lbs. oil pressure to inlet. When wastegate closes, measure clearance between butterfly and housing. If adjustment is necessary, disconnect linkage and lengthen or shorten as required. To check full open, release oil pressure and allow wastegate to open full and measure clearance between butterfly and housing. If adjustment is necessary, loosen jam nut at top of cylinder and turn adjustment in or out as required. Retighten jam nut. If butterfly is sticking, loosen by manually moving back and forth until free, the lubricate with a corrosion penetrant like mouse milk, manufactured and sold by Worldwide Aircraft Filter Corporation, 1685 Abram Ct., San Leandro, CA. It may also be used as a preventative by applying to butterfly shaft at 25 hour inspections. If actuator cylinder is leaking, disassemble, clean cylinder and replace seal. If any parts are replaced, check open and closed limits as described above.
4. Bad bearings in turbocharger.	4. Replace or overhaul turbocharger. *NOTE:* Spin turbine by hand to check for free rotation	4. Check radial and axial bearing limits, as per AiResearch Turbocharger Manual.
5. Suck-open door on compressor discharge housing not fully closed or door gasket damaged (TIO-540 engines).	5. Adjust magnet so door closes properly. Replace gasket.	5. Observe that no physical damage has occurred to door and no foreign material is lodged between door and gaskets.
6. Faulty controller.	6. Repair or replace.	6. Absolute Variable. If engine loses power, consider leaking poppet valve or oil leaking into induction system because of broken boot bellows. Remove controller and check for oil in induction housing. In either case, controller will have to be replaced.

CANNOT REACH SPECIFIED CRITICAL ALTITUDE (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
6. Faulty controller. (Cont.)	6. Repair or replace. (Cont.)	6. (Cont.) Density Controller. Check as per solution #2 under "Loss of Power Going to Altitude". Differential Controller. Apply 80 psi oil to inlet port. Observe that only minute draining occurs at drain port.
7. Improperly adjusted controllers.	7. Adjust same.	7. Absolute Variable. The variable absolute pressure controller is only sensitive to pressure settings so no special equipment is necessary for adjustment. To increase manifold pressure turn adjusting screw at cam end of controller counterclockwise. To decrease manifold pressure, turn adjusting screw clockwise. These adjustments to be made for full throttle power settings only. Manifold pressure settings will be found in Operator's Manual. Density Controller is sensitive to temperature and pressure and does require special equipment to set. Procedures for setting density controllers are set forth in latest revision of Service Instruction No. 1187. Differential Controller. If differential controller is leaking then critical altitude would not be reached. Check by applying 80 psi oil to inlet port and observing that only minute oil is seen at drain port. If excess oil is seen at drain port, controller is leaking at all times and must be replaced.
8. Insufficient oil pressure to close wastegate.	8. Adjust oil pressure to specifications found in Operator's Manual. Check for links or restrictions in actuator supply line.	8. Check to be sure the proper spring is in the oil pressure relief valve and is not broken or that no foreign material is under the relief ball. Eliminate restrictions in actuator supply line and route line to eliminate any kinks.
9. Damage to compressor or turbine wheel.	9. Replace turbocharger.	9. Visually inspect turbocharger wheels for damage such as bent or broken blades, rub marks on compressor or turbocharger housing. If parts of blades are missing, check for excessive bearing wear caused by severe out of balance condition.
10. Leaks in exhaust system.	10. Repair or replace as required.	10. Tighten all clamps and bolts on turbocharger system. Check gaskets for good condition and proper seating. Also inspect for any cracks (may be located by the presence of white stains on exhaust system). Make sure all nuts on exhaust stack flanges are tight and no gaskets are burned out.

CANNOT REACH SPECIFIED CRITICAL ALTITUDE (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
11. Poor combustion.	11. Do a differential compression check and borescope inspection to locate excessively leaking valves, valve guides or rings and to locate any broken rings.	11. Do a top overhaul to correct this problem.

LOW OIL PRESSURE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Insufficient oil.	1. Fill oil sump or tank to proper level.	1. *NOTE:* Make sure you are using the correct grade and weight of oil.
2. Pressure relief out of adjustment.	2. Adjust oil pressure to proper limits.	2. On external adjustable type increase oil pressure by turning adjusting screw clockwise, and to decrease turn counterclockwise. On types with solid tower standard ¼ inch flat washers are used to control oil pressure. Add washers to increase oil pressure and remove washers to decrease oil pressure. On short tower, a maximum of three washers may be used – on a tall tower, a maximum of nine washers may be used.
3. Dirt or metal chips under oil pressure relief valve.	3. Remove, disassemble, and clean.	3. Solution is self-explanatory.
4. Damaged oil pressure relief seat.	4. Replace or repair.	4. On engines with the removable seat, seat may be pulled out and another pressed into place. On engines that have seat machined in the case, repairs must be made by repairing existing seat with Special Tools ST-243, ST-248 and ST-340 that make up the reseating tool assembly. (Refer to latest revision of Service Instruction No. 1172.)
5. High oil temperature.	5. Check all areas that involve lube system and lube oil cooling system.	5. Inspect the following areas for trouble: (a) Proper oil level. (b) Proper grade and weight of oil. (c) Thermostatic bypass valve working properly and seating squarely. (d) Plugged or partially plugged oil cooler lines or oil cooler. (e) Excessive blowby. (f) Air duct to cooler blocked or cooler partially covered. (g) Defective temperature gage.
6. Restriction at inlet side of oil pump.	6. Remove and clean oil suction screen and oil passage to inlet side of oil pump, if necessary.	6. Solution is self-explanatory.
7. Excessive internal spill off of oil.	7. Check the following areas for excessive oil flow and repair or replace. (a) Loose or missing plugs in oil galley. (b) Piston cooling squirts blocked open. *NOTE:* Low oil pressure usually occurs at low or idle RPM. (c) Excessive bearing clearance. (d) Cracked crankcase in area of oil galley.	7. Solution is self-explanatory.

LOW OIL PRESSURE (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
8. Relocating the oil pressure take-off point on the engine.	8. Use only the oil pressure take-off point approved by the engine manufacturer.	8. Solution is self-explanatory.
9. Oil pressure relief seat in crankcase cocked (could be cage type or flat type).	9. Remove and replace seat.	9. Solution is self-explanatory.

HIGH OIL CONSUMPTION

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Improper grade of oil.	1. Consult Operator's Manual for type and weight of oil.	1. *NOTE:* Consult latest revision of Service Instruction No. 1014 for information on approved lubricating oils for Lycoming engines.
2. Failure of new rings to seat properly.	2. Use correct grade of oil and proper operating procedures.	2. On new and rebuilt engines, use mineral oil until consumption stabilizes (usually from 50 to 100 hours) then if desired, change to ashless dispersant oil. On the 541 series of engines, ashless dispersant oil must be used from the beginning. *NOTE:* Consult latest revision of Service Instruction No. 1014 for recommended lubricating oils. For best ring seating, always use full throttle take-off wherever the application applies (the only exception is the gear supercharged engines where take-off power is limited by a specific manifold pressure). Also use a high cruise power setting for break in.
3. Failed or failing bearings.	3. Replace same.	3. Disassemble engine for inspection and replacement or bearings. Prior to disassembly, excessive bearing wear may be determined by the presence of metal in oil suction screen or oil filter.
4. Worn piston rings and/or cylinder barrels.	4. Remove cylinders and deglaze barrels, replace with new piston rings.	4. Prior to disassembly, the condition of the rings may be determined by doing a differential compression check. This is accomplished by rotating the cylinder to be checked to T.D.C. on compression stroke. After insuring that the propeller will not turn, introduce 80 psi air in cylinder and observe how much is retained. Air leaking by rings can be detected by listening at breather entrance for a hissing sound in crankcase indicating air escaping around the rings. For equipment required and procedures, consult latest revision of Service Instruction No. 1191.

HIGH OIL CONSUMPTION (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
5. Worn valve guides.	5. Replace same.	5. Remove cylinders from engine and take out valves. Measure guides and if worn beyond tolerances allowed in the latest revision of Table of Limits, the guides will have to be replaced. Use procedures set forth in applicable Overhaul Manual.
6. Excessive oil leaks.	6. Inspect external of engine for leaks and repair same.	6. Solution is self-explanatory.
7. Oil being siphoned from engine in flight.	7. Insure that oil filler cap is on tight and oil access door closes properly. Also be sure that the breather hose is cut properly and located so there is no change of siphoning oil from engine.	7. Solution is self-explanatory.
8. Expander in oil control ring improperly installed or lost its tension.	8. When using oil control ring with corrugated type expander, make sure ends of expander are butted together not overlapped. When using oil control ring with spiral wound type expander, ring design is such that improper assembly is not likely.	8. Solution is self-explanatory.
9. Oil level too high.	9. Maintain oil at manufacturer's recommended level.	9. Solution is self-explanatory.
10. Oil passing through turbocharger seals.	10. Overhaul or replace turbocharger.	10. *NOTE:* On engines where the lubricating oil to the turbocharger is returned to the crankcase by gravity drain, inspect the crankcase breather line to be sure it is not plugged. If it is, this will cause high crankcase pressure and not allow the oil to return to the crankcase freely and eventually push the oil past the turbocharger seals into the compressor and turbine section of the turbocharger.

HIGH CYLINDER HEAD TEMPERATURE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Spark plugs of improper heat rating installed in engine.	1. Use only approved spark plugs for your engine.	1. *NOTE:* Consult latest revision of Service Instruction No. 1042 for approved spark plugs.
2. Cooling baffles missing, broken or improperly installed.	2. Insure that all baffles are installed properly and not broken.	2. *NOTE:* Never attempt to modify, relocate or eliminate any cooling baffles.
3. Partially plugged fuel nozzles.	3. Clean in methyl-ethyl-ketone or acetone and blow out with compressed air.	3. Solution is self-explanatory.
4. Fuel lines of improper I.D. being used.	4. Fuel line I.D. should be .085-.090 in.	4. *NOTE:* Primer lines have same threaded connections are fuel lines but are of much smaller I.D. *NOTE:* The only exception to this rule is the IO-540-E1B5 used in the Aero Commander 500S. This engine uses primer lines for fuel lines and they are .060 in. I.D.

HIGH CYLINDER HEAD TEMPERATURE (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
5. Engine improperly timed.	5. Check magneto to engine timing and insure that engine is timed to the correct number of degrees B.T.C.	5. *NOTE:* Even though magneto synchronization is correct, if engine is timed at 25° BTC when it should be 20° BTC, engine will run hotter.
6. Engine being operated excessively lean.	6. Check Operator's Manual for minimum fuel flow for various power settings and never go below them.	6. *NOTE:* If this condition is suspected, check combustion chamber for carbon deposits. If there are none, this is sufficient reason to be suspicious of a continuous lean engine operation.
7. Mix control improperly rigged.	7. Rig for complete travel.	7. *NOTE:* Even though mix control lever at pilot seat appears to have full travel, be sure to check at carburetor or injector to insure that mix lever is going against the F.R. (full rich) and I.C.O. (idle cut-off) stops.

SPLIT IN MANIFOLD PRESSURE (Twin Engine)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Propeller blade angle not adjusted properly.	1. Adjust propellers for correct blade angle when against flat pitch stops.	1. Solution is self-explanatory.
2. Controllers out of adjustment (turbocharged).	2. Adjust to proper limits.	2. Variable absolute pressure controller is adjusted to a specific manifold pressure as found in Operator's Manual with no compensation for temperature. Density controllers are adjusted as per latest revision of Service Instruction No. 1187. Where procedures and equipment requirements are set forth on density controlled engines, some split in manifold pressure may have to be accepted because of variations in turbocharger efficiency. *NOTE:* Both controllers are adjusted for full throttle setting condition only.
3. Excessively dirty air filter.	3. Replace with new filter.	3. *NOTE:* Problem may be more noticeable when aircraft is flown to altitude because of the decrease in air density.
4. Alternate air door leaking.	4. Replace door or adjust for complete closing	4. *NOTE:* Although door may appear to close completely on the ground, it may be opening slightly in flight due to vibration or air currents. To determine if this is happening, tape alternate air door shut and fly aircraft to altitude and observe manifold pressure.
5. Incorrect hydraulic lifters or hydraulic lifters bleeding down too rapidly.	5. Replace hydraulic lifters.	5. *NOTE:* On turbocharged engines manifold pressures will come back together when manifold pressure gets above 30 in.

SPLIT IN MANIFOLD PRESSURE (Twin Engine) (CONT.)

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
6. Restriction in airframe or engine induction system.	6. Inspect and remove restriction.	6. Solution is self-explanatory.
7. Leaks in airframe or engine induction system.	7. Inspect and repair leaks.	7. Solution is self-explanatory.

HIGH OIL TEMPERATURE

CAUSE	SOLUTION	PROCEDURE FOR SOUTION
1. Insufficient oil supply.	1. Check oil at regular intervals and maintain proper level.	1. Solution is self-explanatory.
2. Insufficient cooling air.	2. Check air inlet and outlet to cooler and replace or repair parts and ducting as required.	2. Solution is self-explanatory.
3. Improper grade of oil.	3. Use only grade and weight of oil specified for engine.	3. *NOTE:* Consult latest revision of Service Instruction No. 1014 for proper grades and weight of oils used in Lycoming engines.
4. Oil cooler or lines plugged or partially plugged.	4. Remove cooler and lines and flush out.	4. Solution is self-explanatory.
5. Thermostatic bypass valve not operating properly or seating squarely.	5. Replace thermostatic bypass valve.	5. *NOTE:* If valve is not seating properly, the filter base may have to be replaced.
6. Excessive blow by.	6. (Do a top overhaul.) This condition usually caused by worn or stuck rings.	6. *NOTE:* To locate exactly where the blow by is originating from , do a differential compression check as described in latest revision of Service Instruction No. 1191.
7. Defective temperature gage.	7. Replace same.	7. Solution is self-explanatory.

HIGH MANIFOLD PRESSURE AT IDLE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Improperly adjusted fuel injector or carburetor.	1. Adjust idle mixture to get a 25 to 50 RPM rise when moving mixture control from full rich to idle cut-off.	1. *NOTE:* Speed may have to be adjusted also.
2. Incorrect hydraulic lifters installed.	2. Replace with correct part number lifters.	2. Solution is self-explanatory.
3. Hydraulic lifters bleeding down too rapidly.	3. Replace with new hydraulic lifters.	3. *NOTE:* Any time hydraulic lifters are removed from an engine for cleaning and inspection be sure to keep the cylinder and plunger together as an assembly. If they become separated, do not just arbitrarily assemble any body and plunger together because you may change the leak-down rate. On twin engine installations, a split in manifold pressure will be noticed during acceleration.
4. Air leak in induction system.	4. Check induction system and repair leak.	4. *NOTE:* Engine will be rough at idle.

HIGH OIL PRESSURE

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Oil pressure improperly adjusted.	1. Adjust to within minimum and maximum range as found in Operator's Manual.	1. On external adjustable type oil pressure relief adjustment, turn adjustment counterclockwise to decrease oil pressure. On engines using the pressure relief that is not externally adjustable, remove the pressure relief valve from the engine and take out washers from behind spring.
2. Improper weight of oil.	2. Use the suggested weight of oil for the ambient temperature in which the engine is being operated.	2. Consult latest revision of Service Instruction No. 1014 for lubricating oil recommendations.
3. Oil passage from pressure relief valve to sump plugged.	3. Remove blockage from oil passage.	3. Remove pressure relief from engine and run a soft copper wire down through oil passage to sump; if blockage is found, remove same. *NOTE:* If blockage persists, sump may have to be removed to clear passage.
4. Incorrect pressure relief spring being used.	4. Replace with correct pressure relief spring.	4. Solution is self-explanatory.
5. Relocating the oil pressure take-off point on the engine.	5. Use only the oil pressure take-off point on engine approved by manufacturer.	5. *NOTE:* If the oil pressure take-off point on the engine is moved closer to oil pump discharge, a rise in oil pressure will be noted.
6. Oil temperature too cold.	6. Allow oil temperature to increase before increasing throttle.	6. Solution is self-explanatory.

MANIFOLD PRESSURE FLUCTUATES

CAUSE	SOLUTION	PROCEDURE FOR SOLUTION
1. Wastegate sticks intermittently.	1. Free wastegate by turning it with a wrench at the butterfly and apply a corrosion penetrant. (Replace wastegate if necessary.)	1. Solution is self-explanatory.
2. Oil sump baffle modification required. Models affected, TIO-540-A, -S1AD, -T2AD, -AA1B5, -AE2A; (L)TIO-540-F2BD, -J, -N2BD, -R2AD, -U2A.	2. For information concerning this problem, consult latest revision of Service Instruction No. 1279.	2. Step-by-step procedures found in latest revision of Service Instruction No. 1279.
3. Oil in fitting on differential pressure controller not restricted. Models affected, TIO-540-A, -F, -J; LTIO-540-F, -J	3. Replace with oil in fitting having .075 in. restriction.	3. Solution is self-explanatory.
4. Linkage from fuel injector to controller not rigged properly. (TIO and TIGO-541 series engines only.)	4. Procedures for properly rigging linkage is found in latest revision of Service Instruction No. 1211.	4. Solution is self-explanatory.

APPENDIX I

TROUBLE-SHOOTING THE BENDIX RSA FUEL INJECTOR

There are some sections of the Bendix fuel injector that a mechanic may not work on in the field, such as the regulator section which consists of the air and fuel diaphragm and associated parts. Any modification of the regulator section by a mechanic without the use of a flow bench could result in a change in fuel flow through the injector. However, there are some things that a mechanic may do that will not affect the operation of the fuel injector.

In the following paragraphs we would like to discuss some of the things that a mechanic can do, and some procedures a mechanic can use to determine if the problem is in the fuel injector or an associated part, i.e. – flow divider, fuel nozzles, fuel lines, etc.

Whenever a fuel injector problem arises, the first thing a mechanic should do before he removes the injector or any part of it, is to make sure the rigging is correct, and that the throttle and mixture controls are both traveling to their full open and full closed stops; and make sure there are no fuel leaks. Another important item to consider is – Do you get a rise of 25 to 50 RPM at idle when the mixture control is moved from full rich to idle cut-off? If you are experiencing poor acceleration of the engine, this may be the problem. To adjust the idle mixture, turn the scalloped wheel at the side of the injector either rich or lean, as required, until the desired rise in RPM is reached. When adjusting the idle mixture, you will have to adjust the idle RPM too. A good idle RPM is around 600 to 650 RPM.

We would like to make everyone aware that there is a filter screen at the fuel inlet to the injector. This screen should be removed and cleaned at 100 hour inspection. Some cleaning solvents that can be used are methyl-ethyl-ketone or acetone. It is also permissible to use a sonic cleaner. After the screen has been cleaned, blow it out with compressed air. When removing the screen from the fuel injector, always take it from the same side of the injector to which the fuel line is attached. This is to prevent depositing any dirt back in the fuel injector that might have bee picked up in the screen. On early injectors, the screen is attached to the inlet adapter, so it can only be removed from that side. On later model injectors the screen is spring loaded to provide a fuel bypass in case it becomes plugged. This type of screen can be removed from either side.

If you are experiencing a rough shut-down and the engine does not want to quit when the mixture control is retarded, it may be because there is a score on either the mixture control jet or rotating plate, or a bad “O” ring on the jet. Prior to disassembly of the fuel injector, a test can be run to see if this is the problem area. Disconnect the fuel line coming out of the fuel injector and leave the fitting open. Pull the mixture control and throttle all the way back (off) and turn on the booster pump. If any fuel is observed coming out of the open fitting, there is a score on the mixture control jet, or rotating plate, or the “O” ring is damaged or deformed. The repair is to remove the mixture control assembly and eliminate the scores by lapping the mixture control jet and rotating plate on a good lap plate using a mild abrasive. The final repair should be done by lapping the jet and plate together, using Bon-Ami or equivalent type abrasive. After this is accomplished, clean and reassemble the parts using a new “O” ring each time.

If no fuel is observed coming out of the open fitting on the injector when the test is performed, the mixture control assembly is working correctly and other causes should be looked at. Some things to consider are the fuel injector nozzles. If the air bleed hole becomes plugged, the engine will not shut down smoothly. On normally aspirated engines, there is a screen covering the air bleed hole which makes a visual inspection impossible. Therefore, you must remove the nozzles from the engine and clean them thoroughly and blow them out with compressed air. If this does not solve the problem, then there may be a nozzle that is improperly assembled, or the only other solution is to replace the nozzles.

On turbocharged engines, the air bleed hole is shrouded and vented back to the compressor discharge pressure “deck pressure”. Inspect these lines and fittings to make sure they are free of dirt, leaks or obstructions. After the shroud is removed from the nozzle, it can be removed from the cylinder, cleaned thoroughly and blown out with compressed air.

NOTE

When any nozzle that is installed horizontally is reassembled into a cylinder, make sure that the letter “A” that is stamped on the hex portion of the nozzle is pointing down; this positions the air bleed hole up, and the correct torque valve is applied at 60 in.-lbs.

Another area to consider would be an internal leak in the fuel injector body seal. All of the fuel that is delivered to the engine should go through the individual fuel lines to the nozzles and on into the combustion chamber. If there is an internal leak in the injector, there will also be fuel entering the injector at the throat, and going to the cylinder much like a carbureted engine. If a center body seal is suspected of leaking, there is a brief test that can be run. First, remove enough of the induction system to enable one to see the impact tubes on the fuel injector. Then disconnect the fuel line from the fuel injector to the flow divider and cap off the fitting in the fuel injector. Move the controls to the full throttle and full rich position and turn on the booster pump. If any fuel is observed coming out of the impact tubes of the injector, this indicates that there is a center body seal leaking. Since this is part of the regulator system the mechanic may not make the necessary repairs, but must remove the injector from the engine and send it to an overhaul facility for reconditioning and recalibration.

In addition to a rough shut-down, the engine may display some other symptoms that may indicate that there is a center body seal leak. Some of these indicators are:

The engine is rich at idle and low power settings, or the pilot has to retard the mixture control upon flare-out and landing to prevent the engine from becoming too rich and stopping, or if the mechanic has to adjust the idle mixture lean every few days or weeks because it has drifted rich. Each of these symptoms indicates a drift to the rich side and may be a warning of an internal leak in the injector.

Another area where problems may be encountered in the fuel injector is the possibility of scores on the main meter jet and rotating plate assembly. Any scores in this area may be removed by lapping the main meter jet and rotating plate on a good lap plate using a mild abrasive. The final repair should be made by lapping the jet and plate together. When all scores are removed, clean thoroughly and reassemble the injector. Any indication that the main meter jet is scored would be a rich idle mixture, and by adjusting the mixture control lean, the mechanic could get a satisfactory idle, but when the engine was accelerated, it would stumble and not accelerate smoothly.

If there is any occasion when the fuel injector idle mixture adjusting wheel has been turned to its limit, either rich or lean, and the idle is not satisfactory, the linkage between the air valve and the fuel valve on the injector may be removed and the idle mixture adjusting wheel positioned back to the center of its travel. Prior to removing the linkage from the injector, measure the overall length of the linkage. This must be the same after repositioning the wheel back on center as it was before removing it from the injector. After the length of the linkage has been established, adjust the wheel back to center of travel by backing one end of the linkage assembly out half the distance and adjusting the other end of the linkage in until you have the same overall length you had prior to removing it from the injector. After the linkage is adjusted, assemble the injector, making sure to install the pins, wave washers and cotter keys correctly.

Other items in the fuel injection system that could be a source of trouble are the flow divider, fuel lines and injector nozzles. If you suspect that the flow divider valve is sticking, remove the flow divider from the engine and disassemble it. The valve can be freed by polishing the valve and bore together using a mild abrasive. Do not interchange flow divider parts because they are a matched assembly. After the valve is operating freely, clean thoroughly and reassemble the flow divider.

NOTE

Also reference the latest revision of Lycoming Service Bulletin No. 382 or Bendix Bulletin No. RS43 for latest modification to flow dividers.

If the fuel flow gage suddenly shows an increase in flow, the first thing to do is check for a plugged or partially plugged fuel nozzle. The procedure for doing this is as follows:

Disconnect the fuel lines and remove the nozzles from the cylinders. Then attach the nozzles to the fuel lines and direct the nozzles into bottles of equal size. Baby food or coke bottles work very well. Move the throttle and mixture controls full forward and turn on the booster pump. Fill the bottles approximately one-half full. Turn off the booster pump and retard the throttle and mixture. Remove the bottles from the engine and set them on a table or other flat surface. A visual check of the fuel contents in the bottles will tell you which nozzle is plugged.

NOTE

While flowing fuel into the bottles, check each nozzle to make sure all of the fuel is coming out of the discharger end of the nozzle in a solid stream approximately the size of the lead in a mechanical pencil and not some fuel coming out of the air bleed hole.

After locating the plugged nozzle, it can be cleaned in methyl-ethyl-ketone or acetone and blown out with compressed air. If a thorough cleaning fails to remove the dirt, the nozzle will have to be replaced. Prior to replacing the nozzle, check the fuel line to be sure that a primer line is being used for a fuel line. Primer lines are smaller on the inside diameter, and will give a false reading on the fuel flow gage. Also check the flow divider for obstructions.

NOTE

When cleaning fuel nozzles, fuel lines or flow dividers, never use a small drill or a piece of wire.

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REALIZING THE WEALTH OF INFORMATION IN THE FIELD, WE WELCOME ANY AND ALL COMMENTS AND ADDITIONS TO THIS GUIDE. THIS BOOKLET IS MADE TO HELP ALL SERVICE PERSONNEL AND MECHANICS. THE MORE COMPLETE WE MAKE IT, THE MORE HELPFUL IT WILL BE. WE LOOK FORWARD TO HEARING FROM YOU AND HOPE TO MAKE ANY LATER EDITION BIGGER AND BETTER. PLEASE ADDRESS YOUR COMMENTS TO:

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